

Genomic Visions:
Nature, Biotechnology, and Sexual Difference

by

Stephen R. Garlick

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Prof. Patricia Ticineto Clough

Date

Chair of Examining Committee

Prof. Philip Kasinitz

Date

Executive Officer

Prof. Patricia Ticineto Clough

Prof. Barbara Katz Rothman

Prof. Stanley Aronowitz

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

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Advisor: Patricia Ticineto Clough

With the advent of high-profile biotechnology projects such as the Human Genome Project (HGP), genetic science promises to reshape the ways in which we think about the relationship between nature and society. While critical attention has to date mostly been focused on issues associated with race, in this dissertation I examine the relationship between genomic science, biotechnology, and the concepts of sex and gender. My research draws together several bodies of work that have until now had little contact. Most notably, on the one hand, feminist critiques that tend to view scientific institutions and technological practices as identifiably masculine, and, on the other hand, science and technology studies that emphasize the disunity of technoscientific cultures. I argue that these two approaches can be reconciled by theorizing both science and gender as technological modes of desire that seek to establish a common set of relations to the natural world. In substantiating this claim, the dissertation presents a historical study of the relations between sex, gender, and genetic science from the eighteenth century up to the present day. Most notably, I suggest that early photographic practices provide a useful model by which to theorize the technological character of both gender and genomics. By drawing

out a crucial tension in biological thought between meaning and information in relation to 'sex', I show how the HGP and associated biotechnologies promote an ambivalent cultural shift away from meaningful, organic bodies, and towards virtual, bioinformatic bodies. I suggest that a critical examination of new biotechnologies such as cloning allows us to recognize that the exaggerated public image of genomics is actually a conservative force, which obscures the potential for rethinking the nature of sexual difference contained within the history of genetic science. Ultimately, my argument is that both biological technoscience and gender respond to one of the central problematics of modernity – the need to reconcile control over nature with the desire to submit to the ultimate authority of that same nature.

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Introduction: The Politics of Gender and Science

The power to define what counts as technical or as political is very much at the heart of technoscience (Haraway, 1997:89).

When the Human Genome Project (HGP) began in the early 1990s, science was widely perceived to be under attack from a loose coalition of feminists, postmodernists, and other left-wing cultural critics who were increasingly challenging the 'disinterested' objectivity of scientific knowledge. By the time that the HGP was concluded in 2003, however, it had become possible to argue that science was equally, if not more so, under attack from conservative, right-wing critics. Moreover, it might well be suggested that the HGP itself, alongside associated developments in biotechnology, is in part responsible for this changing political landscape. There is a certain ambiguity associated with the production of genomic knowledge, which makes it difficult to situate politically. On the one hand, the HGP represents a reaffirmation of the influence of nature in our lives; its immense power now more securely located at the molecular level, waiting only to be decoded and unlocked. Yet, on the other hand, the seemingly rapid, dizzying progress of biotechnologies in reconfiguring the basic elements of life threatens to undermine any meaningful sense of nature as a presocial legislator of human existence.

A tension is thereby produced; an ambiguous space is generated between the natural, the technological, and the social. The HGP serves as our preliminary marker of this space, which is also increasingly drawn into the circuits of global capital, thus intensifying both the effects of technoscience and our need to critically engage with it. While the new genomics may have started out with the implicit promise of providing *the* explanation of both human sameness and the source of differences between people, its results are altogether more ambiguous for the politics of social relations. In this dissertation, I attempt to plumb the depths of this ambiguity, and to consider some of the implications that

contemporary genomics and biotechnology hold for social life and the politics of science.

One important area of ongoing political debate is the relation of science to sexual differences and gender categories. The recent controversy over public comments made by Lawrence Summers, then president of Harvard University, concerning differences between men and women and how they may relate to the production of scientific knowledge is only the latest incident in a long-standing area of contention. The terms of this debate have largely been set within a framework that presumes an ontological separation between the natural and the social — with sexual difference cast on the side of nature, and as opposed to the social institutions that shape and restrict entry to the practice of science. My interest, by contrast, is in raising questions concerning the co-implication of gender and science. On the one hand, I ask what role sex and gender concepts play in shaping our very understanding of what 'science' is. In what ways is biological science inextricably bound up with certain social and technological understandings of nature from the outset? On the other hand, this is not merely a situation in which society influences science. Insofar as scientific practices, productions, and representations necessarily inform and delimit our understandings of natural, social, and cultural life, contemporary genomics provokes a reexamination of many sociological categories. The identification of genomic patterns specific to particular ethnic groups has increased the potential for a renewed scientific form of racism, and social critics have identified 'race' as a key point of contention within the new genetics. Given the close association of genetics with eugenic practices in the past, there is obvious potential for racial

inequalities to become further entrenched. Similarly, issues of access to biotech innovations, and of the neglect of environmental causes of disease, have led many to detect socioeconomic bias in the way that capital and federal funding have shifted to genomics, with deleterious effects for the poor as a result.

Without minimizing such issues, in this dissertation I suggest that critical reflection on 'sex' — a concept that always seems ambiguously situated between being and doing — is equally crucial to understanding the significance of today's biotechnologies for the future. Indeed, from one perspective, it may be said that genetic science is all about sex. Even when it is not foregrounded, the key concept of heredity — i.e. the transmission of genetic material — places sex (again, in the double sense of ontology and action) at the center of genetics. It may be that sex is difficult to think about in relation to contemporary genomics precisely because it is so central to the conceptual foundation of the discipline. Yet, at minimum, it can be noted that a presumption of reproductive sexual difference has generally underlain modern biology, just as it has been central to many hegemonic forms of modern social organization. Sex mediates nature and society. It is arguably the central component of self-identity, and also often represents our most immediate connection to nature. Furthermore, the meaning of 'sex', alongside associated issues concerning the propriety of different sexual relationships, is increasingly at issue in public moral discourses (gay marriage being the most prominent recent example), and it may be that anxiety over developments in biotechnology, with its potential to re-engineer the fabric of life, is a little-acknowledged factor in these debates.

In this light, it is apposite to raise questions over the fate of sexual difference in the context of the new genomics, and to enquire whether 'sex' remains the same throughout its articulation with biotechnology. Is the genomic body gendered in the same way as the organic body of modern biology? My interest is in asking to what extent has a particular discourse of 'natural' (hetero)sexual difference informed the emergence and development of genetic science and, in turn, whether the latter is currently reshaping our understandings of sex, nature, and the relations between biological, technological, and sociological dimensions of life. As a prolegomenon to this task, this introductory chapter sketches out two divergent tendencies within social and cultural studies of science in order to consider the potential that some form of synthesis may hold for a better understanding of the relations between sex, gender, technology, and scientific knowledge. My goal is to identify a path which may perhaps lead us in the direction of a more fruitful engagement with the forces and affects of biological technoscience, and towards a renewed social criticism of scientific knowledge.

The Gender of Science and Technology

Feminist-inspired sociological research centering upon the conjunction of sexual difference and science has mainly focused on the influence of cultural ideas about gender on scientific institutions, practices, and representations. Research into the relationships that hold between gender and science has been steadily accumulating ever since a number of key works were published in the mid-1980s (Bleier, 1984; Keller, 1985; Fausto-Sterling, 1985; Harding, 1986).

The past ten years, in particular, has seen the consolidation of this field with the publication of numerous edited collections on the topic (Keller & Longino, 1996; Laslett, 1996; Kohlstedt & Longino, 1997; Kourany, 2002).

In summarizing this body of work, we can identify three central areas of concern. First, there is the question of who produces scientific knowledge. Here attention has been directed to the ways in which educational institutions and other gatekeepers have restricted women's access to positions of power within the scientific field. As a response to male dominance in the production of scientific knowledge, a number of feminist theorists have developed influential alternative approaches such as 'critical contextual empiricism' (Longino, 1990), feminist standpoint theory (Harding, 1991), and 'situated knowledges' (Haraway, 1991). All these theories contend that knowledge or objectivity depends upon the perspective given from a particular social position.

A second focus concerns the question of whether modern Western science, particularly in regard to its conflation of scientific method and mathematical rationality, and to its overriding goal of dominating and controlling nature, has been shaped by a masculinist ideology from the outset. Many scholars trace the connection between masculinity and science back to the emergence of modern science in the period of the Enlightenment (Jordanova, 1989; Schiebinger, 1993). These studies document the dominance of men in science, but also focus on the language of science and the metaphors of domination over nature as characterized in feminine terms. They suggest that culturally prevalent ideas about sexual differences influenced the formation of scientific method and

practice. The implication is that what we characteristically take to be scientific vision, with its reliance on the oppositions of subject/object and mind/body, may be informed by gendered discourses, and the question of the extent to which contemporary science may be understood in masculine terms is a key one for my study.

Finally, the third area of concern encompasses the ways in which scientists have explicitly studied sexual differences in nature, especially with regard to the characterizations of women that such studies produce. A good example here is a recent series of texts that all deal with neuroendocrinology and the belief that prenatal 'sex hormones' explain gendered behaviors (Oudshoorn, 1994; van den Wijngaard, 1997; Fausto-Sterling, 2000). These studies reveal the way in which cultural ideas about gender come to be incorporated into the everyday workings of scientific practice and thereby shape what is supposedly merely 'found' in nature. Such research is important in that it points to the sort of circular relationship that can become established between gender and biological science. Not only do ideas about gender inform scientific technologies and practice, the latter also contributes to the constitution of what we take to be sexual differences.

Recent years have also seen a significant body of research that either extends questions concerning gender and science to encompass technology, or focuses specifically on the gender-technology relation itself (Grint & Gill, 1995; Treichler, Cartwright & Penley, 1998; Hopkins, 1999). Much of the early work in this area focused on the gender politics that typically surround the incorporation of new technologies into the workplace. Domestic technologies, and questions

concerning whether they do indeed benefit women, have also been important, with feminist critics often tracing these issues back to a process of gendering that informs the design process itself (Cockburn & Ormrod, 1993). More recently, there has been a move to consider the impact of information technologies on women's work as part of a general shift towards issues generated by computer culture and the Internet (Green & Adam, 2001). The majority of this work, however, tends to presume that the two terms of the gender-technology relation belong to independent and autonomous categories of existence, which only later enter into interactions with each other.

A more pertinent area of research falling under the rubric of gender and technology studies concerns biomedical technologies. Focusing especially on reproductive technologies, feminist critics have often charged such interventions with perpetuating a patriarchal ideology that legitimates men's power over women's bodies. Particularly important here have been critical evaluations of the role that ultrasound fetal images and other visual technologies have played in antiabortion politics (Petchesky, 1987). This remains relevant given that prenatal genetic screening is currently one of the main applications of genomic science. More recently, Lisa Cartwright's (1995) work on the history of X-ray images and scientific cinematography in medicine has sought to demonstrate the ways in which scientific vision is culturally dependent, and that scientific knowledge itself changes along with changes in technology.

As with feminist studies of science, gender and technology theorists frequently allege that technology itself is inherently masculine because it is shaped

by male power and interests (Wajcman, 1991). Ruth Oldenziel (1999), for example, argues that the very concept of 'technology' is a product of early twentieth-century class and gender politics, whereby middle-class, male engineers employed the term to stake out their claim for control of the means of industrial capitalism. Similarly, Cynthia Cockburn (1985) argues that the intersection of capitalist and patriarchal interests in maintaining a sexual division of labor serves to produce a cultural affinity between men and technology. Yet, as is the case with modern science, while the concept of 'technology' has long been associated with the exertion of Man's innate rationality in the effort to control nature, the precise sense in which such a gendering of technology should be understood remains at issue. For example, in contrast to Oldenziel and Cockburn's accounts of the gendering of technology in ideological terms, Timothy Kaufman-Osborn (1997) argues that material, linguistic, and technological artifacts have a co-constitutive relation with gendered human bodies. This line of thought can be traced back to Donna Haraway's 'Cyborg Manifesto' (1991), which perhaps first opened up a terrain of thought upon which the human is not necessarily distinct from the nonhuman, and the technological is no longer distinct from the biological. Such ways of thinking have today become even more significant as researchers begin to grapple with contemporary developments in biotechnology and questions about 'posthumanism'.

As something of an appendix to the work cited above, and given the cultural associations and connections that have been drawn between men, masculinity, science and technology, we might expect to find that research focusing on men

and masculinities would offer us substantial analyses of these issues. This is a literature that has burgeoned over the past fifteen years; yet, even though prominent scholars such as R.W.Connell (1995) and Victor Seidler (1994) acknowledge the force of identity between masculinity, rationality, and science, little explicit attention has been paid to this relationship. Perhaps the only notable exceptions are Brian Easlea's (1983) psychologically-orientated study of 'womb-envy' in nuclear scientists, and Karl Figlio's (2001) psychoanalytic take on Western science as rooted in masculine phantasies of mastery over the origins of life. These studies notwithstanding, the absence of attention to science is puzzling, for if Western science has dominated knowledge production in contemporary societies, as have men, then surely the relationship between the two would seem to merit more critical attention.

As far as technology is concerned, scholars studying men and masculinities have also tended to consider it mainly insofar as it is a central feature of the workplace. Here, the use and control of technology is seen as crucial to the establishing and sustaining of masculine identities. Notable in this regard is the collection *Boys and Their Toys?* (Horowitz, 2001) which explores the connections between masculinity, technology, and class in American labor history. As with the literature on gender and technology, however, such work tends to operate with the presumption that both men and technology, in themselves, exist independently prior to assuming their roles in the drama of gender politics. In contrast, I wish to suggest that an approach which recognizes that modern technologies (along with modern science) arise within a conceptual and historical context that

is already informed by discourses of sexual difference, which, in turn, are themselves technological through and through.

Science and Technology Studies

Turning to the literature generated around the HGP since it began in 1990, and which ranges from the very critical to the extremely optimistic, we find little evidence of any influence exerted by the work discussed above on gender and science or technology. Instead, this literature can be organized into three main categories. First, there are the accounts of the genome project written by scientists, or by science journalists, which seek to popularize the topic. These began appearing in the early years of the project and, to varying degrees, offer tales of the history, politics, and science behind the HGP. These texts generally feature some discussion of the ethical dilemmas raised by potential genetic discoveries, but in the main offer confident predictions of the tremendous scientific and medical advances that knowledge of the human genome will bring (Bishop & Waldholz, 1990; Wingerson, 1990; Shapiro, 1991). In recent years, another wave of similar books has emerged to coincide with the conclusion of the HGP (Davies, 2001; Sulston & Ferry, 2002; Wickelgren, 2002; Watson, 2003). The large number of popular works on this topic is itself testament to the currency that all things genetic enjoy today. Such texts are significant insofar as they both reflect and shape public perceptions of genomics, and they will be discussed in greater detail in chapter four.

Secondly, there are studies addressing themselves to the ethical and philosophical issues raised by the HGP. Often written by philosophers, these texts consider topics such as 'playing God' and what it means to be human (Heller, 1996; Peters, 1998, 2003), genetic interventions and the specter of eugenics (Kitcher, 1997; Sloan, 2000), and the potential for various forms of discrimination based on disclosures of genetic information (Mehlman & Botkin, 1998; Zilinskas & Balint, 2001). Here, the claims of the writers in the first category above are largely taken as given, and the consequences for various possible genetic futures are assessed. My final chapter will stage a critical return to this bioethical literature that has sprung up around genomics.

Social critics in the third category also raise ethical concerns, but go further to challenge the concept of the HGP itself and the claims that its proponents make with regard to its beneficent consequences. The focus here tends to be on the genetic reductionism, or gene fetishism, that purveys the public discourse on the HGP. Critics such as Ruth Hubbard (Hubbard & Wald, 1993), Dorothy Nelkin (Nelkin & Lindee, 1995), Donna Haraway (1997), and Barbara Katz Rothman (1998), all contend that the scientific discourses surrounding the HGP tend to ignore the fact that genes always act within specific environments (both within and outside of the human body). They argue that it is only this selective focus which allows HGP advocates to maintain their extravagant claims concerning the order and control of nature that can be achieved through biotechnology. Such claims are also faulted for ignoring the social causes of medical problems. Other authors complement this critique by examining the political economy of the HGP,

arguing that it is driven by the pursuit of private profit and status (Lewontin, 1992; Rosenberg, 1996; Loeppky, 1999). Within this critical literature, however, very little attention has been given to the relationship between gender or sexual difference and the HGP, especially when compared to the voluminous work on genetics and race. Nor, with the partial exception of Haraway (whose work will be discussed in greater detail below), has the biotechnology involved received any substantial attention other than in instrumental terms.

The latter is perhaps surprising given that the philosophy of technology has been somewhat reinvigorated in recent years through the influence of the environmental movement, social studies of technoscience, and the ensuing 'science wars' (Feenberg & Hannay, 1995; Parsons, 2003; Misa, Brey & Feenberg, 2003). Philosophers such as Andrew Feenberg (1995, 1999) and Don Ihde (1990, 1993) have argued that studies of technology can no longer afford to ignore the political and cultural dimensions of the environments in which technological developments emerge. Although influenced by contemporary developments, this line of thinking can be traced back to hermeneutical philosophy and critical theory of the 1950s and 1960s. The key figures of this tradition are Martin Heidegger, Herbert Marcuse, and Jurgen Habermas, each of whom is interested in the connection between technology and the project or condition of modernity itself. The association of modern technology with instrumental rationality, scientific method, and the quest for social progress via the control of nature, continues to provoke important questions, and this work offers us a theoretical framework in which to situate the more narrowly focused

and empirically-driven studies of gender, science and technology. In this dissertation, I draw especially on Heidegger's theory of modern technology as 'enframing' (which will be discussed in greater detail in chapter two) in order to theorize the relations that hold between nature, gender, genetic science, and biotechnology.

As Barbara Marshall (2003) has recently pointed out, analyses of sexual differences have still not found a central place in philosophical studies of technology. Gender tends to be conceived merely as an external variable, a property of persons already fully formed before entering into relations with technology. Although feminist perspectives are now routinely included in philosophy of technology anthologies, the identity of technology remains essentially untouched. This remains true even of avowedly anti-essentialist conceptions of technology such as that found in Feenberg's *Questioning Technology* (1999), where issues of gender receive scant attention. The reason for this, I suggest, is that while Feenberg and others work hard to dismantle the social/ technological opposition, the analysis presented still presumes an underlying human/nonhuman, or natural/artificial opposition that keeps technology and sexual difference on separate ontological planes.

Today, the most influential body of work to fall under the broad umbrella of social criticism of science is probably that which has come to be known as science and technology studies (STS). These investigations tend to focus upon the diversity of scientific ways of knowing, the complex and contingent ways in which scientific knowledge is produced, and the micro-level politics that are

involved in the construction of scientific facts. Such studies of scientific knowledge are generally traced back to the work of Barry Barnes and David Bloor, who were part of what came to be known as the Edinburgh School. Bloor's *Knowledge and Social Imagery* (1976) set out the basic tenets of the school's so-called Strong Program, which controversially and influentially proposed that both truth and falsity in science could be explained by examining the social and political interests of those involved. Bloor treated science as a social phenomenon, and argued that scientific knowledge should be subject to sociological analysis. Nevertheless, the narrow focus of the Edinburgh School, and its reliance upon a rigid opposition of the social to the natural, has led to much criticism of its approach. The importance of their work, however, is perhaps insofar as it allowed social critics to imagine how historical and sociological contingencies could affect the content and import of scientific knowledge.

The most influential approach within STS today, however, takes a step back from questions about macro social categories, and turns instead to micro-level social interactions. This method of enquiry is most closely associated with the work of Bruno Latour and Steve Woolgar (1979), and Karin Knorr Cetina (1981) among others. These authors are known for their small-scale laboratory studies, which aim to document the social interactions and negotiations that come together to produce accepted scientific facts. The key texts in this tradition were written in the 1980s, although Knorr Cetina has more recently produced a notable comparative study on high-energy physics and molecular biology (1999). The most influential text in this tradition is probably Latour's *Science in Action*

(1987), which rejects the idea that abstractions such as 'social classes' can be appealed to in order to explain the interests of actors within a scientific field. Instead, he argues that social structures are themselves the products of the micro-level, political interactions that are always taking place within scientific networks. For Latour, scientific practice produces new social relations and new forms of power. Significantly, he includes nonhuman actors within his conception of Actor Network Theory (ANT), thereby suggesting a way around the problem that social constructivist approaches have in trying to account for the agency of nature. This also implies a rethinking of the role of technology in the production of scientific knowledge. Most notably, Latour (1990) suggests that technologies of inscription and visualization drive the historical development of science by enabling ever more mobile 'translations' of objects across different domains of experience. Indeed, the privilege accorded to 'observation' in modern science is central to its constitution, and the place of visual technologies in the production of scientific knowledge will be a key concern throughout this dissertation.

One of the limitations of the micro-level focus of STS and ANT, however, is that they cannot easily account for forces that are not immediately present or apparent within the laboratory or network. This is perhaps where their divergence from studies focusing upon gender and science/technology is most keenly felt¹. While STS scholars usefully point to the role of science and technology in the production of social categories such as gender, their refusal to consider feminist insights into the reverse dynamic leaves their accounts somewhat one-sided. Traffic between these two literatures has been limited by the fact that feminist

critics start with external social structures and attempt to discern their influence upon science, whereas proponents of STS reject the priority of social categories such as gender and, instead, argue that the internal environment of the scientific laboratory has a key role in producing the society around it.

Bringing this situation into focus serves to raise some important questions in regard to a critical engagement with genetic science and biotechnology. Is it the case that feminist critiques of science and technology, of their 'masculine' desires to establish order and control over a feminized conception of nature, only hold for the early days of modern science? Are we now in a situation where we recognize the plurality of scientific methods, and the diversity of practices that are somewhat incongruously grouped together under the broad label of 'science', to the extent that to speak of a gendering of science or scientific method is redundant for lack of a proper object? On the one hand, there is the suggestion that the practice of modern science grows directly out of a gendered culture. Indeed, as Robert Nye notes in a critique of Latour and Woolgar's *Laboratory Life*, 'Though the authors do not acknowledge this point, their account of lab life takes the almost caricatural form of an oral, face-to-face male honor culture' (1997:77). On the other hand, however, given recent studies emphasizing not only the disunity of the sciences, but also the diversity of contemporary gender identities, it is not immediately clear in what sense something could be broadly characterized as 'masculine' or 'feminine' today. The two main approaches surveyed above — feminist and STS — come at the construction of scientific

knowledge from diametrically opposite directions. The question is whether either is adequate to the task of accounting for the complexity of technoscience today.

This dissertation seeks to forge a link, or to effect a reconciliation of sorts, between these two approaches by drawing attention to what might be described as an antinomy in social studies of scientific knowledge. On the one hand, it seems undeniable that the desires for order, rationality, and control that are apparent in scientific methods bear a distinctly masculine cast, and that the upper echelons of scientific disciplines and their associated industries remain dominated by men. On the other hand, however, it appears equally true that science today is an internally contradictory enterprise with a great diversity of practices, forces, affects, and ways of knowing. The physical sciences have not yet achieved a unified theory, and any attempt to endow them with a single identity appears doomed to failure.

In an effort to find a way out of this impasse, my suggestion is that the HGP marks a moment in the history of science and technology in which it may be possible to draw together the disparate and yet interlinked bodies of work discussed above in order to formulate a new understanding of the relations between sex, gender, science, and technology. The HGP is not merely a massive technoscientific undertaking concerned with the natural ground of our existence, it is also an ontological venture that animates some of the most pressing concerns and anxieties of Western societies in regard to the conceptualization of both biological and social life. Central here are questions about the meaning of 'sex' at a time when genetic transfers are conceptualized in

terms of the transmission of biological information, and of the role that sexual differences play in the reproduction of both individual identities and social order in a society where strategies of control increasingly operate at the subindividual level. Significantly, critical reflection upon biotechnology today leads us toward the deconstruction of dualisms such nature vs. culture and passive vs. active, which have confined 'gender' to the realm of culture and about 'sex' to the realm of nature. Feminist theory has for some time now been engaged in a critical deconstruction of the sex/gender opposition, and it is my belief that contemporary biotechnologies offer conceptual resources to those who wish to rethink the relation of the natural to the social.

Ontological Challenges

Another strand of recent feminist theory offers a path that leads toward promising conceptions of technology and sexual difference as always already open to and implicated in the other, and which may be of use to us in thinking through our current situation. As noted above, Donna Haraway's 'Cyborg Manifesto' was influential in challenging the taken-for-granted status of dualisms such as nature vs. culture and human vs. machine. She has also written more specifically on technoscience, especially in regard to biotechnology. The concept of 'technoscience' is itself an important one here. It reflects the fact that contemporary scientific objects are technologically revealed in a space between the human and the nonhuman, and that these objects exist for us only insofar as they conform to the visualizing capacities of the technologies at hand. Thus,

technology cannot be thought of merely in instrumental terms as the tools that facilitate the practice of science. Technoscience is a matter of *how* we know and, especially, of *how* we see. Indeed, with the increasing prominence of microphysics and molecular biology today, questions concerning observation, visualizability, and what counts as an 'object' are more pertinent and problematic than ever (Aronowitz, 2001). Hence, in this dissertation I place particular emphasis on the visual dimension of genetic science and the 'pictures' of nature that it provides to us. More specifically, I take up early photography as both metaphor and model of modern scientific vision. Both photography and biology are conceptual products of early nineteenth-century Europe, and I am interested in examining this shared provenance to see what it may reveal in regard to the technicity of biological science, and to the relation of technoscience to nature more generally.

Haraway, whose work has perhaps done more than anyone's to bring together the insights of both feminist and STS scholarship, has this to say regarding the concept of technoscience:

I want to use technoscience to designate dense nodes of human and nonhuman actors that are brought into alliance by the material, social, and semiotic technologies through which what will count as nature and as matters of fact get constituted for – and by – many millions of people. ...The world-building alliances of humans and nonhumans in technoscience shape subjects and objects, subjectivity and objectivity, action and passion, inside and outside in ways that enfeeble other

modes of speaking about science and technology. In short, technoscience is about worldly, materialized, signifying and significant power (1997:50-51).

Here, rather than the reductionism of modern science, it is the *productive* force of technoscience that is emphasized. Haraway draws our attention to the power of technoscience to generate new forms of life, new relations of sociality, as well as new forms of domination. Her 'cyborgs' are products of technoscience insofar as they are 'the offspring of implosions of subjects and objects and of the natural and the artificial' (1997:12). This description moves Haraway further in the direction of an ontology of difference that disrupts the original identity of beings in themselves, and goes some way towards answering Vicki Kirby's accusation that the 'Cyborg Manifesto' still presumed that nature and culture possessed coherent independent identities prior to their combination in the hybrid cyborg.

Kirby's *Telling Flesh* (1997) is significant here for its extended elaboration of the Derridean concept of *différance* as it pertains to feminist theories of corporeality. *Différance* here refers to a difference that 'internally' disrupts all forms of identity prior to any oppositional logic such as male vs. female. Her deconstruction of the opposition between the natural and the social/cultural challenges us to rethink the basis of anti-essentialist approaches to the body and sexual difference, which tend to presume that 'nature' and 'culture' can be identified and delimited as separate ontological planes. Kirby does not directly address technoscience, but her argument that we should extend the workings of textuality into the very matter of life itself has significant implications for the ways in which we come to know nature through science. Here, the biological is an

ever-changing *différential* script, an open system whose truth is not contained within itself, but, rather, is co-constituted in relation to technologies.

The work of Judith Butler and Elizabeth Grosz should also be mentioned in this context. Butler's *Bodies That Matter* (1993) is an important text in terms of its effort to rethink the status of nature. Rather than accepting that human bodies belong to a natural realm existing outside of social relations, Butler argues that nature always appears to us according to the effects of discursive power. For her, natural matter is an 'outside' that is only given through, or 'inside' of discourse. She thereby introduces a certain politics of nature, and questions the belief that 'sex' is an immutable natural category. For Butler, sex is produced via the performative reiteration of heterosexual norms in the form of gender, which simultaneously produces a domain of abject identities. Her analysis has been influential in its elaboration of the intimate connections that hold between discourses of sex, gender, and sexuality. Butler's insistence that these categories cannot be properly understood in isolation from one another provides an important provocation toward challenging the idea of sexual difference as an unproblematic natural ground that underlies gendered culture, and this is a point I will take up again in chapter one.

Butler's account has been criticized (by Kirby among others), however, for its implicit linguistic idealism in considering nature only in terms of the sphere of culture. As such, it presumes that the identity of both nature and culture can be established, and places dynamic agency on the side of the latter. Grosz's (1994) concept of 'volatile bodies' seeks to move beyond such a position and gestures

toward an account of the human subject which incorporates a dynamism found within matter itself. Drawing upon the work of Gilles Deleuze and Félix Guattari, Grosz understands natural bodies not on the model of the closed organism, but, rather, as organically incomplete and open to social relations from the start. From this position, it becomes possible to envisage 'natural' bodies not as other to technology, but as technological through and through, as 'machinic assemblages' in the language of Deleuze and Guattari (1987). Grosz has for some time now advocated for a shift in feminist theory towards bringing the productive and creative force of nature into analyses of cultural and social formations. Her more recent work (2004; 2005), alongside that of other scholars such as Elizabeth Wilson (1998; 2004), constitutes an important perspective on the relation of nature and biology to social life, which suggests that feminism needs to look again at the ontology of gendered bodies. This approach, which is sometimes referred to as 'new materialism', seeks to reintroduce the biological into cultural theory².

Although neither Butler nor Grosz directly engages with issues concerning techno-science in these texts, their work draws theory towards a point where it is able to address some of the challenges that face us today. In this regard, Patricia Clough has proposed that their writings are an important part of a more general move, carried along by 'the unconscious thought of teletechnology', to rethink our ontological categories. Here, it is not merely that new technologies are changing our world, but rather that they now reveal it to us in a way that calls for a different type of thought. Clough sets out her position as follows:

I want to propose that the development of teletechnology in the late twentieth century not only has drawn cultural criticism to the reconfiguration of the social, the political, and the economic conditions of human agency. The development of teletechnology also has drawn cultural criticism to the deconstruction of the opposition of nature and technology, the human and the machine, the virtual and the real, the living and the inert, thereby giving thought over to the ontologization of agencies other than human agency (2000:2).

‘Teletechnology’ is employed here to signify the effects of an intermingling of the technological with the scientific, the cultural, and the natural, which has become increasingly apparent with the speed and reach of information and communication technologies, and with biotech interventions that are productive of new forms of life. Technology, science, culture, and nature are thereby all given to us in such a way that the complexity of their relations frustrates the desire to seal off any realm from the others. In this context, sexual difference demands to be rethought in terms of an ontology of open systems that incorporates the thought of both techno-nature and techno-culture. Developments in biotechnology call upon us to consider a situation where ‘sex’ is no longer simply a matter of the reproduction of organic bodies, but instead involves a repetition of information across nonorganic bodies.

In this regard, one of the three over-arching theses of this dissertation is that we are witnessing a general, albeit ambivalent cultural shift away from meaningful, organic bodies and towards bodies of information, or what we might call bioinformatic bodies. More specifically, where the concept of sex was

formerly a repository of meaning crucial to the integrity of the living organism, we are now seeing a process of dissipation whereby the organic is giving way to subindividual forces that inform bodies in ways that do not necessarily bear the weight of a natural order of things. This may be understood in terms of what Deleuze (1992) has referred to as the move from disciplinary societies to societies of control. Whereas disciplinary power was formerly aimed at individual subjects through the internalization of social norms, control refers to a form of power that works through the production of affects at the prepersonal, molecular level, and which addresses the human body in statistical terms of data and information — thus inviting a rethinking of the body ‘beyond sex and gender’ (Clough, 2003). While contemporary developments in genomics and biotechnology promise an unprecedented mode of control that bypasses the individual by offering access to the very ‘codes of life’, the implications for ‘sex’ and ‘gender’ are as yet largely unthought.

There is also the potential here to go beyond the somewhat tired debate over genetic determinism, which has today reached an uneasy truce brokered by the compromise of ‘interactions’ between ‘nature’ and ‘culture’. It is my belief that this situation conceals an unresolved tension concerning the freedom that may be ascribed to human beings in their natural conditions and in their social formations. Moreover, the weight of this issue tends to fall upon concepts such as ‘sex’, which mediate the relation between nature and culture. Contemporary concerns over genetic engineering feed off similar uncertainties regarding the authority of nature, the appropriate limits of scientific control, and the possibilities

of human freedom. While social constructionist approaches tend to obfuscate the problem of freedom by deferring to social determinism, scientific or essentialist accounts ultimately try to resolve it through genetic determinism. Left unanswered is the question of how we are to live with/in freedom. Here, it is the second over-arching thesis of this dissertation that sex and gender concepts are key mechanisms by which modern human beings have tried to resolve this problem of freedom by re-establishing the security of a natural order. Gender, from this perspective, involves not only nature and social structure, but is a philosophical issue and a technological response to the condition of modernity. Moreover, I argue that culturally hegemonic concepts of gender and sexual difference can be plausibly formulated as such precisely because nature itself has always been open to technology.

Like gender, biological science is also a way of relating to the natural world. As noted above, the emergence of biology in its distinctly modern form can be roughly dated to the early nineteenth century. This is the same period in which many distinctly modern ideas about 'masculinity' and 'femininity' first began to appear, and one of my goals here is to examine this contemporaneous genesis as it relates to the persistent association of science with masculinity. I will suggest that the historically specific *opposition* of masculine to feminine, which begins to emerge during the eighteenth century, and the generalization of this division as a conceptual mechanism for understanding social and natural life, may be seen as providing a means of displacing a fundamental contradiction inherent in our scientific efforts to know the natural world – viz. the fact that the

knowledge, domination, and control which we gain must ultimately be reconciled with the authority of our object of investigation: nature. Gender provides a mechanism for displacing and coping with this contradiction, insofar as the feminine may be seen as answering our need to be subject to something beyond ourselves, while the masculine expresses the desire to be in control of the world in which we live. If, as I will argue, modern science (along with photography) and modern sex/gender categories emerge as a part of the event which Nietzsche terms ‘the death of God’, then both may be seen as ways of trying to deal with a troubling sense of freedom that comes to underlie the relation of humanity to nature. Hence, the final thesis advanced in this dissertation is that if there is a masculine ‘essence’ to science, it is not in terms of an identity or causal relation, but rather, it is to be found in a historical and structural relation that expresses a form of *desire* common to both science and masculinity — a desire to assuage the fear of freedom by establishing control over nature. This desire is ambivalent, however, insofar as realizing its goal would result in an even more unsettling state of free self-determination. Thus, the scientific subject can never be fully ‘masculine’ because, in order to secure its epistemological authority, it must maintain a certain deference to its ‘feminine’ object, even as it seeks to control it.

In this dissertation, I approach these issues mainly from a historical perspective that aims to understand the mutual influences of gender, technoscientific knowledge, and the theological heritage of the West on our relation to the concept of nature. My goal is to bring together a number of different bodies of work — historical, philosophical, and sociological — in order to generate a

different perspective on contemporary biological science and the politics of gender. The questions that I address are twofold: firstly, what can the history of biological thought and science, alongside the history of sexual differences, reveal to us about the relationship between modern sex and gender concepts and the ways of knowing that constitute genomic technoscience? Secondly, what do contemporary developments in genomics and biotechnology allow us to think about the future of sexual difference and the concept of 'nature', especially in relation to sociological concepts of gender? More specifically, if technoscience has always sought the knowledge and power that will allow it to control nature, how does the changing mode of control that is evident today in the move to the nonorganic, subindividual level of life affect our understanding of the relation between science and gender? Ultimately, I argue that a consideration of the complex relations that hold between genomics, biotechnology, nature, and sexual difference today forces us to reassess the politics of gender and science.

Research Strategy

The research approach that I take in this study can be situated in a tradition of 'ontohistorical', rather than epistemological or methodological inquiry. Not to be confused with social constructionism, an ontohistorical approach does not place its faith in key distinctions such as subject vs. object, nature vs. society, or human vs. nonhuman. Hence, it does not presume that fundamental categories of being are given *a priori* (Aronowitz & Ausch, 2000). Instead, an ontohistorical approach is attentive to the historical production of different forms of knowledge

and being, and attempts to map out the contingent connections between them. In this dissertation, it is the coincident emergence of biology, photography, and modern sex and gender concepts that is of most significance. In attempting to produce an ontohistorical analysis of the relations between gender and genetic science, I am particularly interested in historical moments when relations between nature, technoscience, and society are reconfigured through the lens of sexual difference.

Following Michel Foucault (1998a), the approach that I take in this research can be also be described as genealogical – in the sense of an interpretive, historical investigation that is animated by a critical concern for uncovering the contingencies and details that have produced a present state of affairs, particularly insofar as that state is (mis)taken as a natural and immutable condition. Genealogy is not conventional history. It does not purport to uncover the complete or ‘true’ account of a particular period, but rather often pursues the marginal detail or perspective that has been excluded by the dominant discourses of history. Genealogy does not study ‘the past’ as such; instead, it is interested in elements of history which may be yet to come. Such an approach presumes that there is an unconscious or unthought dimension to the present, which is both the product of history *and* holds a potential for the future. Guided by this approach, the structure of my project features a historical narrative aimed at producing a fresh perspective on the present.

For Foucault, one of the most important elements of the genealogical approach is an interest in interrogating that which is near to us, or which is so

close as to normally escape our attention. He characterized genealogy as bearing witness to the singularity of events ‘in the most unpromising places, in what we tend to feel is without history — in sentiments, love, conscience, instincts’ (1998a:369). ‘Sex’ is thus an exemplary object for genealogical investigation.

Three Themes and an Overview of the Dissertation

The trajectory of enquiry that I pursue throughout this dissertation is guided by three interlinked themes: (hetero)sexual difference, onto-theology, and technovision. These themes weave their way in and out of each of the chapters, which are themselves organized in a temporal sequence that unfolds a genealogy of genomic vision.

The work of Judith Butler has been central to research into gender over the past fifteen years, and I derive the notion of (hetero)sexual difference from her theory of melancholic gender (1997). This concept refers to the configuration of sexual difference that underlies the peculiarly modern gender categories of ‘masculinity’ and ‘femininity’. Butler has argued that inextricable connections exist between gender categories and normative heterosexuality, and my first chapter takes its cue from this insight, but immediately seeks to historicize it by examining the emergence of modern understandings of ‘sex’ during the Enlightenment. This involves revisiting Foucault’s influential *History of Sexuality, Vol.1* (1990) and discovering in it a connection to the accounts of plant sexuality developed by prominent eighteenth-century natural historians such as Carl

Linnaeus. Natural history, which attempts to identify a divine order in nature, provides us with something like a prehistory of biology proper. Also at issue in the transition to biological science is Nietzsche's question regarding the meaning of the 'death of God', and in this context I argue that the notion of (hetero)sexual difference comes to function as an unthought 'God' for natural science and philosophy.

This idea sets the scene for chapter two, in which Martin Heidegger's concepts of 'modern technology' and 'onto-theology' are introduced. Heidegger's account of modern technology as a historical mode of revealing the world – one which is said to inhabit modern science – provides us with the concepts of 'enframing' and 'technovision', and with a way of conceiving the technological nature of gender itself. Onto-theology, on the other hand, characterizes any representational system that infers both the fundamental nature and the ultimate source of beings on the basis of what is present to observation, and I employ it here to reconceptualize the relationship of God to nature as it evolves from eighteenth-century natural science towards the emergence of biology proper in the nineteenth century. The main focus of this chapter, however, is on the birth of photography during the first half of the nineteenth century, and how this expresses the changing relationship of human knowledge to a more historical concept of nature. I take early photography, particularly in its relation to sex and death, to be exemplary of a nascent biological and technoscientific approach to nature, which I ultimately argue is both re-expressed and reconfigured in contemporary genomics.

In chapter three, I turn more explicitly to genetic science. Specifically, I examine two crucial moments in the formation of modern genetics and molecular biology: first, the work of Gregor Mendel (the so-called ‘father’ of genetic science) in the mid-nineteenth century; and then the mid-twentieth-century convergence of thermodynamics, information theory, and cybernetics in relation to the constitution of molecular biology as a discipline. After identifying certain tensions in Mendel’s pioneering investigations concerning (hetero)sexual difference, technovision, and onto-theology, I suggest that he implicitly inaugurates a shift from meaning to information in conceptualizing the basis of life. My argument is that certain unthought issues within Mendel’s work reappear in the ‘cyberscience’ of the postwar period, and can in fact be traced right through to contemporary genomics.

The Human Genome Project is the main topic of chapter four. First, however, I return to the two divergent streams of social studies of science identified in this introduction, and examine how well these feminist and STS approaches are able to account for recent developments in molecular biology. I suggest that moving beyond the impasse that these positions lead us to will require identifying both what is the same and what is different in the ‘new’ genomics. At this point, I turn to examine several popular accounts of the HGP and its potential for the future. I argue that these genomic narratives, which are often criticized for their exaggerated claims and genetic determinism, are in fact rather prosaic, conservative accounts that miss the real potential of the new biotechnologies. As an alternative to these narratives, I attempt to locate the HGP within a history of

technovision. I suggest that the genome project may be understood as expressing a 'photographic' mode of desire in relation to nature — specifically, one which repeats the gendered dynamic found in nineteenth-century photography and technoscientific knowledge. As such, the HGP is characterized by productive instabilities and openings that arise at the limits of its technovision.

The final chapter draws together the three themes of (hetero)sexual difference, technovision, and onto-theology as they bear upon contemporary genetic technoscience. I take up the issue of human cloning, and argue that the bioethical debate has not really come to terms with the way in which this idea is peculiarly 'uncanny'. My reading of the debate suggests that cloning raises problematic issues and anxieties concerning human freedom in large part because it disrupts the illusion of a natural order based in (hetero)sexual reproduction. Taking this analysis as a point of departure, I go on to examine alternative understandings of 'sex' that have emerged in recent years. I suggest that these competing sexual visions are reflected in recent discussions of 'posthumanism', and that it is here that we find the ambiguous potential of genomics and biotechnology in relation to gender and other social categories. Finally, I consider what a social criticism of biological science for the twenty-first century might look like. I contend that it will need to ask the question: what is 'sex' becoming?

Notes

¹ See Whelan (2001) for a more comprehensive discussion of the differences between feminist and 'mainstream' STS scholars (such as Latour).

² See Hird (2004) for a useful overview of new materialism and nonlinear biology as they relate to both gender and science.

Chapter 1

Presenting Nature: Sex, History, and (the Death of) God

All *crimina carnis contra naturam* degrade human nature to a level below that of animal nature and make man unworthy of his humanity. He no longer deserves to be a person.... It is the most abominable conduct of which man can be guilty. So abominable are these *crimina carnis contra naturam* that they are unmentionable, for the very mention of them is nauseating.... But as they are of frequent occurrence, we are in a dilemma... (Kant, 1963:170).

In the early 21st century, the authority attributed to Nature is both unprecedented in its legislating power, and yet, at the same time, somehow strangely diminished. On the one hand, genetic science claims to be increasingly uncovering the molecular structures that lie at the basis of nature, and which inexorably shape all life as we know it. On the other hand, however, developing biotechnologies hold out the promise of ever-greater control over life, of diverting the course of nature towards ends that are difficult to characterize in terms of 'natural' or 'unnatural'. The 'ends' of nature are at issue today in a way that draws us back to the past even as it propels our thought into the future. Does human intervention correct the course of nature, allowing it to realize its inherent potential, or does it create new forms of life, effectively subverting any notion of a natural *telos*? Of course, even to pose the question in this way, implicitly assumes a disjunction between humanity and nature, between the human and the nonhuman, which is itself called into question more insistently than ever

today by technoscientific practices such as those involved with recombinant DNA technologies. While the power and authority of nature reasserts itself, its source becomes ever more difficult to locate.

From one perspective, such anxieties over where humanity stands in regard to nature can be traced back to the eighteenth century in the West. Distinctly modern disciplinary forms of knowledge – in both the sciences and the arts – were taking shape at this time in dialogue with a concept of nature that bore the weight of divine provenance. For philosophers such as Immanuel Kant, writing in the latter part of the century, the rational forms of nature served as guarantors of meaning and morality in the world of phenomena accessible to human understanding. Freedom from natural determination was a human privilege, but such discretion was also troubling to the stability of social and natural orders. Particularly problematic were *crimina carnis* – sins of the flesh, ‘unnatural’ bodily desires, transgressions of sexual order – which for Kant, as for many others, mocked the rightful state of the world. Sex represented the force of (divine) nature in human beings, and the uses to which it was put, whether in terms of what we would now refer to as ‘sexuality’ or in ‘gender’ performances, had significant bearing on the meaning and value that could be bestowed upon the state of Western civilization. The freedom that inheres within human sociality is decidedly problematic in this context. As the eighteenth-century French thinker Jean-Jacques Rousseau was to lament, ‘Everything is good as it leaves the hands of the Author of things; everything degenerates in the hands of man’ (1979:37).

We will return to the work of Rousseau, and to that of Kant, at the end of this chapter, for our topic here will be `sex' in the eighteenth century – its history, its stakes, and its place in the genealogy of biological science. First, however, I wish to take up matters more recent. For our interest here is not, primarily, in ascertaining the `truth' about sex or sexual relations in the past. Rather, this chapter intends to illuminate certain aspects of earlier times that continue to play a part in shaping our present. It is a question of discerning certain conceptual and material investments and their traces in the complicated temporality of `our' time. Our starting point will be the work of Judith Butler, whose writings on the intersections of sex, gender, and sexuality have been pivotal in shaping theoretical considerations of these topics over the past fifteen years. After a review of the issues raised by her work, we will return to the eighteenth century, and to the histories of sex and sexuality found in the writings of authors such as Michel Foucault and Thomas Laqueur. By situating these texts in regard to the evolving relation of science to religion, and to the practice of natural history, I hope to formulate something like a prehistory of modern biology and genetic science. To this end, feminist critiques of science will also be drawn upon to elucidate the workings of sexual difference in eighteenth-century science and philosophy.

(Hetero)sex

Beginning with *Gender Trouble* (1990), Butler inaugurates a theoretical project that seeks to undermine the complicity of much feminist gender theory,

particularly those variants that affirm a feminine identity, with heterosexual hegemony. Her guiding question is this, 'To what extent does the category of women achieve stability and coherence only in the context of the heterosexual matrix?' (1990:5). Of course, implied here is the same question with regard to the relation of men to heterosexuality. For Butler, the notion of a heterosexual matrix designates a 'grid of cultural intelligibility through which bodies, genders, and desires are naturalized' (1990:151). At issue is the centrality of heterosexuality in the production of coherent and intelligible human identities. Butler challenges the belief that gender categories (masculine/feminine) are merely the social expression of underlying, biological sexes (male/female), where 'social' is understood to imply mutability, and 'biological' is presumed to refer to an immutable nature. Instead, she argues that, 'This production of sex as the prediscursive ought to be understood as the effect of the apparatus of cultural construction designated by *gender*' (1990: 7). On this reading, insofar as sexual difference is thought in terms of the dimorphic categories of male and female, it is effectively (hetero)sexual difference. Equally, gender categories characterized in oppositional terms of masculinity and femininity implicitly presume a biological and ahistorical basis in (hetero)sex¹. For Butler, gender is performative; it is always a matter of becoming rather than being. Hence, 'There is no gender identity behind the expressions of gender; that identity is performatively constituted by the very "expressions" that are said to be its results' (1990:25). Sex does not provide the ground of gender identities on this account, rather, social and cultural strictures compelling gender performances in terms of the

reiteration of norms are said to produce the belief in a biological substratum which, in turn, appears as the authority legislating the force of the former.

Further elaboration of this performative production of 'sex' is the central concern of Butler's *Bodies That Matter* (1993). Here, the specific materiality of the body is characterized as an effect of discursive power. In short, Butler's argument is that, 'the regulatory norms of "sex" work in a performative fashion to constitute the materiality of bodies and, more specifically, to materialize the body's sex, to materialize sexual difference in the service of the consolidation of the heterosexual imperative' (1993:2). This is not a simple statement of social constructionism whereby all that can be said to exist is discourse or language. Rather, Butler's point is that matter can only enter into culture *as the outside of* the latter; that is to say, nature can only be materialized as such by being *posited* as external. Thus, the constitution of sex as an outside to the social realm cannot escape its relation to the inside, as both are defined in and by the relation. This amounts to the claim that we cannot conceive of an absolute outside to discourse, for the outside is always *of* the inside. The category of 'sex' is thereby seen as a regulatory ideal that governs the material formation of a subject and simultaneously produces a domain of abjection. Hence, gender is not a contingent feature of human subjects, for it is intrinsic to the heterosexual matrix, and thereby prior to the emergence of bodies that count as 'human' via their assumption of (hetero)sex. In other words, 'sex' is always already gendered.

The reception of Butler's work has focused mainly upon the issue of gender performativity and the political 'ontology' of matter that informs her theory. Critics

such as Pheng Cheah (1996) and Vicki Kirby (1997) have argued, primarily from a Derridean perspective, that the account of materiality given in *Bodies That Matter* remains trapped within a framework that presumes an unbridgeable divide between nature and culture. Cheah argues that Butler's position is anthropological and Kantian insofar as the determination of materiality is wholly dependent upon the epistemic and linguistic grid of the human subject. He claims that matter here remains an immutable substance, with form providing the principle of dynamism. Hence, bodies possess no inherent dynamism of their own on Butler's anti-naturalistic account. The only agency that can be ascribed to them is given negatively according to the resistance of matter to its identification through socially mandated categories. Having demonstrated the ways in which 'sex' is materialized as an effect of discursive power, there appears to be no space in Butler's theory in which matter, or the body, can manifest its own force. Nature is effectively barred from the realm of culture. Given this situation, the task, according to Cheah, '... is not just to reverse the correlation of activity with productive form by ascribing activity to matter. It is instead an attempt to grasp the peculiar dynamism of the given, which is prior to the distinctions between activity and passivity, form and matter, because this dynamism is the constitutive play of difference' (1996: 134). It is a question of how the productive activity of nature can be accommodated within cultural theory in such a way that the identity of both is open to the other from the very start.

An impetus towards deconstructing the opposition of nature and culture in the name of a certain originary difference also lies at the heart of Kirby's critique

of Butler's position. For Kirby, Derrida's dictum that 'there is no outside of text' can be understood to mean that substance, materiality, or the ground of being, is a mutable intertext – a process of writing that both circumscribes and exceeds the nature/culture distinction. Thus, the body both writes and is written upon. Kirby argues that Butler unnecessarily forecloses the workings of textuality because in her work the mutually constitutive implication of form and matter appears solely *within* the realm of culture. Matter, for Butler, remains an enclosed surface waiting to be written on. In contrast, the Derridean notion of *différance* doesn't so much exceed culture or the social, as it troubles our sense of what encloses terms such as 'culture' or 'nature'. The problem, according to Kirby, lies in Butler's reliance on a Lacanian concept of the sign, in which the identity of the bar that separates the signifier from the signified, language from the non-linguistic, is itself barred from scrutiny. Hence, there is a presumption on Butler's part that entities such as language, culture, or the social can be secure in their identities as other to matter. For Kirby, the crucial point is that, when figured in this way, difference cannot be conceived as an active, internal, and constitutive force. Difference is restricted to a disruption in the reiteration of signs, rather than being located in the becoming of nature and culture as open to and implicated in each other.

Clearly, there is a need to rethink Butler's notion of gender performativity, and its relation to the category of 'sex', in terms that can allow for the co-constitutive activity and difference of materiality. Efforts such as Karen Barad's (1998) reworking of performativity as the 'iterative intra-activity' of material-

discursive apparatuses of bodily production move in this direction. My interest, however, is in examining the production of 'sex' in relation to Butler's concept of gender melancholia, which became increasingly central to her work in the 1990s. In order to really appreciate the connections that Butler makes between heterosexuality and gender, we need to pay attention to the way in which she articulates the psychic with both the social and the material dimensions of human life. For it is here, I will argue, that we find openings to issues concerning the history of sex and of the unconscious in relation to nature and culture, which, in turn, lead us towards an engagement with contemporary understandings of materiality.

Butler's most fully elaborated account of gender melancholia is to be found in the last two chapters of *The Psychic Life of Power*. There, she reads Freud's theory of melancholia through the lens of Lacan and Foucault's work to argue that it is only through a process of identification with a lost other that each of us comes to constitute our own identity. More specifically, Butler's interest is in explaining the way that gendered subjects are produced through a process of melancholic identification. In so doing, she draws upon Freud's discussion of the formation of the ego in *The Ego and the Id*. For Freud:

When it happens that a person has to give up a sexual object, there quite often ensues an alteration of his ego which can only be described as a setting up of the object inside the ego, as it occurs in melancholia.... It may be that this identification is the sole condition under which the id can give up its objects. At any rate, the process, especially in the early phases of development, is a very frequent one, and

it makes it possible to suppose that the character of the ego is a precipitate of abandoned object-cathexes and that it contains the history of those object choices (1991: 368)

By reconceptualizing and extending Freud's thinking here, Butler is able to suggest that the ego itself is originally constituted through a desire that is foreclosed, and which must be subsequently disavowed lest it threatens the subject with its undoing. For Butler, because the Oedipal scenario is culturally structured around the presumption of heterosexual object choices, one's entry into subjecthood and self-identity is produced via the foreclosure of homosexual object choice. Gender is thereby understood as the product of that which must remain unspoken in sexuality — as a means of preserving a desire forsaken in the name of coherence and cultural intelligibility. In other words, one who cannot love a man must instead become one.

The straight man (or woman) is thereby melancholic:

Unowned and incomplete, melancholia is the limit to the subject's sense of *pouvoir*, its sense of what it can accomplish and, in that sense, its power. Melancholia rifts the subject, marking a limit to what it can accommodate. Because the subject does not, cannot, *reflect* on that loss, that loss marks the limit of reflexivity, that which exceeds (and conditions) its circuitry. Understood as foreclosure, that loss inaugurates the subject and threatens it with dissolution (Butler, 1997: 23).

It is not that homosexual desire is repressed in the constitution of masculine or feminine identities. Rather, the foreclosure of such desire is the move that first inaugurates the subject who represses. One cannot *be* prior to this constitutive loss. One must disavow desire for it is presumptively prohibited in the name of the one. This loss must remain hidden from the subject for the sake of its survival. As Butler puts it, 'Survival is a matter of avowing the trace of loss that inaugurates one's own emergence' (1997:195). Mourning is not possible, for one cannot mourn that which one does not know that one has lost. Hence, melancholia becomes both the condition of the subject, and produces a pervasive heteronormative and melancholic culture.

Butler's theory of gender melancholy raises some provocative issues that I believe have not been adequately addressed in the secondary literature on her work, but which are crucial for us here. First, in wielding a Foucaultian critique of psychoanalytic theories of sexual difference, Butler opens up the possibility of a historical reading of the psychic categories that inform a person's fundamental sense of self-identity and bodily integrity. The promise of historical analysis is not one that has been cashed out to any significant extent in her work however, and this has contributed to the predominant view that the political stakes of Butler's post-Lacanian theory revolve solely around individualistic gender performances at the symbolic level. Secondly, in moving beyond gender performativity to the theory of melancholic gender, Butler allows for the existence of unconscious forces within the gendered psyche, and also for the possibility that the body may return as a disruptive element within the discourse of (hetero)sex. Again,

however, this promise remains largely unfulfilled, as Butler has been reluctant to engage with questions of ontology. It may be, however, that this is precisely the direction in which the logic of her work leads us². By rethinking the agency of desires foreclosed in the constitution of the gendered/(hetero)sexed subject in terms of an affective and unstructured bodily dynamism, we may perhaps begin to reconceptualize the unconscious dimensions of contemporary accounts of nature, particularly in terms of the centrality of (hetero)sexual difference to human nature. This, in turn, will require a history of sex, of its historical materializations, and of the coming into being of the heterosexual matrix.

I suggest that the theoretical questions generated by Butler's work lead in two directions. On the one hand, we need to reach back to the time when current formulations of (hetero)sex and gender were taking shape, and to try and trace forward the influences and investments that are active in generating unthought aspects of the present. On the other hand, we need to engage with contemporary ways of revealing nature, with technoscience, with biotechnologies, and with the issue of molecular sex, in order to assess their impact on the melancholic condition of gender, and to take stock of the ontological implications that are giving new shape to critical thought at the current time. The remainder of this chapter will take up the former issue, while the rest of the dissertation moves towards the latter.

Natural Sex

The eighteenth century – the time of Enlightenment, the age of reason – has often been recognized as a period in European history that exerted a particularly strong formative influence upon the modern world. Here, we will attempt to trace out some lines of connection between two concepts that are crucial to the eighteenth century's understanding of itself: sex and nature. The importance accorded these two concepts in the intellectual life of the period can scarcely be overstated. The place of humanity within or in relation to nature has been a vexing issue ever since Descartes located the essence of 'man' in a thinking spirit separated from mechanical, bodily matter. Sex, on the other hand, provided connection. Often disavowed, it was, nevertheless, a possession of the body that transcended mere mechanism to provide a quasi-teleological force to life. If the mind was man's direct route to God, the (female) body's sex indirectly manifested evidence of a divine nature, a nature that revealed a necessary order based in the complementary opposition of man to woman. Sex caused trouble in the eighteenth century; it often threatened disorder (not least in the form of a nascent feminist politics), but its reproductive force also promised stability over time. It thus served as a guarantee of sorts, as a marker of coherence and order that anchored a concept of nature stretched to its limits by the century's end.

It was Newtonian science, with its logico-mathematical cosmology and faith in a rationally ordered world governed by unchanging laws of motion, which initially set the terms for understanding nature in the eighteenth century. Significantly, the mechanical, lifeless conception of nature that followed from

Newton's work, as from Descartes writings, allowed no place for God save as first cause. Historians of the idea of nature tend to see this period as a time of stasis, when the physical world was caught between a medieval concept still informed by the ancient Greek notion of *physis* – the self-moving power of nature – and the becoming-historical of nature that awaited in the biological-evolutionary paradigm of the nineteenth century. Nature in the eighteenth century seems curiously inert. As R.G.Collingwood characterizes it:

The movements which [nature] exhibits, and which the [eighteenth-century] physicist investigates, are imposed upon it from without, and their regularity is due to "laws of nature" likewise imposed from without. Instead of being an organism, the natural world is a machine... an arrangement of bodily parts designed and put together and set going for a definite purpose by an intelligent mind outside of itself (1960:5)

Divine provenance was to secure the timeless forms of the natural world. Just as in the philosophy of Descartes, the role of God was to provide assurance. The deity stood firm at the ground of things, allowing them to be known with certainty. Nature was reduced to a merely mechanical extension of the creator's grand plan. As Raymond Williams puts it, 'by the eighteenth century the idea of nature had become, in the main, a philosophical principle, a principle of order and right reason' (1980:78). At the same time, God himself was thereby displaced to a certain extent; his role having been somewhat diminished. Enlightenment critics had little time for the 'superstitions' of the church establishment; the God of the philosophers was an eminently reasonable figure.

By the latter years of the eighteenth century, however, the fixed image of nature was inexorably giving way to a more dynamic conception. Scientific advances and an increasingly experimental engagement at the empirical level had made the image of the natural world as an immutable harmony appear increasingly untenable. Jacob Oppen (1973), for example, argues that a number of developments in fields such as cosmogony, geology, and embryology converged with a pervasive cultural value attributed to 'progress', and led to an overturning of the inanimate, inorganic, static theory of nature in favor of an animate, organic, development notion of nature that was to eventually culminate in the biological-evolutionary theory of Darwin in the mid-nineteenth century. Foucault (1994) has characterized this moment of transition in terms of a disjunction between the great taxonomies of the Classical age and the profound historicity of things that marks the Modern period. Before it was reconfigured, however, the idea of nature holding sway in the time of the Enlightenment was to exert its own force upon the shaping of the modern world. Hence, our historical questioning of 'sex' must first consider how it functions within the broader eighteenth-century discourse of an eternal natural order.

It was Foucault that put the history of all things sexual firmly upon the intellectual horizon. In *The History of Sexuality, Vol.1* (1990), he highlights a 'discursive explosion' around the topic of sex beginning in the eighteenth century, which he argues led to the emergence of the distinctly modern categories of the homosexual and the heterosexual. Foucault's aim is to show how certain activities and experiences were drawn into circuits of power and

knowledge and thereby marked as 'sexual', thus eventually producing the notion of sexuality as we know it today. 'Toward the beginning of the eighteenth century', he writes, 'there emerged a political, economic, and technical incitement to talk about sex.... as in the form of analysis, stocktaking, classification, and specification, of quantitative or causal studies' (1990:23-4). Foucault's claim is that repression is not the primary mode of power when it comes to sexuality. Rather, through an imperative to speak about sex, to generate knowledge of sex, 'sexuality' comes to be constituted and produced as the truth of one's human nature and identity. Sex became the key target of what Foucault termed 'biopower', which manifested itself primarily in normalizing forces aimed at the control of life through scientific knowledge. The notion of sex was central as it 'was a means of access to both the life of the body and the life of the species' (1990:146). The discourse of sex allowed for both the disciplining of individual bodies and for the regulation of entire populations.

Foucault's work successfully focused attention upon the historicity of sexual identities, and upon the category of homosexuality in particular. It also opened up many paths of enquiry linking sexuality with other cultural formations. Despite the voluminous literature inspired by *The History of Sexuality* however, I want to suggest that the significance of Foucault's problematization of the category of 'sex' itself has not yet been sufficiently thought through³. He is quite clear in the final pages of the book that his intention has not been to write a history of the way that bodies are culturally perceived and given meaning and value. Rather, the logic of his work leads to an examination of the biological itself, of the taken-

for-granted status of sex as the source of the drives and affects characterized as 'sexual'. For Foucault, the challenge is to understand the complex relation of the biological to the historical. It is the historicity of 'sex' – that ungainly category, always somehow suspended between doing and being – which we are called upon to think here. To what do we refer when we speak of sex? Foucault argues that:

First, the notion of "sex" made it possible to group together, in an artificial unity, anatomical elements, biological functions, conducts, sensations, and pleasures, and it enabled one to make use of this fictitious unity as a causal principle, an omnipresent meaning, a secret to be discovered everywhere: sex was thus able to function as a unique signifier and as a universal signified (1990:154).

In this way, sex may be seen as a means of imposing order upon both nature and society. The emergent eighteenth-century dualism of (hetero)sexual difference – the male defined in opposition to the female, and *vice versa* – seemingly provided a rationale for both individual being and for life in general. It promised a stable ground that would hold fast amongst the rapid changes that Western countries were experiencing in the period of industrialization and nascent consumer capitalism.

For Foucault, sex is both a product of power, and an agency of control and discipline that tames the vitality of bodies. Nevertheless, as Gilles Deleuze has characterized it, a molecular or microphysical sexuality always simmers beneath the molar agency of sex, waiting for the chance of escape (1988:76). This gives

us a clue as to how we should understand Foucault's controversial appeal to 'bodies and pleasures' at the end of *The History of Sexuality*. Although many have seen it as a naïve gesture to a realm of nature outside of power, I suggest that it is best understood as a call to rethink the ontology of bodies beyond the territorialization that 'sex' puts into effect. To quote Foucault more fully:

It is the agency of sex that we must break away from, if we aim – through a tactical reversal of the various mechanisms of sexuality – to counter the grips of power with the claims of bodies, pleasures and knowledges, in their multiplicity and their possibility of resistance. The rallying point for the counterattack against the deployment of sexuality ought not to be sex-desire, but bodies and pleasures (1990:157).

The point is that we should not be too quick here to assume that the bodies, and their pleasures, of which Foucault speaks are located either at the level of the organism or in terms of brute matter. It is to the level of the pre-individual, to the multiplicity of forces and affects circulating beneath organic form, that Foucault's words draw us. It is a question of how to free life from (hetero)sex, and of how to live with that freedom.

Foucault's argument for the speculative materialization of sex within the deployment of sexuality sets everything into motion. Historians tend to agree that the period was one of great change in sexual and gender relations, however few are willing to question the natural authority of sex. The work of Randolph Trumbach (1998) on the eighteenth-century 'gender revolution' in North-western

Europe is a good example. According to Trumbach, around the beginning of the century a nascent 'homosexual' minority of men (known as 'sodomites') formed a third 'gender'⁴ category that was to influence the lives of all men and women throughout the era. Male identity, in particular, was henceforth produced out of a struggle to achieve an exclusive heterosexuality. Sometime later, around the 1770s, this was extended to female identity with the emergence of a minority of women who desired other women exclusively. Prior to the eighteenth century, Trumbach asserts that men's sexual desires were not divided into hetero- or homo- orientations, and neither were bodies divided into only two categories. Indeed, in this regard, there is much evidence of tolerance for hermaphrodites in Renaissance Europe in comparison to the post-seventeenth-century 'fetishism' of dualistic gender categories (Jones & Stallybrass, 1991). With this in mind, Trumbach argues that heterosexuality and homosexuality are not biological facts, but rather socially constructed aspects of an increasingly dichotomous gender system premised upon a new ontological dualism at the level of bodies.

On this logic, however, the 'gender revolution' of the eighteenth century might well be said to be a revolution in sexual difference, for it was by means of sex that desirable bodies were identified. Does not the emergence of the sodomite or the homosexual as a distinct identity necessarily presume that a certain (hetero)sexed relationship has already been established? Can one love the same without first being sure of the other? Trumbach perceptively points to the intimate relationship between modern gender categories and heterosexuality,

but he does not push this further to examine the notion of (hetero)sexual difference underlying the changes of the eighteenth century.

Trumbach's work has been influential, but it has also proved to be controversial. Philip Carter (1997) and Robert Shoemaker (1998) have both argued for the position that social standards of gender are of more significance than sexual practices in the early eighteenth century. Carter's claim is that it is the figure of the 'fop', rather than the sodomite, was key to defining the period's masculine ideal. The fop was characterized by his 'polite' education, his vanity, ignorance, superficiality, and overly refined behavior. All of which were deficiencies thought to derive from spending too much time in female society. For Carter, the conspicuous visibility of the fop indicates that social gender behavior rather than sexual deviancy was most important in setting the standards of unmanliness. On the other hand, Shoemaker argues that there is insufficient evidence behind Trumbach's claims that the emergence of a homosexuality minority led to a broader change in the sexual behaviors of all men and women. For Shoemaker, there are notable changes in *ideas* about gender roles in this period, but the state of sexual *practices* remains much more obscure.

The difficulty with such critiques, however, is that they turn upon a distinction between ideological gender roles in the public sphere and private sexual behavior. Hence, they fail to appreciate the deconstructive force of Trumbach's claim that the social construction of heterosexuality is central to gender relations in the eighteenth century. The point is that such distinctions between the social and the sexual are undone by the intertwining of heterosexuality and modern

gender categories. Taking this a step further, we might say that the fop's unmanly qualities depend on his transgressing of the boundaries of what is proper to each sex – where 'sex' is a category that is neither entirely public nor a private possession of the individual body. Gender display cannot be separated from sexual activity.

Restricting our attention to the question of gender misses what is arguably the crucial event of the period: the heterosexualization of modern society. Henry Abelove (1992) was one of the first to note that the evidence at hand pointed to a significant increase in heterosexual genital intercourse during the late eighteenth century, and a concurrent downplaying of nonreproductive sexual activities. Focusing upon England, he speculates that there may be an opaque connection between this disciplining of sexual expression and the emerging discipline of production associated with industrial capitalism. The implication is that the myriad of available sexual pleasures were channeled into a limited reproductive economy organized around the prohibition of waste and excess, and the promotion of a concept of (hetero)sexuality that would provide an apparently natural basis for the emerging capitalist social order.

The question of how changing social and economic norms relate to changes in the meaning and function of 'sex' is an interesting one. It is an issue that Tim Hitchcock (1996) takes up in his study of the meaning of 'sex' in eighteenth-century England. Like Abelove, Hitchcock argues that during this period there is a redefinition of what constitutes 'sexual intercourse'. While at the beginning of the century it was an activity characterized by mutual masturbation,

kissing, and long hours of caressing and touching, but very little penial/vaginal penetration, by the end of the century sexual intercourse had become increasingly 'phallo-centric'. That is, putting a penis into a vagina became *the* sexual act, with all other activities relegated to the idea of 'fore-play'. He concludes, 'what the eighteenth century saw was the development of an obsession with the penis, and an assumption that there was only one thing to do with it' (1996:79). Moreover, given the intimate connection between sex and the gendered presentation of the self, such a development in the realm of sexual activity could hardly fail to be reflected in beliefs about normative masculine and feminine behaviors. Here, Hitchcock notes that a growing homophobic attitude amongst the public at large throughout the eighteenth century meant that '...men increasingly felt the need to participate in penetrative, heterosexual sex in order to demonstrate their masculine "normality"' (1996:84). In this sense, modern ideas about gender and sexuality are formed in an intimate relation of co-production.

To tie our story together, we need to expand it to encompass changes in the nature of the bodies assumed to be propping up the edifice of gender, and which are central to the social construction of sexuality. Hitchcock looks at the meaning of 'sex' as an act (i.e. 'sexual intercourse') but not 'sex' as an ontological category. Hence, he effaces some of the constitutive ambiguity that makes sex such a troubling category for the modern world. The performance of sex cannot be divorced from the ontology of sex, and the eighteenth century was a period when the sexual nature of men and women's bodies came to appear

increasingly troublesome. For example, Anthea Callen (1998) has shown that the question of women's anatomy, and the need to represent it, attained a new and distinctive emphasis in Enlightenment scientific research. According to Callen, up until the mid-eighteenth century the male skeleton was simply taken as representative of the human species, as sexual difference was not a priority for earlier anatomical researchers. This changed, however, as anatomists were increasingly drawn into a social and political context that sought physiological bases for sexual difference and the superiority of men. Indeed, the need to establish oppositional categories of sexual difference, and to find them within (human) nature, is key to understanding 'sex' at this time. Moreover, I suggest that this is a crucial aspect of the heterosexualization of the eighteenth century.

This process, which we might call the heterosexing of natural bodies, is illustrated in Thomas Laqueur's influential study, *Making Sex* (1990). According to Laqueur, sometime in the second half of the eighteenth century our understanding of human sexual nature changed decisively, and 'sex as we know it was invented' (1990:149). Prior to the Enlightenment, the human body was understood as a microcosm of a larger order. Men and women were beings distributed along a sexual continuum where difference was a matter of degree. Woman did not exist as ontologically distinct beings, but rather were regarded as an imperfect version of Man. Laqueur refers to this situation as the 'one-sex' model. Here, it was social rank and cultural roles (i.e. 'gender') that were most important in determining a person's identity. Gender was a category with cosmological significance. It served to locate each person within a greater order

of things, with bodies thereby reduced to epiphenomena. As Laqueur puts it, 'At the very least, what we call sex and gender were in the "one-sex model" explicitly bound up in a circle of meanings from which escape to a supposed biological substrate – the strategy of the Enlightenment – was impossible' (1990:8).

All this changed over the course of the eighteenth century however. A 'two-sex' model, which emphasized the radical dimorphism of natural, sexed bodies, was to emerge and become dominant. An obsession with uncovering difference, with establishing a secure opposition of male to female, characterized the predominant strands of science and philosophy in this period. The human species was split in two, with the division itself providing a new model for all knowledge of human life and of a natural order of things. We might well see this as the moment when something like a biological Copernican revolution occurred. The fundamentals of life were henceforth to be found in the materiality of bodies, rather than outside of it in a greater order – an ontological shift that already implicitly sets out the agenda for the Human Genome Project. Laqueur's argument (which in many respects is congruent with a historical reading of Butler's work) is that this new (hetero)sexed body – which will eventually become the body of modern biology – is not an asocial, natural foundation of human life and society, but is in fact shaped by gender categories from the start. Equally important, Laqueur claims that this change to the two-sex model had little to do with 'purely' scientific discoveries, and everything to do with social and political conflicts of the day.

The question is thereby raised of why the one-sex model was replaced by the two-sex model. If it was not due to scientific progress, then what lay behind this move? Laqueur's answer has two parts. First, although he denies that any specific scientific discoveries regarding human bodies necessitated the rise of the two-sex model, he does allow that the advent of modern science fostered a new way of understanding the world which, in turn, disrupted previous notions of transcendental order and custom governing social relations. His claim is that 'Baconianism, Cartesian mechanism, empiricist epistemology, Newtonian synthesis... radically undermined the whole Galenic mode of comprehending the body in relation to the cosmos' (1990:154). Indeed, implicit in the Cartesian identification of the self with a thinking being divorced from its body was a challenge to received notions of sexual difference, which had previously been grounded in the lesser nature of female bodies. Similarly, Locke's dismissal of the belief that human minds possessed innate ideas also undermined received wisdom on sexual hierarchy. Enlightenment thought thereby opened a space of contestation in which relations between men, women, and their bodies could be reconceived.

This sets the scene for the second part of Laqueur's explanation for the rise of the two-sex model. His claim here is that the notion of an incommensurable sexual difference between men and women was the product of innumerable micro-confrontations over power and position within the enlarged eighteenth-century public sphere. Men strived to define the public sphere in masculine terms and to distinguish it from the private sphere, which was to be the holding pen for

feminine difference. The dissolution of the former cosmological order, in which women were simply inferior versions of men, gave political theorists the problem of either condemning male dominance as baseless, or of finding a new ground for sexual difference and female subordination. Unwilling or unable to choose the former option, social contract theorists such as Hobbes and Locke turned to nature in order to discover a new basis of inequality. Laqueur summarizes thus:

However the argument works in detail, the end result is that women are absent from the new civil society for reasons based in 'nature'. A biology of sexual incommensurability offered these theorists a way of explaining – without resorting to the natural hierarchies of the one-sex model – how in the state of nature and prior to the existence of social relations, women were already subordinated to men. Therefore the social contract could then be created between men only, an exclusively fraternal bond. Ironically, the genderless rational subject engendered opposite, highly gendered sexes (1990:196-7).

Curiously, while Laqueur's concern is with sex, John MacInnes (1998) employs a very similar explanation to account for the invention of modern *gender* categories. According to MacInnes, the existential anxiety and psychic terrors of living in a Godless world have led modern humanity to create a fetish out of 'sex'. The problem, he alleges, is that natural, reproductive sexual differences have been confused with socially constructed gender differences. The blame for this state of affairs is again laid at the door of the social contract theorists of the late-seventeenth and eighteenth centuries. These theorists are said to have invented

`gender' – understood here as social roles putatively prescribed by sexual difference – in order to perpetuate the oppression of women and defend men's privilege. Hence, MacInnes' claim that gender categories are ideological fictions, which serve only to legitimate inequalities in the sexual division of labor, appears as a mirror image of Laqueur's position that dualistic sex categories are the product of gender politics.

If we look a little closer, however, we find that the seemingly confusing differences between the two accounts are easily resolvable. For, while MacInnes openly relies upon an opposition of the ideological to the material, and of gender to sex, Laqueur's work also turns out to be premised on this basis⁵. In effect, Laqueur drags `sex' into the realm of gender, that is, into the province of the socially constructed. For both writers, the body in its natural identity with itself is radically sealed off from the social and, in a similar fashion to Butler, all dynamism is seen to lie with the latter. By relying upon the opposition of nature to culture, neither Laqueur nor MacInnes are able to give the materiality of sex any meaningful social agency. Furthermore, the relation of sexual difference to the emergence of heterosexuality is left unexamined.

A second problem with the work of Laqueur and MacInnes is that their almost exclusive focus upon gender politics and the self-interested actions of men in maintaining power and privilege gives their explanations of the rise of the two-sex model, or of modern gender ideology, something of the character of conspiracy theories. It is almost as if eighteenth-century men simply got together and invented a sex/gender ideology that suited their collective economic and

political interests. That the actual situation may be more complex than this, however, is in fact registered by both MacInnes and Laqueur. Both subscribe to the position that the changes they describe in sex/gender are initiated by the advent of modern science and Enlightenment rationalism as it undermines established religious beliefs and traditions. As MacInnes puts it:

I wish to argue that as sacred forms of escape from this awareness [that we are the authors of our own destiny] have become less feasible, the fetishism of religion... has been replaced by the fetishism of sex, whereby existential anxiety is often dealt with by projecting it onto sexual difference, imagined as gender.... This is why sex has become the secular religion of disenchanted modernity, dominating all aspects of its culture, and gender the chief means of hiding from the psychic terrors of mortality (1998:13).

This is an argument that I think deserves some serious reflection, but both MacInnes and Laqueur are too quick to assume that scientific rationalism sweeps away religion and creates a secular environment in the eighteenth century. In so doing, they neglect the important relationship that holds between Nature and God in this period. Even Nietzsche, well known for his pronouncement that 'God is dead', also noted that, 'This tremendous event is still on its way, still wandering; it has not yet reached the ears of men' (1974:182).

We can pursue this issue further if we turn our attention to Laqueur's (2003) more recent work, which attempts to explain the moral panic surrounding 'solitary sex' in the eighteenth century. The question broached here is why, after

centuries of relative inattention, should masturbation suddenly become such a prominent social issue and suffer such harsh general condemnation. Laqueur sets the frame for his study with a decisive opening statement: 'Modern masturbation is profane' (2003:13). Again, it is to processes of secularization and the emergence of modern science that we are directed to turn in our quest for lucidity. For Laqueur, the solitary pleasures so derided by eighteenth-century writers are an essential part of the modern, secular society that is taking shape at this time. A continually recurring theme of his book concerns the claim that it is nature rather than God that now sets the standard for normative sexual expression. Masturbation is problematic in the eyes of Enlightenment moralists because it transgresses the *natural* order, because it has no *real* object of desire, because it goes beyond *natural* limits. At the heart of these objections to the unnaturalness of solitary sex, according to Laqueur, are pervasive anxieties over commercial culture and civil society. At bottom, masturbation, in its excessive and private desires, represents deeper concerns about the fate of the social good within capitalist society. Sexual desire unbounded and out of control is said to conjure up underlying fears about where the private desires of the individual in the marketplace might lead. In this sense, masturbation threatens modern society with moral dissolution.

Laqueur's argument is insightful, and clearly holds much force. Nevertheless, we may still wish to ask whether there are other factors to be considered here. Not only is solitary sex an individual activity, it appears all but alone in Laqueur's book. There is little consideration of its relation to the emerging two-

sex model, nor is there any significant consideration of how the condemnation heaped upon masturbation fits in with the rise of heteronormativity. The exception is a brief section where Laqueur discusses Trumbach's assertion that the censure of masturbation goes along with that of sodomy as a part of the new heteronormative economy of sexual pleasure (1998:63)⁶. Curiously, Laqueur rather summarily dismisses this position by claiming that it cannot explain why solitary vice is now more significant than in previous crackdowns on sodomitical behavior throughout Western history. Yet, he doesn't pause here to consider what is distinctive about the period under discussion – much of which is in fact presented in his own earlier work on the emergence of the two-sex model. Laqueur asserts that sodomy, and by extension heteronormativity, has no special place in relation to masturbation, as the latter is associated with 'every other sort of sexual and moral deviance as well' (2003:267). This is, however, to fail to take into account the relation between (hetero)sexual difference, heterosexuality, and the divinity of the natural order, which frames all forms of deviance in the period.

Laqueur is, however, alert to the importance of natural authority in the eighteenth century, particularly as it appears in anti-masturbatory discourses. He notes, for example, that medical science gained much social standing at this time as moral norms came to be viewed as products of nature. Yet, he never pursues the question of where this natural authority is derived from. Why does nature come to possess such authority at a time when knowledge is predominately conceived to be the product of disembodied rationality? Laqueur presumes that the shift from the premodern, cosmological worldview to the modern, scientific

account of the world necessarily involves a parallel shift from God to Nature, in which the former loses his authority. As we have already seen, however, the assumption of such a decisive break is problematic. The shift in question may be more of a displacement in the sense that God is expressed through nature for the eighteenth-century mind. It may be the case, then, that (hetero)sexual difference and heterosexuality provide nature with a quasi-teleology at a time when divine authority can be present only in a more indirect fashion. Curiously, Laqueur evinces no interest in drawing a connection between his previous analyses of the eighteenth century's obsession with establishing an oppositional notion of sex, and his account of how solitary sex was simultaneously obsessively denounced. Yet, surely the 'unnaturalness' of masturbation is related to its ambiguous sexual nature, which alludes to the waywardness and wastefulness of nature, and its potential transgression of heterosexual ends. The self-absorption of masturbation threatens the marriage of the two sexes as *telos* of the social order. It is 'profane' not because it is dissociated from the holy, but rather, because it is a defilement of the sacred.

A founding presumption of Laqueur's account of solitary sex in the eighteenth century is that modern science and medicine stand in opposition to the premodern, religious worldview. One might say that the divide between divine authority and scientific enquiry appears as sacrosanct in his work. But is this necessarily the case? Can we be so sure that we know where we should locate the sacred? Or, indeed, of what we refer to when we utter the term 'God'? In the next two sections, we will consider these questions as they relate, first, to

Enlightenment science in general, and second, to the prehistory of biology in particular.

Divine Sex

Perhaps it was Georges Bataille (1986) who most forcefully pointed to the connection between sexuality and religion. 'Eroticism' is Bataille's term for the wanton spending of excessive sexual energy, an exuberance of life that implicitly aims to transgress the boundaries of individuated existence and to reach something greater. Religious impulses are said to desire the same: an experience of continuity that draws one beyond the limits of one's being. For Bataille, eroticism and religion move in the same direction, they desire the same experience of divine intimacy. Where eroticism opens us up to God, however, reproductive 'sexuality' closes things down and tries to contain sexual energy within the economy of a closed system. In a piece written in the early 1960s commenting on Bataille's work, Foucault asserts that, 'the speech given to sexuality is contemporaneous, both in time and in structure, with that through which we announced to ourselves that God is dead' (1998:70). Hence, 'Perhaps the importance of sexuality in our culture... derives from nothing else than this correspondence which connects it to the death of God' (1998:71). Taken out of context, such comments might seem to imply that sexuality is a merely secular product of modern scientific discourse. For Foucault, however, as for Nietzsche, 'The death of God is not merely an "event" that gives shape to contemporary experience as we now know it: it continues indefinitely tracing its great skeletal

outline' (1998:71). We are given the task, then, of thinking further on the intimacy that brings together God's ongoing death and sexuality.

The context for the emergence of (hetero)sexual difference and (hetero)sexuality, and for the 'event' signifying the death of God, is to be found in the account of the Classical episteme sketched out by Foucault in *The Order of Things*. Arising in the late-seventeenth century, Classical thought is characterized by its rationalism and desire for the completeness of a scientific order. For Foucault, it is the notion of *Order* that is fundamental to Classical knowledge. All talk of sex was driven by the need to produce order '...in the form of analysis, stocktaking, classification, and specification, of quantitative or causal studies' (1990:23-4). The world is thereby understood in terms of mathematical concepts, such that all beings may be arranged upon a great table of knowledge:

In any case, the Classical *episteme* can be defined in its most general arrangement in terms of the articulated system of a *mathesis*, a *taxinomia*, and a *genetic analysis*. The sciences always carry within themselves the project, however remote it may be, of an exhaustive ordering of the world; they are always directed, too, towards the discovery of simple elements and their progressive combination; and at their center they form a table on which knowledge is displayed in a system contemporary with itself (1994:74).

Knowledge, in the eighteenth century, is a matter of putting things into order, of reading the signs of nature and determining the relations that hold between each and every one. One might say that this expressed an inchoate desire for

something like a comprehensive database of life. Here, our interest is in 'sex', how it functions as a sign within this system, and what its relation to the death of God might be. In particular, we wish to know if scientific enquiry into the nature of sex deserves to be regarded simply as a secular venture.

David Noble (1993) has argued that, rather than being opposed to religion, modern Western science emerges directly out of Christian clerical culture. He points out that the Church in the seventeenth century supported the new mechanistic and mathematical approach to nature. Moreover, Isaac Newton, who epitomized the new science, wrote many volumes of theology, and considered himself to be a devoted Christian uncovering the traces of God's creation. According to Noble:

Now, in the wake of a religious and philosophical revival which had identified God with nature and had thereby afforded people a more immediate connection with God through nature itself, without clerical invention, the re-establishment of orthodoxy required a new form of mediation between mankind and nature. This, above all, was the meaning of the so-called scientific revolution. Linked closely to religious institutions, the emergent scientific establishment constituted in effect a new layer of ecclesiastical (but increasingly lay) 'clergy', interposed between mankind and nature, and thus between mankind and God (1993:240).

On the one hand, the Church did not oppose scientific enquiry into nature because it considered this to be a matter of deciphering the signs of God. On the other hand, leading scientists, although they may have opposed institutionalized

religion, did not see their work as being in conflict with the notion of a divinely created world. Of course, it is a simple matter to show that professions of religious intent abound in the eighteenth century. More difficult is the question of determining precisely what meanings or forces are generated by these theological discourses.

The thesis we are pursuing here brings God's increasingly spectral presence into conjunction with the emergence of (hetero)sexual difference and (hetero)sexuality. In this regard, there has been some debate amongst readers of *The History of Sexuality, Vol.1* as to when Foucault believes sexuality to have been invented. While we should not pay too much heed to specific dates, if we look to the essay on Bataille, read alongside *The Order of Things* (1994), there is no doubt that Foucault posits sexuality as emerging along with the discursive formation he refers to as the modern episteme⁷. The transition from the Classical episteme to that of the modern, which occurs around the turn of the nineteenth century, marks the emergence of Man, who, for Foucault, is a finite being, newly aware of his limits, and thoroughly immersed in history. Sexuality is not yet named as such, but its gathering presence already makes itself felt in the constitution of human nature. *The Order of Things* traces a movement whereby Man displaces God, yet without being able to completely free himself from the latter. It is the opaque connection between the continued presence of the absent God and the emergence of 'sex' as the *truth* of human nature that gives us pause in announcing that we are witnessing the advent of the secular modern world. In speaking of the dissolution of Classical knowledge, Foucault writes,

'This event, probably because we are caught inside it, is largely beyond our comprehension' (1994:221). We do not know what the death of God means for us; it is central to the unthought of our modern being; its history is yet to be told.

If we cannot be sure of God's death, then how can we mourn? Indeed, how could one mourn a death through which one has been given the freedom to think through the implications of that very event? Might it be, then, that (hetero)sexual difference is a melancholic formation, the product of an affective force that unconsciously preserves the 'dead' God through a process of bodily incorporation and psychic identification? In this light, Foucault's *The History of Sexuality* could be read as an attempt to understand the way in which 'sex' comes to function as an unthought 'God' for nineteenth-century natural science, and for modern Western society more generally. Sex is the uncaused cause, the truth of nature and of human being. It provides a guarantee of our ability to know both the natural world and ourselves, in the same way that God provided a foundation for eighteenth-century natural history. (Hetero)sex, through its difference and its repetition, organizes the time of nature.

The plausibility of this reading of Foucault's work may not be apparent at first, for he speaks little of God, or of his death, in *The History of Sexuality*. Nevertheless, a structural reference to religion is indeed central to the book in the form of the confession. For Foucault, the Christian confession developed over the centuries into one of the West's most valued techniques for producing truth. Indeed, he claims that we have internalized the process of confession to such an extent that it pervades almost every corner of our lives:

The obligation to confess is now relayed through so many points, is so deeply ingrained in us, that we no longer perceive it as the effect of a power that constrains us; on the contrary, it seems to us that truth, lodged in our most secret nature, 'demands' only to surface (1990:60).

No longer does our 'religious' quest lead us outside of ourselves towards the infinite. On the contrary, our search for truth takes us to 'our most secret nature'. But what is our *secret*? What do we confess? For Foucault:

We must not forget that by making sex into that which, above all else, had to be confessed, the Christian pastoral always presented it as the disquieting enigma.... What is peculiar to modern societies, in fact, is not that they consigned sex to a shadow existence, but that they dedicated themselves to speaking of it *ad infinitum*, while exploiting it as *the* secret (1990:35) [emphasis in original].

Sex is *the* secret. It is a matter of secrecy, of its function, of its location. Does the secret bear the weight of the unthought? Has God become lodged within the darkest reaches of human nature? Today, we are told that the Human Genome Project has revealed to us the 'secret of life'; but we are getting ahead of ourselves. The next chapter will take up again these questions concerning the unthought dimensions of sex, science, and modernity. For now, we will stay a little longer in the eighteenth century.

Plant Sex

The work of reading and classifying the signs of nature during the Enlightenment fell largely to the science of 'natural history'. This is an endeavor that should not be confused with either present-day biology or history. In the eighteenth-century world of stable and unchanging forms, notions of historical development concerned the gradual unfolding of a pregiven origin, rather than the emergence of the new. The role of the natural historian was one of comprehensive classification and the production of a descriptive order that encompassed all of nature in a unified system. We cannot speak of biology at this time either, for the object of modern biological discourse had not yet been identified. As Foucault puts it, 'if biology was unknown, there was a very simple reason for it: that life itself did not exist. All that existed were living beings, which were viewed through a grid of knowledge constituted by *natural history*' (1994:129). Life, as the concept of a vital force hidden within the depths of beings, would not emerge until the nineteenth century, bringing with it the disciplinary formation that came to be known as biology.

This notwithstanding, we can look at natural history as forming something like a prehistory of biology. Rather than merely tracing the beginnings of biological science back to the work of Mendel and Darwin, we can ask how the interests and modes of inquiry that characterize Enlightenment science persist in the later formations of the nineteenth century. Botany has a preeminent place here. In large part due to the influx of exotic plant specimens as a byproduct of colonial expeditions, European societies were faced with a seemingly chaotic

disorder that called forth a desire to classify. The natural world – consisting of both human and nonhuman ‘racial’ diversity – appeared to overflow the categorical constraints that had previously been charged with ensuring that everything remained in its rightful place. Someone would have to discern a system amongst the disarray, and the task fell to the Swedish botanist Carl Linnaeus. As one of the most influential scientific figures of his time, Linnaeus played an important role in shaping public understandings of nature. His *System of Nature*, which went through numerous editions between 1735 and 1768, each larger than the preceding one, and was translated into many different languages, was an epoch-defining work. In part, this was due to the resonance that Linnaeus’ sexual system of classification found with other currents of eighteenth-century thought⁸.

The beginnings of botanical science are often traced back to the work of John Ray in the late seventeenth century. Prior to this time, botany had been closely associated with medicine and its investigations were driven by the desire to discover new curative properties of plants. Departing from this model, Ray inaugurated a new type of botanical science, one which pursued the classification of *all* plant species as a way of manifesting the divine order of the natural world. This comprehensive, descriptive approach was to pave the way for the great classificatory systems of prominent naturalists like Linnaeus and Cuvier (Oppen, 1973:127). (Indeed, a line might well be drawn right through to the Human Genome Project, and to late twentieth-century debates over the merits of grandiose nomenclatural or cartographic projects). No longer bound to practical

applications, botany expanded its reach to the entirety of nature, including, if only by analogy, animal and human bodies. This last point is not without interest when we place it alongside the other significant feature of late seventeenth-century botany: a sudden interest in the sexuality of plants. In his *History of Genetics* (1972), Hans Stubbe dates the discovery of plant sex to 1694 with the publication of Rudolf Camerarius' *Letter on the Sex of Plants*. This was, however, just one of many fledgling attempts to describe the sex life of plants, an endeavor which culminated in Linnaeus' grandiose sexual system of nature. In an exemplary Foucaultian fashion, botanical science was in the process of becoming consumed by a desire to uncover sex, to name it, to speak it, to find it everywhere in nature.

The work of Linnaeus was central to the popularization of plant sexuality, and to its positioning as central to the understanding of all of nature. Like Ray, he understood his task to be that of revealing the magnificence of God's creation through demonstrating the underlying rationality and order of nature. Unlike earlier Christian attitudes, however, it was now through sex that the path to God was to be found. Linnaeus had no doubt about the validity of his sexual classifications, claiming that '...*Anthers* are the male genital organs; when they strew their genital flour (pollen) on the *stigma*, the female genital organ, *fertilization* takes place; this has been proved by observations, experiments, analogy, anatomy, antecedents, consequences, and its use' (1964:23). As many commentators have noted, however, Linnaeus also admitted that his sexual system was 'artificial': 'No natural system of plants... has so far been

constructed; nor do I contend that this system is really natural.... In the meantime, however, as long as a natural system is lacking, artificial systems will definitely be needed' (1964:23). The 'artificiality' of the sexual system of classification lay in organizing plants according to a single, predetermined factor applied exclusively. Although the ultimate goal was to reveal the natural system in all its multifaceted glory, when faced with such a gigantic task a start had to be made somewhere. The question is, why was sex the privileged category?

Plant sexuality can be situated in terms of one of the central problems of eighteenth-century natural science: how to explain generation and reproduction. For Linnaeus, everything revolved around fructification – the process of impregnation and the bearing of fruit – as the sign of God's hand in the creation of complementary natural structures. A plant's sex testified to its place within a greater whole animated by divine purpose. James Larson provides a useful summary of the Linnaean position:

The 'naturalness' of Linnaean genera rests, then, upon assumptions about the principle of activity for the performance of which plants have come into being. The 'nature' of the genus has here a narrower sense than 'reality': it is the formative factor in reality. The simple elements of fructification, when isolated, analyzed, and given explicit form, teach the naturalist the characters of the genera spelled out by the hand of God (1971:93).

The essence of nature is to be found in sex, and here Linnaeus' work gave shape to the modern concepts of 'genus' and 'species', classified in terms of

reproductive organs and physical structures. Despite the overwhelming quantity of *information* produced in the Linnaean system, it is sex alone that determines the reality of the natural world, and which provides it with its *meaning*. Here we must again recall that the eighteenth century is a turbulent time for the concept of sex. The sex of plants is attributed as though it is self-evident once recognized; yet it is only through analogy with human sexual categories, which are themselves undergoing significant reconceptualization at this time, that this may be so. This does not trouble Linnaeus, however, even when plants cannot be unambiguously assigned to either male or female categories. He has no difficulty in recognizing a 'hermaphroditic' category as this is conceived simply as the co-presence of male and female elements rather than as a third category that troubles the coherence of the system. It could not be otherwise, for the framework of the Linnaean system is, in essence, nothing but a technology for the production of (hetero)sexual difference.

In the course of a provocative commentary on this coincidence of 'scientization' and 'sexualization' in modern botany, Londa Schiebinger is alert to the implications of Linnaeus' anthropomorphism: plant sex = (hetero)sex. She draws attention to his obsession with reproductive, heterosexual coupling, noting that, 'Not only were his plants sexed, but they actually became human; more specifically, they became husbands and wives' (1993:22). The Linnaean sexual system is thereby not out of step with the normative tendency toward heterosexual coupling and marriage that characterizes the eighteenth century in general. Schiebinger points out that botanical science participated in a more

general move towards the establishment of natural, complementary sex differences. In this context, she claims that, 'The grounding of sexual difference in the body played to Enlightenment sensibilities that *nature* prescribed the laws of society' (1993:38). For Schiebinger, however, this turn to nature is in reality a matter of the influence of existing gender hierarchies upon definitions of sex. Moreover, her explanation for this process is reminiscent of those given by Laqueur and MacInnes. In the end, it is all a matter of gender politics and the reproduction of male privilege. According to Schiebinger, the newly emergent, oppositional ontology of sex functioned as an ideological response to the question of women's rights. Rather than being a product of disinterested science, 'The doctrine of sexual complementarity... functioned as an important supplement to nascent liberalism, making inequalities seem natural while satisfying the needs of European society for a continued sexual division of labor' (1993:39). This is an important point; yet, is it only the material interests of men that are involved here? How do we explain the availability of 'sex' at this time in such a way that it may be reinscribed in the context of gender politics?

It is notable that Schiebinger subordinates the issue of (hetero)sex to that of gender politics. Nature is thereby occluded as an actor, reduced to an inert substance that underlies the self-evident categories of men and women, and their ideological power struggles. Nor is the heterosexualization of society critically examined in relation to the 'death' of God or the historical condition of nature. Schiebinger's critique is directed towards the influence of *men* in the shaping of modern science, and, by extension, in the shaping of modern society.

Left untouched are ontological and epistemological issues that might have been broached by a more extensive engagement with the meaning and affective force of sex outside of the sexual division of labor. Linnaeus' classification of plant life through analogy with human sex draws upon a historically specific understanding of the latter that cannot simply be reduced to political considerations. His work does more than merely reinforce traditional gender hierarchies; it plays an important role in the production of (hetero)sexual difference as a framework that allows scientific knowledge to *respond* to the presentation of nature after the 'death', or withdrawal of God.

Gender, Science, and Sex

Schiebinger's work can be located within a tradition of feminist critiques of science that stretches back to the mid-1980s. A critical examination of the origins of modern Western science has been an important feature of this literature. Carolyn Merchant's *The Death of Nature* (1980) was perhaps the first influential condemnation of modern science's domination of both women and nature. Framed in an ecological perspective that seeks to revalue a premodern, organic relationship between humanity and nature, Merchant argues that the scientific revolution of the seventeenth century resulted in the 'death of nature'. Wielding new mechanistic metaphors, Francis Bacon and Rene Descartes, among others, conceived and promoted a view of nature as a giant machine moved by external forces. For Merchant, this was a response to a perceived problem of disorder in the natural world, which had, in turn, called forth the desire for order. The

mechanical framework held out the promise of rational – and therefore masculine – control over nature, society, and self.

According to Merchant, premodern, organic nature was considered feminine in the sense of being a nurturing 'Earth Mother', but it also possessed a dark underside where the wild and seemingly uncontrollable power of nature was figured in female terms. The philosophies of the scientific revolution employ the latter characterization of an apparently disordered feminine nature in order that they may assert themselves by transforming it into something passive and under control. Hence, the emergence of modern science is premised upon a refiguration of the nature of woman. Rather than a wild and dangerous feminine power, often figured in terms of sexual appetite or witchcraft, nature is subdued and stabilized by characterizing her as a passive, mechanical system lacking its own creative power. Put simply, it is a question of sexual order, and of the domestication of desire. Moreover, it can also be seen as a response to the 'death' of God insofar as the authority underlying the production of nature is now re-established through the mediation of the feminine.

Merchant's argument implies is that there is a tension in predominant characterizations of nature, and of the nature of woman, built into the origins of modern science. Similarly, Ludmilla Jordanova, in her study of images of gender in modern science, notes that throughout the Enlightenment nature was represented as either '...that which had been understood and mastered, or that which was yet wild and dangerous'. Moreover, 'women could be identified with both senses of nature' (1989:41). It is as if the order of nature is established by

displacing its complexity, creative force, and disordered energy onto women's sex, where the question of its control could be framed in terms of social regulation. The order of nature, we might say, is thereby projected through the ideal of normative femininity. Science, on the other hand, was identified with the masculine mind (and, ultimately, with God) divorced from the matter of sex. Or so it seemed.

In one of the most influential texts on gender and the origins of modern science, Evelyn Fox Keller (1985) argues that the scientific revolution was instrumental in establishing the very polarization of gender categories upon which the separation of science and nature, subject and object, depended. The dualism of gender (premised on (hetero)sex) provides a model for scientific knowing. Like Merchant, Keller suggests that men's fear of women's sexuality, of its potential for causing disorder within the context of the social, political, and economic changes that the emergence of commercial capitalist society was bringing to Europe, plays a crucial role in the development of modern science. Summarizing, she writes:

If concepts of rationality and objectivity, and the will to dominate nature, supported the growth of a particular vision of science, they supported at the same time the institutionalization of a new definition of manhood. Given the success of modern science, defined in opposition to everything female, fears of both Nature and Woman could subside (1985:64).

Keller's argument is that scientific method provides men with a way to feel more secure about their place in the world. By separating themselves from women, and by dominating nature, men can enjoy the feeling of being in control. The question that arises here is: why did men, at this particular time, feel insecure? Why is there such a perceived desire or need to be in control?

The claim that changing ideas about gender or sex in the late seventeenth- or eighteenth century are a response to the loosening of tradition associated with the rise of capitalist society and its attendant liberal ideologies that threatened male privilege is implicitly or explicitly made by most feminist critiques of early modern science. No doubt this is part of the story. We might want to ask, however, whether this is sufficient to account for the coalescence of science with a masculine desire for control over nature. Noble, for instance, argues that in these pioneering feminist attempts to come to grips with the masculine quality of the scientific tradition, '...for the most part the exclusive identification of science with men has been taken as a given, something to be overcome, perhaps, but never really explained' (1993:xiv). His claim is that without examining the evolution of the Latin Church and its ascetic culture, which excluded women, we are unable to appreciate how Western science came to be a deeply masculine endeavor. Hence, he suggests that, 'It is here, in the struggle of the Latin clergy to impose itself between God and the rest of humanity, that the curious culture which spawned Western science took shape' (1993:xv). For Noble, science takes upon a masculine character because it emerges out of a preexisting masculine culture — that of the Christian clergy. His work has the merit of bringing (the

death of) God back into the question of the relation between scientific knowledge and sexual difference. For, as noted above, between God and humanity in the eighteenth century we find nature, most notably in the form of a putatively natural sexual order. This suggests that the male scientists who took up this clerical heritage were involved in both gender politics and the attempt to reconcile religious and scientific worldviews through the agency of sex. What Noble's position does not reflect, however, are the changes in both sex and gender categories that are apparent throughout this process.

We may also question whether men dominated the science of the period to the extent generally assumed. Geoffrey Sutton (1995), for one, has argued that the case is often overstated. Focusing on French society in the seventeenth and eighteenth centuries, Sutton claims that women played a much greater role in the promotion and development of science than is generally recognized. He bases his argument on an examination of the reception and validation of science within the 'polite' culture centered upon the salons, coffee houses and other new public spaces of the period. In this setting, the priority of visual observation in the construction of scientific facts is particularly apparent, as claims to scientific knowledge were dependent on display rather than on logical proofs. Sutton's, somewhat surprising, conclusion is that people accepted the new science because they enjoyed seeing it demonstrated. The elite of society did not understand the 'truth' behind what they saw, but were willing to support scientific progress because they found it entertaining. With regard to the gender politics of science, then, Sutton points out that women had a significant presence within

salon culture, and that polite society in general bore many feminine characteristics. Hence, he argues that, 'the participation of women and their role in the formation of the science of the scientific revolution must temper our notions of the manly character of science' (1995:344).

Yet, while a focus on the social interactions that are inevitably involved in the acceptance of any scientific claim as a 'truth' is always valuable, Sutton's work suffers from an over-emphasis upon the actual presence of women themselves. Indeed, we might say the same about Noble's work, save that his focus is on the presence of men. Both take the masculine or feminine character of modern science to be largely a straightforward function of the predominance of men or women in the immediate vicinity of the scientific action. Two comments can be made in this regard. First, as Keller notes, 'Most culturally validated intellectual and creative endeavors have, after all, historically been the domain of men. Few of these endeavors, however, bear so unmistakably the connotation of masculine in the very nature of the activity' (1985:76). A simple, but forceful point; it is also one that bears upon contemporary science as women become increasingly more involved in empirical terms, but the issue of how to assess gendered inheritances is more complicated. Secondly, neither Sutton nor Noble considers the changes taking place with regard to (hetero)sexual difference in the eighteenth century. Both presume that the categories of men and women are essentially stable in their meanings throughout the period, and hence are available to simply bestow those meanings upon the beliefs and practices of science. It may be, however, that it is not so much the reproduction of a gender

hierarchy as it is the emergent duality of sex and the concurrent heterosexualization of eighteenth-century society that gives shape to scientific ways of knowing. Of particular interest here is the way in which science begins to be opposed to other ways of knowing such as art or religion. Within the oppositional framework of (hetero)sexual difference, these alternate forms of knowledge increasingly come to connote the 'feminine' due to their supposedly passive relation to nature.

How, then, are we to approach the questions that feminist critiques of early modern science raise for us today? On the one hand, the suggestion is clearly that masculine interests have shaped the Western scientific worldview, and the methods that it employs to know the natural world. From this perspective, the scientific tradition from the seventeenth century up to the present continues to privilege a masculine epistemology. On the other hand, however, how could we assert this to be true today, when the unity of the natural sciences is far from secure, and when much research in recent years has revealed the great diversity that exists in enactments of masculinity? From this perspective, it would make little sense to refer to science as inherently masculine. The difficulty is that both these claims seem to possess a certain validity, both impose a seemingly undeniable force on us, and hence we are caught in what appears to be an impasse.

This perhaps explains why the association of scientific tradition and method with masculinity is today often implied or presumed, but rarely examined in any depth. An exception would be Karl Figlio's (2001) recent study, which explicitly

characterizes science both in terms of masculine domination over nature, and as the product of an unconscious desire for phallic mastery. As is the case with Keller's influential early work, *Figlio* employs Kleinian (or object relations) psychoanalytic theory in seeking to uncover the gendered roots of modern science. While such explanations tend to produce universalistic and ahistoric accounts of human subjectivity, and are problematic on that basis, it may not be insignificant to note that attempts to engage with the relationship between science and masculinity are often led in the direction of unconscious processes and affects. Without necessarily subscribing to the specifics of the Kleinian, or any other psychoanalytic system, I suggest that a certain notion of unconscious or unthought desire may assist us in our efforts to find a way out of the impasse mentioned above. We may ask: what role does the eighteenth-century reformulation of 'sex' as an ontological (hetero)sexual difference, which incorporates a quasi-teleological form of desire, play in establishing the authority of the modern philosophic and natural scientific tradition of the West? To what extent does the discourse of (hetero)sexual difference, especially with regard to control over female sexual expression, underlie the reproduction of a natural order that legitimates not only male dominance throughout changing socio-economic circumstances, but also the very possibility of scientific knowledge in regard to life and the world? I will pursue these questions, initially, by returning for a final time to the thought of the eighteenth century in an effort to discern the workings of (hetero)sexual difference in some of the most prominent philosophies of the period.

Unnatural Sex

If there was one European thinker whose writings were central in shaping the way that the eighteenth century public understood nature, sex, and the relation between them, it was perhaps Jean-Jacques Rousseau. His work expresses the first stirrings of a 'romantic' perspective that has characterized one of the most influential ways of thinking about nature right up to the present day. Romanticism, conceived as an artistic movement of the early nineteenth century, is generally seen as a reaction to the imperious claims of Enlightenment rationalist philosophy, to the alienation produced by commercial society, and to the exploitation of nature intrinsic to the developing industrial economy. Rousseau was not against the progress of science, but he saw clearly that there were dangers involved. If the (scientific) desire to order and catalogue nature – to know it so that it may be controlled, dominated, and set to human uses – can be characterized as one of the distinctly modern ways in which we relate to nature, then Rousseau might be said to give voice to a persistent alternative within modernity that pines for an earlier, more intimate relation to nature now seemingly lost to us. At the same time, however, the discursive construction of nature within this romantic ideal drew from both the new formulation of (hetero)sexual difference and from the Linnaean sexual system of botanical classification.

We can begin to understand Rousseau's perspective on nature by examining his reaction to the botanical enterprise of Linnaeus and others. At the time, questions about transplantation and reproduction were of concern due to the vast

influx of foreign plant species pouring back into Europe from colonial expeditions to other parts of the world. Linnaeus was a strong advocate for the domestication of imported species, but Rousseau took the position that this process of denaturalization corrupted these foreign plants, and thereby disrupted the order of nature. Moreover, he claims that the transportation of plants outside of their native environments contributes to the further separation of humanity from nature. Rousseau writes, 'To cover the mantel of one's fireplace in the month of January with forced vegetation, with pale and odorless flowers, is less to embellish winter than to spoil spring' (1979:346). The implication is that the authority of nature is dependent on it freely giving of itself in its own time and place. If human beings are to live in accordance with nature, then they must respect the way in which nature presents itself, rather than attempting to rearrange the order of things.

Such a position, needless to say, resonates strongly with contemporary debates over genetic engineering and other biotechnologies that attempt to 'play God'. The specter of the monstrous was a persistent anxiety for eighteenth-century thinkers, just as it haunts the public imagination today. Monstrosity was an especially problematic category for Enlightenment scientists as they struggled to arrange all of nature into a rational order (Curran & Graille, 1997). By appearing to contradict the laws of nature, the monstrous birth challenged the notion of a divine order. For Rousseau, as Alexandra Cook (2002) has shown, monsters are the result of human intervention into nature. Exotic plants forced to reproduce in a foreign climate, or through unnatural relations with native species,

result in monstrous offspring. When boundaries are transgressed, the beauty and order of nature is lost. Hence, disputing the domestication strategy of Linnaeus and those who wished to disregard the spatial and temporal order of the natural world was no minor matter. As Jacques Derrida has argued, for Rousseau, when botany is reduced to a supplement of society, this is '...the catastrophe of the catastrophe. For in Nature, the plant is the most *natural* thing' (1998:148). At issue is the way in which social forces, unchecked, can pervert the course of nature. The threat of the monstrous birth reminds us that sex and its consequences stand at the intersection of science and society in the eighteenth century. Unnatural sex, plants breeding in extravagant manner, causes Rousseau much consternation.

Derrida, as is well known, also points to another sexual supplement of nature that is especially troubling to Rousseau:

The dangerous supplement, which Rousseau also calls a 'fatal advantage', is properly *seductive*; it leads desire away from the good path, makes it err far from natural ways, guides it toward its loss or fall and therefore it is a sort of lapse or scandal. It thus destroys nature.... The dangerous supplement destroys very quickly the forces that Nature has slowly constituted and accumulated (1998:151).

The 'dangerous supplement' referred to here is, of course, what Laqueur terms 'solitary sex'. Standing outside the reproductive economy, masturbation not only supplements, it threatens the dissolution of natural order. This danger runs, like a treacherous undercurrent, through Rousseau's most comprehensive and

important text, *Emile* (1979). Framed as an educational treatise, *Emile* should perhaps be regarded more as a philosophical work on the human condition. Originally published in 1762, and tremendously popular throughout the remainder of the century, *Emile* provides us with Rousseau's vision of how to live in accordance with nature. Like Thomas Hobbes and other social contract theorists, Rousseau believes that the primordial and natural condition of the human being lies in his or her individual existence. But he also recognizes that this has no meaningful contemporary reality. The problem then becomes: how can one lead a natural life in society? Rousseau's solution, in brief, calls for the sheltering of children from the unnatural stimulations of contemporary society. Social forces must be held at bay during childhood, thus allowing time for nature to do its work in shaping a strong adult character that is able to resist the seductions of a society promising the quick satisfaction of individual desires. Sexual expression, according to Rousseau, *naturally* emerges within the coupling of husband and wife – the fundamental social unit. Should sexual desire be stimulated too early, especially via masturbatory pleasures, there is great danger that nature will be thrown off course.

The influence of Rousseau's work is well recognized. In *Solitary Sex*, Laqueur notes that, 'The wide dissemination of *Emile* and its many interlocutors had already carried the anxiety about masturbation far from its starting point, and a whole new educational literature carried it farther' (2003:53). Indeed, Rousseau provides much evidence for Laqueur's explanation of the rise of solitary sex as a social problem in the eighteenth century. To recall, Laqueur's argument is that

the pervasive cultural anxiety generated around the issue of private pleasures was a product of displaced fears over the strength of social bonds in the context of the emergent commercial society. Here, the fear is that an individual's unrestrained imaginings, which have no inherent limits, will lead in an asocial direction. For Rousseau, too, masturbation is a result of the imagination being stimulated out of control by modern socio-economic forces that disregard traditional morality, thus perverting the natural course of events, and undermining the establishment of healthy social relations. There is a crucial distinction, however, insofar as Laqueur views solitary sex solely as a threat to the sociability of secular, commercial society, whereas Rousseau considers it a danger to the (divine) natural order that must necessarily underlie a well-organized society:

Once he knows this dangerous supplement, he is lost. From then on he will always have an enervated body and heart. He will suffer until his death the sad effects of this habit, the most fatal to which a man can be subjected.... If the furies of an ardent temperament become invincible, my dear Emile, I pity you; but I shall not hesitate for a moment, I shall not allow nature's goal to be eluded (1979:334).

Rousseau's account of the danger of masturbation places it within a broader context that draws in changing notions of sexual difference and heterosexual marriage in relation to the place of human social relations within the natural order of things. In order to see this more clearly, we will briefly consider Rousseau's notorious account of sexual complementarity between men and women.

In keeping with his time, Rousseau posited a dualistic opposition between the male and female sexes: 'In everything connected with sex, woman and man are in every respect related and in every respect different' (1979:357). In effect, this meant that while men were the guardians of reason whose proper domain was public life, women were destined for a childbearing role in the home. Identified more strongly with the body, with sex, women are ruled by emotion and natural feelings. Controversially, Rousseau claimed that women should therefore not have the same education as men, for their social role as upholders of natural virtue demands that they possess a certain simplicity of being. Unsullied by commercial society, women represent an ideal of nature that is to be both preserved and aspired to. Science is characterized as a manly undertaking, whereas women's role is that of exemplar of a natural order that should not be transgressed by the hubris of human reason. The complementary characters of men and women come together to form a social whole according to Rousseau. His well-known account of the necessity of this process can be found in Book Five of *Emile*. One quote will suffice:

In the union of the sexes each contributes equally to the common aim, but not in the same way. From this diversity arises the first assignable difference in the moral relations of the two sexes. One ought to be active and strong, the other passive and weak. One must necessarily will and be able; it suffices that the other put up little resistance. Once this principle is established, it follows that woman is made specially to please man. If man ought to please her in return, it is due to a less direct necessity. His merit is in his power; he pleases by the sole fact of his

strength. This is not the law of love, I agree. But it is that of nature, prior to love itself (1979:358).

Rousseau's claims have been subject to many critiques, both in his own time and in more recent years. The rehearsal of such criticisms is unnecessary here. A more interesting point is made by Lieselotte Steinbrügge (1995), who argues that, rather than merely 'inventing' concepts of female nature to serve their own material interests, the gendered accounts of Enlightenment thinkers stand in a necessary relation to the dominance of rationalism and scientific discourse. Rousseau was, indeed, well aware of the limitations of reason and scientific enquiry. In order to find room in life for that which he took to be excluded by the instrumental competitive relations and scientific institutions of commercial society, the logic of sexual division forced him to identify the excluded elements with women. It is as if the ontology of (hetero)sexual difference provides an unconscious spacing in which scientific epistemology can claim a secure grounding for itself, while simultaneously excluding its other from the sphere of legitimate knowledge. This may be seen as a way of dealing with a fundamental paradox of scientific knowledge — the need to reconcile its dominance and control over nature with the necessity of ultimately deferring to the latter's authority (which, in turn, lies at the basis of scientific authority). Gender provides a means of displacing this tension as the masculine comes to represent the desire for knowledge and control, while the feminine expresses the authority of natural order in a non-threatening form of display.

In a similar way to Linnaeus, Rousseau's goal was to demonstrate the existence of a natural system that is governed by a closed economy of (hetero)sexual difference, and which finds its *telos* in marriage and reproductive sexuality. Such is the law of nature as authored by God. Yet, just as Derrida's discussion of the 'dangerous supplement' aims to show that nature cannot operate as a self-sufficient origin for human history, the positing of this divine secret at the heart of things has the effect of opening up this system of (hetero)sexual reproduction to something that cannot be contained within its economy. Rousseau, for his part, resists this thought, and his characterization of (hetero)sex as the point of mediation between nature and society is intended to generate a secure natural foundation for the social bond, which, in turn, is to provide closure and stability to the whole system. As Lawrence Cooper (1999) has recognized, what is primarily at issue here is the modern reconceptualization of nature. Reacting to the theories of Hobbes and Locke, Rousseau believed that the reduction of nature to little more than the desire for individual self-preservation gave legitimacy to a society based in rational self-interest and exploitative social relations. Rousseau believed that there was more to 'self-love', and more to the natural order, than this. At issue is the meaning and centrality of sex in modern life, its relation to the presence of the absent God, and how the (sexual) desire for order attempts to find satisfaction. Rousseau's work suggests to us that 'romantic' philosophical knowledge, like eighteenth-century natural history with its sexual system of botanical classification, depends for its coherence upon the discourse of (hetero)sexual difference. The constitution of

biology in the nineteenth century will later draw on both of these conceptual tributaries.

The Sublime, the Beautiful, and the Telos of Sex

Another important eighteenth-century epistemological arena in which we can trace out the workings of (hetero)sexual difference is that of philosophical aesthetics, especially in regard to its key categories of the sublime and the beautiful. Cooper notes that scholarship on Rousseau has increasingly come to recognize the crucial role that sexual 'sublimation' – the upward transformation of desire – plays in producing 'healthy human development' (1999:80). This is an instance, however, in which 'human' development is implicitly figured in masculine terms. As Paul Mattick (1990) points out, Rousseau's characterizations of male power and female beauty can easily be read in terms of the sublime and the beautiful. It is really only man that can overcome nature and achieve sublimity. Woman's role, according to this gendered opposition, is to please; she represents the beautiful. Such aesthetic issues are not of marginal concern; for the popularity of sensationalist psychology and empiricism in the eighteenth century meant that knowledge produced through the senses was central to philosophical and scientific enquiry. Indeed, the categories of the sublime and the beautiful occupy a crucial place in modern Western thought, and they afford us the opportunity of examining both the role that (hetero)sexual difference plays in the structuring of knowledge, and how the latter can effect the materialization of the former.

It was Edmund Burke's *A Philosophical Enquiry into the Origin of our Ideas of the Sublime and the Beautiful* (1990), first published in 1757, which gave definitive voice to the period's fascination with these categories. Burke's philosophy manifests itself through a taxonomic endeavor that seeks to separate out the sublime and the beautiful, and to classify everything (and everybody) into one category or the other. For the sublime and the beautiful, he tells us, "stand on foundations so different, that it is hard, I had almost said impossible, to think of reconciling them in the same subject..." (1990:103). Needless to say, Burke's categories of the sublime and the beautiful are explicitly, and infamously, coded as masculine and feminine, respectively. The world is thereby known through the modern lens of gender.

Burke's *Enquiry* generates an effect that Robert Jones has described as an 'aesthetic of heterosexual excitement' (1998:57). The prime instance of the beautiful, which represents the harmony and order of nature, is found in the (hetero)sexual attractiveness of women to men. For Burke, it is the natural role of women to embody the beautiful, and to inspire love, while men are positioned both to appreciate and to critically evaluate beauty. This allows the masculine subject to gain some distance from nature, and thus to realize the sublime. The sublime experience is one of 'delight', a pleasure negatively produced through the removal of extreme pain or danger, or what Burke refers to as 'terror'. His theory of the sublime is grounded in the terror of death, the fear of non-being which swells up within the mind when confronted by the might of nature. It is in the psychic reaction to this threat that gender is generated and assigned. To

achieve the 'delight' of the sublime, one must actively remove the danger through a certain mental distancing of it, thus coming to occupy the masculine subject position by taking control of the situation and banishing fear. In contrast, if one remains immobile or passive in the face of this terror, then one is condemned to the feminine, unable to transcend nature.

It is, in part, the obscurity of the object that produces terror. Burke claims that, 'hardly anything can strike the mind with its greatness which does not make some sort of approach towards infinity' (1990:58). Man must rise up and conquer the unknown in order to achieve the sublime. Closure is elusive however. The system of nature is opened to that which is other, thus ultimately leaving the masculine subject somewhat uncertainly located. On the one hand, he is naturally determined by his sex within a closed economy of heterosexual desire; yet, on the other hand, he must achieve a sublimation of his natural instincts as he rises up to a transcendent epistemological position. Between sex and (the death of) God, man can never be sure of himself. Burke draws the emergent ontology of (hetero)sexual difference into the orbit of aesthetic epistemology, and in so doing he reveals something of the way in which it serves to structure knowledge of the natural world.

That the underside of this aesthetics is a system of nature driven by a logic of (hetero)sexual difference can also be seen in Kant's early text, *Observations on the Feeling of the Beautiful and Sublime* (1960). This 1763 volume, which contains many of the ideas that appear in his later *Critique of Judgment* (1987), bears much resemblance to Burke's *Enquiry*. In particular, we find the same

gendering and classifying of experiences into the same two aesthetic categories: the sublime being that which ‘moves’, and the beautiful being that which ‘charms’ (1960:46). Kant makes it clear that the female sex is, ‘known by the mark of the beautiful’, whilst ‘among the masculine qualities the sublime clearly stands out as the criterion of his kind’ (1960:76). Paralleling Burke, Kant’s *Observations* orientates itself around an almost obsessive desire to establish the divide between two oppositional sexes. For both thinkers, ‘woman’ is essentially defined by her natural, (hetero)sexual attractiveness to men. Kant lists a number of qualities which are becoming for a woman, but in the end, he claims that, ‘the sexual instinct still ultimately underlies all her remaining charms’ (1960:85). Man, on the other hand, naturally desires women, but he is essentially defined by the power of his understanding, which subordinates his natural instinct. For Kant, ‘subduing one’s passions through principles is sublime’ (1960:57). This is the road to scientific knowledge as distinct from the aesthetic concern with beauty — another gendered opposition that has exerted great influence upon Western knowledge since the eighteenth century.

The explicitly (hetero)sexual nature of Kant’s *Observations* gives way to a more implicit gendering in his *Critique of Judgment*. Here, beauty represents natural order, while the sublime opens up the natural system to that which is beyond. As with Burke, many commentators have noted the ‘masculine’ nature of the Kantian sublime in this text. Although the judgment of the sublime ‘has its foundation in human nature’, according to Kant, it cannot be automatically demanded of everyone, as it ‘presuppose[s] moral feeling in man’ (1987:125).

Morality, for Kant, is determined by pure reason, existing independent of the realm of sensibility, and thus is implicitly identified with *men*. Kant's description of the sublime experience is also decidedly masculine. He writes, 'it is produced by the feeling of a momentary inhibition of the vital forces followed immediately by an outpouring of them that is all the stronger' (1987:98). The 'momentary inhibition' to which Kant refers is an experience of the overwhelming force or size of a particular phenomenon, and one's imaginative impotence in the face of it. Again, as with Burke, it is the active response to this threat that is the key. For Kant, however, it is not simply a matter of the pleasure gained through distancing oneself from the threat of death. Rather, he claims, 'this inadequacy itself is the arousal in us of the feeling that we have within us as a supersensible power' (1987:106). This supersensible power is the virile power of reason to rise above the phenomenal world of nature. It is the mind which is truly sublime in Kant's account; all that belongs to the body, to nature, to the feminine, is transcended as the Kantian (masculine and rational) subject is formed through extracting himself from that which threatens to overwhelm him and reduce him to nothing.

Kant was a keen reader of Rousseau, and the influence of the latter's *Emile*, especially the high value it places upon nature, is particularly apparent when we turn to the topic of beauty. In his *Observations*, Kant's discussion of the effect of woman's beauty upon man is premised upon the claim that, 'the impression that the form and features of the fair sex makes on the masculine. This complete fascination is really overlaid by the sex instinct'. He continues, 'Nature pursues its great purpose, and all refinements that join together, though

they may appear to stand as far from that as they will, are only trimmings and borrow their charm ultimately from that very source' (1960:86). Here, the complementary attributes of the sexes give expression to the ultimate purpose of nature, while in the later *Critique* it is precisely this purposive quality that accounts for the possibility of 'pure aesthetic judgments' of beauty.

The arguments of the third *Critique* in regard to aesthetic judgments are both well known and formidably complex. In a move reminiscent of Rousseau's appeal to the notion of a 'General Will', Kant appeals to a form of transcendental subjectivity – the *sensus communis* – in explaining the universal validity of aesthetic judgments. For our purposes, however, it will suffice to note that the experience of the beautiful is said to be produced through a harmonization of the workings of the human mind with the purposive forms of nature. Counter-intuitively, this holds even for beauty in art, as Kant's influential account of artistic 'genius' turns upon the artist's ability to unconsciously channel the force of nature. Rather than rehearse Kant's arguments regarding aesthetic judgments, however, we will turn our attention to the lesser-read 'Critique of Teleological Judgment', which forms the second part of the *Critique of Judgment*. This supplement to Kant's aesthetics is more germane to our concerns insofar as it plays an important role in the emergence of biological thought.

Poised as it is between the first murmurings of evolutionary thought and the emergence of biology as a scientific discipline, Georges Canguilhem (1994) claims that Kant's *Critique of Judgment* is a crucial text in propelling the concept of 'organism' to the forefront of thinking about nature. In his account of the

constitution of biology as a distinctly modern form of knowledge, Canguilhem notes that the term 'organism' emerged towards the end of the eighteenth century as a semantic substitute for the action of a 'soul' in providing the organizing force of a body. For him, Kant takes a step beyond the mechanistic view of nature in claiming that, 'An organized being is in one sense a machine, but a machine that requires a formative energy, something more than mere motor energy and capable of organizing otherwise inert matter. The organic body is not only organized, it is self-organizing' (1994:82). Kant anticipates the nineteenth-century's concept of 'life' as a vital force animating living bodies (and, indeed, the twentieth century's notion of autopoiesis), but, at the same time, he remains tied to the previous century's faith in the stability of the natural order.

Congruent with Canguilhem's assessment of the third *Critique*, Phillip Sloan (2002) argues that Kant's later work was strongly marked by the period's fierce debate over natural processes of generation. In keeping with the overall character of his philosophy, Kant sought to find a middle way between the competing positions of preformation and epigenesis. He attempted to allow for the action of organizing (i.e. epigenetic) forces within an embryo, but only within strict limits set by preformed 'germs'. Sloan has shown that, immediately prior to the writing of his *Critique of Judgment*, Kant was exposed to the new epigenetic theory of Johann Blumenbach, and consequently abandoned his stronger advocacy for the preformist position. This was to leave Kant's theory of nature poised on the edge of embracing an immanent dynamism, but still clinging to a somewhat mysterious, eternal natural order.

By focusing on the 'Critique of Teleological Judgment', we can see the way in which these issues of natural generation play out in Kant's work. There, it is the 'organized being' that is charged with the task of mediating between the unknowable source of nature and the vital forces evident in the phenomenal world. In a sense, the concept of an 'organism' can be seen as playing a crucial role in bringing Kant's overall philosophical project to a conclusion. In the first *Critique* he had attempted to secure the basis for scientific enquiry into nature by sealing off science and philosophy from metaphysical issues; his second *Critique* sought the basis for human morality and found it in a transcendental realm of freedom separate from nature's realm of necessity; now, in the third *Critique*, Kant turned to the evidence of the senses, or the power of aesthetic judgment, in order to try and bridge the distance that he had created between moral freedom and mechanistic nature (an opposition that might well be read in terms of the masculine and the feminine, respectively). This required a legitimate way of establishing a systematic connection between natural beings in the phenomenal world and God's presence in the supersensible realm. For Kant, it is the concept of an organism that provides this bridge:

Now it is entirely possible that some parts in (say) an animal body (such as skin, bone, or hair) could be grasped as accumulations governed by merely mechanical laws. Still the cause that procures the appropriate matter, that modifies and forms it in that way, and that deposits it in the pertinent locations must always be judged teleologically. Hence everything in such a body must be regarded as organized;

and everything, in a certain relation to the thing itself, is also an organ in turn (1987:257).

He continues:

Hence only as far as matter is organized does it necessarily carry with it the concept of it as a natural purpose, because the specific [purposive] form it has is at the same time a product of nature. But this concept of a natural purpose leads us necessarily to the idea of all of nature as a system in terms of the rule of purposes, and we must subordinate all mechanism of nature to this idea according to principles of reason... (1987:258-9).

Kant's argument is that the existence of organized beings in nature, at least as they appear to us, automatically generates a teleological judgment that applies to nature the concept of intention. Hence, as many commentators have noted, Kant's solution to the problematic disjunction between God and nature relies upon a form of philosophical anthropomorphism. As the freedom and rationality of the human mind interacts with the necessity of its aesthetic judgments of organized or 'beautiful' beings, the noumenal is brought to touch the phenomenal. At the same time, as Pheng Cheah (2003) points out, Kant's account of organic life relies upon a 'technic of nature' that is, ultimately, 'inhuman' insofar as it has the quality of being 'given'. Hence, just as we found with Rousseau's characterization of nature, (the death of) God, or his absent presence, opens up the closed system of (human) nature to the uncontrollable other.

In order for Kant's account of the teleological order of nature to convince, however, he must proceed to justify the honor that he has bestowed upon humanity as conduit. His claim is that '...man is the ultimate purpose of creation here on earth, because he is the only being on earth who can form a concept of purposes and use his reason to turn an aggregate of purposively structured things into a system of purposes' (1987:314). It is a matter of reason then, of *man's mental abilities*; the body, as ever, remains trapped in natural necessity. Yet, what is it that allows for the systematic aggregating of purposively organized beings? Although it is not thematized by Kant as such, I want to argue that (hetero)sexual difference is crucial here, and that it plays a key role in his account of organized beings and of the organization of nature as a whole.

The difficulty in recognizing the existence of a telos in nature, according to Kant, comes in finding a way to overcome the apparently arbitrary and contingent relations of extrinsic purposiveness that hold between natural things, and to relate this to the intrinsic purposiveness of organized beings⁹. In this regard, we read:

There is only one [case where] extrinsic purposiveness is connected with the intrinsic purposiveness of organization. This [case] is the organization of the two sexes as related to each other to propagate their species. Here, although we must not ask what is the end for which the being had to exist [as] so organized, [that being] still serves as a means extrinsically related to a purpose. For here, just as in the case of an individual, we can always go on to ask: Why did such a pair have to

exist? The answer is: This pair is what first amounts to an *organizing* whole, even if not to an organized whole in a single body (1987:312-3).

In other words, the teleology of (hetero)sexual difference lifts us up out of disordered nature and allows us to grasp the systematicity of the whole. It is through (hetero)sex that the inner purposiveness of an organism is drawn out of itself to connect with the external purposiveness of other beings, thereby exhibiting the systematic ability of nature to (re)produce its own order. A teleological system of nature is thus given to us via the appearance of a (hetero)sexual encounter. It only requires that we employ our faculty of reason in discerning the existence of this purpose.

This suggests that 'sex' is the key concept through which the organized being comes to be organized. It suggests that the essence of the human being may not lie solely in the moral freedom of the rational subject, but instead might depend more upon phenomenal being that Kant would like to admit. It is, perhaps, a question of an unconscious *telos* – a displacement of the 'soul' – that adheres to the notion of the organism. Indeed, this question can be linked to a certain (gendered) tension running throughout Kant's work (and which we have already touched on in connection with his concept of the sublime) between a desire to transcend nature, and anxiety over the need to remain faithful to it.

We can see more clearly how this plays out in relation to sex if we return to where we began this chapter, Kant's *Lectures on Ethics*. To recall, in our epigraph we quoted Kant thus: 'All *crimina carnis contra naturam* degrade human nature to a level below that of animal nature and make man unworthy of

his humanity. He no longer deserves to be a person' (1963:170). These crimes against nature, of which Kant singles out three for special attention – masturbation, homosexual intercourse, and bestiality – are apparently of such severity that they annul any claim to personhood on the basis of a human being's inherent rationality. The moral freedom of the human subject, which facilitates an identification with God independent of nature, also allows for transgressions of the natural order that fatally undermine humanity. If the organized being is to exhibit its greater purpose, it must, first and foremost, be secure in its (hetero)sexual organization, and in control of its carnal desires. From this perspective, the organism might well be seen as a conceptual device for creating order out of sexual chaos.

This chapter has traced out a movement back in time in order to prepare for a critical return to the present. Beginning with Butler's analysis of the melancholic complicity of sex, gender, and heterosexuality, we traveled back to the eighteenth century with an eye for the historicity of sex, and for its relation to the dynamism of matter. Moving through a rereading of the Foucaultian history of sexuality and the emergence of Laqueur's 'two-sex' model of difference, we have been circling around a number of interconnected concepts – (hetero)sexual difference, masturbation, the sexuality of plants, scientific knowledge, natural order, and (the death of) God – that were central to the intellectual and social life of the period. Finally, we turned to Rousseau, Burke, and Kant, not merely because their work has remained influential beyond their own time, but insofar as

they give voice to many of the themes that this chapter has pursued. They each articulate crucial tensions that emerged in the eighteenth century surrounding the interrelations between scientific knowledge, (hetero)sexual difference, nature, and the 'death of God'. Their work reveals the way in which (hetero)sexual difference comes to be located as an ontological center of authority governing the epistemologies of natural science and aesthetics in the eighteenth century. Aside from preparing the way for the emergence of biological thought, this move, whereby (*hetero*)sex comes to secretly occupy the place of *God*, gives us two of the three focal points for this study. We turn now to the third – the becoming historical of nature in relation to an emergent form of 'technovision'.

Notes

¹ Butler does not employ the terms '(hetero)sexual difference' or '(hetero)sex' herself. I use them throughout this dissertation however, as a way of foregrounding the participation of male and female sexual categories within a heteronormative conceptual regime.

² I discuss the ontological implications of Butler's account of gender melancholia in greater detail elsewhere (Garlick, 2002). This issue is also taken up again in chapter five.

³ I would also argue that this neglect is mirrored in the reception of Butler's work and her Foucaultian claim that male and female sexes are discursively produced as prediscursive categories through the apparatus of gender.

⁴ Trumbach never really explains his use of the term 'gender', but it appears to mean something like the social aspect of a sexual identity. His title, *Sex and the Gender Revolution*, is thus somewhat misleading as his concern is primarily with the emergence of modern sexualities.

⁵ For an extended discussion of Laqueur's reliance upon the sex/gender opposition, understood in terms of the linguistic vs. the extra-linguistic, see Cealey Harrison and Hood-Williams (2002), especially chapter 5.

⁶ Hitchcock also takes a similar position in arguing that the significance of anti-masturbatory literature is that it polices heteronormative sexual intercourse (1996:82).

⁷ For example, readers of both texts could not fail to note an anterior resonance of *The Order of Things* in the periodization evident in the following passage from the Bataille essay: 'On the day that sexuality began to speak and to be spoken, language no longer served as a veil for the infinite; and in the density it acquired on that day, we now experience finitude and being' (1998:85).

⁸ The fact that Linnaeus' sexually based system was formulated in a time of anxiety over racial diversity points to an important connection between European colonialism, racial categories, and the emergence of (hetero)sexual difference, which I do not have the space to elaborate further here. But, it is worth noting here that this connection persists in contemporary genomics.

⁹ For Kant, 'extrinsic purposiveness' is 'a purposiveness where one thing of nature serves another as a means to a purpose', whereas 'intrinsic purposiveness has to do with the possibility of an object regardless of whether or not the object's actuality is itself a purpose' (1987:312).

Chapter 2

Given Time: Photography, Science, and Technovision

It was as though he had grasped time itself, made it stand still, and then made it run again, over and over. Time was at his command as it had never been at anyone's before. A new world had opened up for science, for art, for entertainment, for consciousness, and an old world had retreated farther (Solnit, 2003:3).

Edward Muybridge's instantaneous photographs of a fast moving horse in mid-stride provide some of the nineteenth-century's most emblematic images. For many, it marks the moment when technological perception definitively outstripped the human eye and ushered in a new mode of seeing – the coming of the age of technovision. The speed of the photograph appeared to defeat time itself, giving the fleeting impression over to the leisurely gaze of the observer. The promise of photography was that of a technology of truth. Engendering the agency of nature itself, it appeared to provide a more truthful representation of the world than had previously been allowed by the slowness of human perception.

Muybridge perfected his process over the course of the 1870s, and the resulting motion studies were to lead directly to the invention of the cinema in little more than a decade. Indeed, photography itself is often regarded as a mere technical pause on the path towards the superior realism and effect of the motion picture. This is perhaps, in part, due to the prominence of Muybridge's 'moving' pictures in the iconography of nineteenth-century photography. When it is

scientific vision that is at issue, however, the earlier invention of 'still' photography is of central importance. The emergence of photography in the first few decades of the nineteenth century led to disruptions in the temporal order that are by no means simple in their ontological or epistemological implications. The startling images produced by Muybridge's camera are but exemplars of a general relation that holds between photography and the temporality of vision. A horse frozen in motion allows the eye to grasp movement that had formerly passed by unrecognized, but even the most banal of photographic images offers up a visual field withdrawn from the flow of time, brought into focus, and generous in its provision of unforeseen detail.

Photography changed the way that we see the world. It is an inextricable element of global modernity, and has played a key role in the development of Western science. The invention of the microscope in the seventeenth century, along with a renewed emphasis on the senses as sources of knowledge in eighteenth-century aesthetic and empiricist philosophies, had produced an intellectual environment where technologies of perception were central to the ongoing accumulation of scientific knowledge. As one of the key technological inventions of the nineteenth century, photography is a product of the same period and culture as biology (indeed, as is the case with many of the human sciences). It is this coincidence in birth that I am interested in here. How should we understand the fact that the biological and the photographic are part of the same *episteme*? What import does the coincidence of biological and photographic vision hold for later developments in genomic technoscience?

It may be that by examining the relationship of early photography to nature, we can gain some insight into the technological underpinnings of biological vision. Aside from playing an important role in reinforcing the primacy of visual representation in modern science, photography raises issues of repetition, of time, and of survival after death, which are crucial to genetics. Moreover, the desire for effacement that contemporary biotechnologies manifest while allowing energy and matter to appear to visual observation appears to reiterate a 'photographic' relation to nature. In many respects, photography remains exemplary for the technological imaging of nature, and my contention is that an analysis of nineteenth-century photography can alert us to key issues that remain in play with the Human Genome Project and beyond.

By turning our attention to early photography, we are well positioned to examine the history of genetics in terms of the concept of *technoscience*. From this perspective, we cannot regard technology simply as the mere tools employed by science in its quest to know the natural world. Instead, we must recognize that scientific objects are generated according to the capacities of the visualizing technologies at hand, and, furthermore, that technologies themselves have their own histories, contexts, and ways of being. Modern science is inseparable from technology; hence the latter must be brought within the orbit of any enquiry into scientific knowledge. Indeed, the discipline of biology may be said to be a technoscience from the very start.

The work of Donna Haraway has been important in opening up the landscape of technoscience for critical enquiry. She writes:

It is the nonhyphenated energy of technoscience that makes me adopt the term. This condensed signifier mimes the implosion of science and technology into each other in the past two hundred years around the world. I want to use technoscience to designate dense nodes of human and nonhuman actors that are brought into alliance by the material, social, and semiotic technologies through which what will count as nature and as matters of fact get constituted for – and by – many millions of people (1997:50).

For Haraway, 'technoscience' designates more than a simple coalescence between two forms of praxis; it signals the inextricable intertwining of human and nonhuman, and the implosion of space and time in the speeded-up circuits of technological advance, global capitalism, and the scientific production of nature. The Human Genome Project, with its coalition of technological, scientific, and capitalist interests, may be regarded as a preeminent example of technoscience, and the analysis of contemporary genomics calls for an approach that is alert to the many histories that play into its constitution.

To this end, this chapter will be primarily concerned with photographic technology and its role in the genealogy of genomic vision. I will argue that, in many respects, photography provides the model for modern scientific vision. At the same time, however, photography has always been ambiguously located between art and science, between nature and culture, and between the living and the dead. Hence, while it may be a technological expression of the scientific desire to know and thereby to control nature, photography is also continually disrupting and frustrating the ambitions of science. In order to situate

photographic vision in the context of modernity, we will first examine what many consider to be an epochal change in the visual regime associated with Western knowledge production at the beginning of the nineteenth century, especially as it relates to the emerging discipline of biology. This will open up the question of whether modernity can be characterized in terms of 'ocularcentrism' and, furthermore, of whether this may be understood in gendered terms. In order to clarify the concept of technology itself, we will then turn to the work of Martin Heidegger, whose concept of 'enframing' provides a way in which to understand the conjunction of photography, gender, and science in the nineteenth century. Following on from chapter one's discussion of natural history, the place of botany in relation to photography and (techno)scientific enquiry into nature will be examined. Aesthetics is also important here, and the relation between the Romantic movement of the early nineteenth century and the invention of photography cannot be neglected. Situated between Romantic insight and the vision of positivist science, I will suggest that photography complicates the epistemological divisions that structure biological knowledge of nature and life. Roland Barthes' influential work on photography will also be taken up and discussed here. I will suggest that Barthes' concern with the ontology, eroticism, and trauma of the photograph allows us to understand something of what is at stake in contemporary visualizing technologies. Finally, the authority attributed to the Romantic concept of nature in early photographic discourse brings us back to the 'death of God'. Here, Heidegger's notion of 'onto-theology' will be drawn

upon to provide a way of reconceiving this occurrence in terms of technovision and scientific knowledge.

History, Subjectivity, Vision

The practice of natural history in the eighteenth century was premised upon a privileging of the visible, and of optical instruments such as the microscope. It was a matter of reading the signs that nature presented and of recording them in the language of science. As Foucault puts it, 'Natural history is nothing more than the nomination of the visible' (1994a:132). It is the self-certainty and transparency of representation, grounded in the eternal natural order, which defines scientific practice and knowledge during this period. Hence, as we saw in chapter one, Linnaeus' sexual system of classification was based upon the seemingly unproblematic recording of natural characteristics as they presented themselves to the eye of the naturalist. Meaning was assumed to be manifest and evident at the level of the visible.

By the end of the eighteenth century, however, this representational order had become increasingly difficult to sustain in the face of growing evidence of immense diversity in life forms, their unpredictably, and of change over time. For heuristic purposes, this may be understood in terms of what Foucault refers to as an 'epistemic break'. For him, the growing recognition of the limits of representational modes of knowledge in relation to the truth of the natural world marks the end of the Classical *episteme*. Although the impact of this shift is not immediately

felt in all areas of scientific enquiry, it is, nonetheless, a moment which marks a fundamental reorganization of scientific knowledge:

It is... a mutation in the natural dimension of Western culture: the end of *history* in the sense in which it was understood by Tournefort, Linnaeus, Buffon, and Adanson.... And it was also to be the beginning of what, by substituting anatomy for classification, organism for structure, internal subordination for visible character, the series for tabulation, was to make possible the precipitation into the old flat world of animals and plants, engraved in black and white, a whole profound mass of time to which men were to give the renewed name of *history* (1994a:138).

The eternal order of natural history gives way to historical development as the organizing principle of knowledge. Life emerges as the invisible secret of nature.

This epistemic shift does not imply a turning away from the visual however. Rather, as Foucault (1994b) has shown in his work on the medical 'gaze', a different, more discerning and demystifying model of vision emerged in the early nineteenth century. No longer content to merely read signs off the surface of the body, the medical gaze now seeks its truths within the space of the body's opaque density. Central to this reconceiving of scientific vision was a different understanding of death in relation to life and medicine. This was most apparent in the practice of clinical anatomy, where death becomes the key both to the mapping out of disease, and to the new temporality of the body. Instead of being regarded as external accident, death now inhabits the natural body from the start as a constant presence struggling against life. Disease becomes the marker of

this battle, and of the inherently pathological nature of the body. At the same time, however, it is death as limit that gives life in the form of change through time. As an 'invisible visibility', it withdraws to allow positive knowledge of the organic body to be produced. Foucault, speaking of the importance of the perception of death in the nineteenth century, evokes a move to which we shall return: 'Death left its old tragic heaven and became the lyrical core of man: his invisible truth, his visible secret (1994b:172). As we will come to see, the uncanny visibility of death is also central to the production of photographic vision and affect.

The concept of 'life', defined through this death-defying dialectic, provided an object around which the discipline of biology could be organized. According to Foucault, 'the organism is the visible form of life in its resistance to that which does not live and which opposes it' (1994b:154). Life is offered up to observation and knowledge *through* its struggle against chaos and death within the organism. Hence, from the point of view of *The Order of Things*, the birth of modern medicine coincides with the emergence of biology as both take the same object of knowledge — the life of the organism. Foucault describes the way in which the concept of organic structure comes to function as a method of characterization and classification for the first time at the end of the eighteenth century, thereby providing a new foundation for organizing living nature. This move creates 'a profound, interior, and essential space' within living beings, and entails 'the radicalization of the dividing line between organic and inorganic' (1994a:231). Life, as biological object, is in this way inextricably tied to the space of the visibly

organized body, which exists, though time, in constant danger of dissolution into the invisibility of death. The drive to reproduce, to repeat, to reorganize, is therefore crucial to the life of nature, and to its historicity. Foucault sums up the situation as follows:

The organic becomes the living and the living is that which produces, grows, and reproduces; the inorganic is the non-living, that which neither develops nor reproduces; it lies at the frontiers of life, the inert, the unfruitful – death (1994a:232).

With death as the invisible limit that opens up and reveals the organized space of the organism, we are reminded of Kant's claim of the unknowable God who, through his absent presence, establishes the transcendental basis of scientific knowledge¹. Indeed, for Foucault, the Kantian critique of the limits of representation 'marks the threshold of our modernity', insofar as '...it sanctions for the first time that event in European culture which coincides with the end of the eighteenth century: the withdrawal of knowledge and thought outside the space of representation' (1994a:242). 'Life', as the 'transcendental' object of biology, is beyond positive knowledge; yet, at the same time, it is that which forms the basis of a science of living beings. Foucault notes, however, that the force of life is not quite a transcendental in the Kantian sense, for it is both in and beyond its objects – the *a priori* and the *a posteriori*. Hence, the notion of life can easily take on a metaphysical cast that is disallowed in the Kantian system, as well as giving itself over to a positivist system of knowledge. Yet, if we recall our analysis of the 'Critique of Teleological Reason' from chapter one (where I

argued that Kant's concept of transcendental judgment is actually dependent on the (hetero)sexually organized body) it becomes apparent that the structure of biological knowledge may not be so very different from Kant's own epistemological position. For it is apparent that the concept of life is here functioning in the same way in regard to the organism as the concept of (hetero)sexual difference does for Kant. Both serve as the essential connection between the inner nature of each organism and the overall unity of nature to which the living being belongs. The visible organization of each living organism corresponds to the normative (hetero)sexual order of nature as a whole. 'Sex' defines the life of the organism, as well as being a reminder of the constant threat of death and of the deferred presence of God.

It is important to note here that, for Foucault, when natural history becomes biology, i.e. when life emerges in the visible form of the organism, this also marks the moment when '...man appears in his ambiguous position as an object of knowledge and as a subject that knows' (1994a:312). The one who sees, is also seen in the very act of seeing. It is, therefore, not merely a question of a subject who sees (into) natural bodies in a new way, but of an ontological shift entailing a reconfiguration of the observing subject itself. At issue is the embodiment of vision within the human organism, and its relationship to the new optical technologies of the nineteenth century.

Jonathan Crary addresses this topic in his *Techniques of the Observer* (1990). There, he claims that Kant's work marks a new organization of knowledge that revolves around the observing subject rather than the external

object. Significantly, the subject is now active in the constitution of knowledge. It is no longer a matter of the passive reception of impressions from nature. As Crary characterizes this change:

From the beginning of the nineteenth century a science of vision will tend to mean increasingly an interrogation of the physiological makeup of the human subject, rather than the mechanics of light and optical transmission. It is a moment when the visible escapes from the timeless order of the camera obscura and becomes lodged in another apparatus, within the unstable physiology and temporality of the human body (1990:70).

Crary also points to the work of Goethe, and of Schopenhauer, as advancing a wide-ranging investigation into the subjective, physiological elements of vision during the first few decades of the nineteenth century. For Crary, the static figure of the camera obscura provided a paradigm by which the act of seeing was understood during the seventeenth and eighteenth centuries. It functioned to position the observing subject outside of nature, as a passive onlooker simply recording visual truths as they were presented to the disembodied mind. During the Enlightenment, as we saw in chapter one, humanity was figured as if in a position between God and nature. The vision of the camera obscura corresponds to this 'God's eye' viewpoint, which was the privilege of the rational mind, and which, at the same time, obscured the material and social underpinnings of its aesthetic epistemology. The result, according to Crary, is that, 'the eighteenth century observer confronts a unified space of order, unmodified by his or her own

sensory and physiological apparatus, on which the contents of the world can be studied and compared, known in terms of a multitude of relationships' (1990:55). This is the world of natural history.

The overthrowing of the camera obscura model can be located within the broad realignment of scientific knowledge that Foucault identifies as occurring at the end of the eighteenth century. For Crary, 'Above all, it is a moment when light loses its ontological privilege' (1990:88). There is a loss of faith in (implicitly theological) theories of light as radiant and emanative, thus implying something like a 'death of God' – the loss of an eternal source from which all things emanate. Human vision is thereby returned to materiality, reconnected to the mortal body, and fresh questions are raised concerning the knowledge that is produced by the eyes. Concurrent with the rise of new wave theories of light in the 1820s, the physiology of the eye itself takes on increased importance in theories about vision. Alongside the becoming-historical of nature, this effectively issues a further challenge to humanity's ability to know the natural world with any certainty. As Crary notes, 'Once vision became located in the empirical immediacy of the observer's body, it belonged to time, to flux, to death' (1990:24).

In this context, our particular interest is in the new technologies of vision that appear to augment the human eye. Although the timing of photography's birth corresponds with the transformation in visual thinking and practice that Crary describes, he does not privilege the photographic camera as a key metaphor for the new form of visual subjectivity. Indeed, his main claim with

regard to photography is to demonstrate the negative point that its invention is not the cause of the profound questioning of human vision that occurs in this period. He emphasizes that processes of visual perception were already under examination before photographs first emerged into public view. At the same time, Crary claims that, 'The widespread preoccupation with the defects of human vision defined ever more precisely an outline of the normal, and generated new technologies for imposing a normative vision on the observer' (1990:16). The implication, therefore, is that photography was invented as part of a broader response to the historical condition of the human observer in the early nineteenth century. Thrown back into nature, and into time, the observing subject seeks technological assistance in representing a world that no longer appears to be simply 'there'. For Crary, 'Beginning in the nineteenth century, the relation between eye and optical apparatus becomes one of metonymy: both were now contiguous instruments on the same plane of operation, with varying capacities and features' (1990:129). The camera supplements the human eye, allowing it to grasp the passing of time and to thereby bestow some order upon it. Photography, like biology, aims to be more adequate to nature as it is given *in time*.

The relations that hold between photography, nature, and time, will interest us again below. First, however, we will pause to address some more general issues concerning the importance of the visual, and of visual technologies, within modernity.

Ocularcentrism, Technology, and Masculine Vision

Many scholars have posited the existence of a heightened state of visuality in Western societies since the time of the Enlightenment. There is a belief that images rather than things themselves increasingly define people's experience of reality. In this vein, Crary claims that, 'The photograph becomes a central element not only in a new commodity economy but in the reshaping of an entire territory on which signs and images, each effectively severed from a referent, circulate and proliferate' (1990:13). The centrality of observation and empirical experimentation to modern science, along with the rise of philosophical aesthetics in the eighteenth century, also suggest the increased importance of the visual in knowledge production. The invention of the microscope is exemplary of this move in that it both augments and isolates the human eye. Yet, at the same time, we can also note a radical distrust developing towards the mere evidence of the eyes alone. Most famously in the work of Rene Descartes, we find a doubting of any knowledge that is not securely grounded in reason. In this way, the Enlightenment effects something like a split in vision, whereby the (rational) mind's eye is privileged over the corporeal eye. Hence, the act of seeing may be at once lauded *and* regarded with suspicion.

As we have seen above, the visual continues to dominate in nineteenth-century science, but the questioning of human vision is also intensified. Indeed, in a sense, these two trends might well be traced right through to late twentieth-century attitudes, albeit with a shift from questioning *human* vision to that of the visual dimension of social life more generally. Thus, while technoscientific

endeavors such as the HGP are characterized both in popular and scientific texts by the presumption of an unproblematic visual rendering of life's 'secret code', the epistemological and social predominance of 'technovision' has been subject to much critical examination within cultural theory. Foucault's (1995) analysis of the power relations inherent in the panoptic visibility of 'disciplinary' societies stands out as perhaps the best-known critique of modern technovision. The Panopticon, originally a nineteenth-century architectural plan for a prison, wherein the prisoners would be constantly exposed to surveillance without knowing if they were actually being observed at any one particular moment or not, is generalized by Foucault to characterize the workings of power in modern societies. Crucial to the success of disciplinary power is the way that it is exercised through the compulsory visibility of those subject to it, while remaining invisible itself. The normative forces at work in a disciplinary society draw their power from the individual's feeling of being under perpetual observation and examination. Hence, for Foucault, the politics of seeing and being seen are deeply implicated in the mutual production of knowledge, subjectivity, and power.

Indeed, the visual dimension of social life has been the subject of much contestation in recent years. In his introduction to *Modernity and the Hegemony of Vision* (1993a), David Levin draws Foucault's work together with that of Heidegger and Derrida in suggesting that these three thinkers are able to develop 'countervisions' which challenge the type of ocularcentrism peculiar to modernity. The danger inherent in the overemphasis on vision, according to Levin's account, is that we become beholden to the given, to that which is

present to our eyes, and being is thus reduced to being-represented. On the other hand, Martin Jay (1993), to take the most prominent example, argues that antiocularcentrism amounts to an abrogation of the modern project that sought to achieve a lucid understanding of the world. He charges that, although there are dangers to excessive faith in the transparency of vision, the antvisual discourse has tended to elide the positive role that sight has to play in the production of knowledge.

One of the most important questions that currently circulates within debates over vision and social power concerns the association of masculinity with the sense of sight. Indeed, insofar as scientific practice involves the visualization and observation of nature, the relation between men and visual technologies is an important factor in assessing whether or not science can be meaningfully associated with masculinity in some sense. Perhaps most notably in feminist film theory of the 1970s and 1980s, the charge has been put forth that the hegemony of vision amounts to masculine domination. Levin expresses a version of this position in arguing that, 'the rule of the masculine is both cause and effect of an ocularcentrism which privileges the autonomy-drive of vision and rewards its aggressiveness, its hunger for control' (1993b:205). Another prominent feminist advocate for this position is Luce Irigaray, who argues that throughout Western history the visible has been sequestered within the closed economy of a masculine logic. From her perspective, escape from this systematic requires a certain renunciation of vision; and a recognition that '...as the eye is already guardian to the reason, the first necessity is to slip away unseen' (1985:192). For

Irigaray, as for many other French feminist thinkers such as Julia Kristeva and Hélène Cixous, the possibility of *speaking* or *writing* differently holds the potential for disrupting the dominant, masculine scopic regime. As Jay notes, 'these various claims for a special women's relationship to language [are] frequently couched in antiocular terms, often pitting the temporal rhythms of the body against the mortifying spatialization of the eye' (1993:258). If the body is alive under the sway of nature, the gaze of the eye discerns and divides in order to secure and control.

The association of the visual with the masculine, however, cannot be regarded as a necessary or universal conjunction independent of social and historical context. What is at issue here are the ways in which vision is situated and employed within particular assemblages of institutions, cultures, scientific methods, technologies and bodies, which both draw from and facilitate the reiteration and reproduction of gendered concepts and social structures. One way to think about different senses of vision has been suggested by Evelyn Fox Keller and Christine Grontkowski (1983). They argue for the existence of two basic types of visual experience – objectifying and communicative – with an emphasis upon the former and a corresponding relegation of the latter being characteristic of masculine vision. It is notable, perhaps, that these qualities of objectification and communication may also be figured in terms of the visual registers of science and art, respectively. Thus, mirroring the split that developed between these two ways of knowing natural and social reality over the course of the eighteenth and nineteenth centuries. If these two modes of vision were

indeed to express gendered characteristics, then this would certainly suggest an association between masculinity and science. Of course, to suggest that visual practices could so easily be divided up between 'objective' and 'communicative' is problematic. Nonetheless, the extent to which vision, and especially technologically enhanced or 'photographic' vision, has become equivalent to objectification perhaps illustrates a subtle process of gendering at work.

Certainly, practices of visual objectification within science have been subject to a significant amount of feminist critique. Jordanova (1989), for example, claims that Enlightenment science and medical practice not only characterized nature as a woman, but that they were also drawn to the masculinist visual metaphor of 'unveiling'. She highlights the prevalence of images of male doctors examining female corpses (i.e. Foucault's 'anatomo-clinical' vision) to argue that science was symbolically male insofar as it embodied 'the masculine practice of looking, analyzing and interpreting' (1989:110). This is an argument that can be located within a broader feminist critique of modern science (as discussed in chapter one) and is here extended to specifically implicate the dimension of visibility. The claim is that the visual objectification of nature is effected through a narrative of (hetero)sexual difference in which the unveiling of nature/woman functions to confirm the dominant subjectivity of man. Again, it is a question of the role that science plays in the attempt to establish control over nature that propels it into the arena of gender politics. The faculty of vision, we might say, lends itself without difficulty to the desire for an organized and manageable world.

The power and importance of the optical dimension is no less apparent in contemporary technoscience. As scientific enquiry increasingly operates at the molecular level, technologies of visualization play a crucial constitutive role in bringing the 'objects' of its practice into being. Haraway's words are apropos here:

Histories of science may be powerfully told as histories of the technologies. These technologies are ways of life, social orders, practices of visualization. Technologies are skilled practices. How to see? Where to see from? What limits to vision? What to see for? Whom to see with? ...Struggles over what will count as rational accounts of the world are struggles over *how* to see (1991:194).

The question of gender is also in play however. Haraway's advocacy of cyborg subjectivity – 'a creature in a postgender world' (1991:150) – expresses a desire to reappropriate technology from the masculine, and to explore the possibilities for seeing otherwise that are offered by embracing our kinship with technology. It is a matter of making technovision itself visible, of interrogating its relation to the reiteration and reproduction of gender categories, and of seeing possibilities for imagining otherwise.

Alongside feminist science studies, there is a significant body of work that deals with issues concerning gender and technology. Biomedical technologies are increasingly a key site here, especially reproductive technologies, which have often been criticized for perpetuating a patriarchal ideology that legitimates men's power over women's bodies. A key characteristic of these studies is the either

implicit or explicit belief that technology has somehow come to be identified with masculinity. In a recent survey of the field, Judy Wajcman notes that:

Feminists have long argued that the symbolic representation of technology is sharply gendered. Men's affinity with technology is now seen as integral to the constitution of male gender identity and the culture of technology. ...This is not to say that there is one masculinity or one form of technology: rather, it is to note that in contemporary Western society, hegemonic masculinity, the culturally dominant form of masculinity, is still strongly associated with technical prowess and power (2000:454).

Here, we feel a similar tension to that discussed in chapter one with regard to the association between masculinity and science. On the one hand, there is undoubtedly much force behind the identification of technology with masculinity – for example, the concept of technology has long been associated with the exertion of Man's rationality in the effort to control nature. Yet, on the other hand, any blanket indictment of technology (or of technovision) in gendered terms would seem to be inadequate to the diversity of masculinities, technologies, and uses to which they are put. Moreover, new technologies can often affect existing gender relations in unexpected ways. Technologies can change what bodies can do, and biotechnologies, in particular, hold the potential for disturbing the natural ground of (hetero)sexual difference, upon which gender categories are erected.

It may be that how we assess the gender of technology depends on what we understand the latter to be. Ruth Oldenziel (1999) claims that the predomi-

nant conception of 'technology' today is actually a product of early twentieth-century class and gender politics. Her argument is that middle-class, male engineers defined 'technology' in masculine terms as part of an attempt to take control of the means of industrial capitalism. Her account draws upon a tradition of feminist scholarship that aims to draw attention to the ways in which activities typically associated with women are accorded lesser cultural prestige than those engaged in by men. The implication would then be that there is no self-evident category of technology outside of social power relations. This raises the question of what it is that we are actually referring to when we speak of 'technology'. Is there anything to the relation of gender and technology beyond ideology? How does technology relate to science? I suggest that, if we are to get to grips with the techno- in technoscience, and if we are to examine the role of photography and other visualizing technologies in the politics of gender and in the production of scientific knowledge, then we must give some thought to how we theorize technology.

The Question Concerning Technology

Since the early 1990s, technology has attracted renewed attention from philosophers. Leading figures such as Andrew Feenberg (1999) and Don Ihde (1993) have argued that the philosophy of technology can no longer afford to ignore the social, political, and cultural dimensions of the environments in which technological developments emerge. Although influenced by contemporary events and theoretical debates, this line of thinking can be traced back to

hermeneutical philosophy and critical theory of the 1950s and 1960s. The key figures of this tradition are Martin Heidegger, Herbert Marcuse, and Jurgen Habermas, each of whom brings together a focus on technology, instrumental rationality, scientific method, and the quest for social progress via the control of nature, with critical reflection upon the project or condition of modernity itself. Heidegger's provocative essay 'The Question Concerning Technology' (1977a) is perhaps the key text for contemporary philosophers of technology as they try to stake out their own positions. Often rejected as flawed or outdated, Heidegger's text continually returns to haunt our technological consciousness today, as if there is still something within it that remains to be thought. This, at least, is the thesis that I will be pursuing in what follows.

The way in which Feenberg (1999) constructs his own 'antiessentialist' philosophy of technology illustrates what I will argue are two common misreadings of Heidegger's view of modern technology. First, Feenberg characterizes Heidegger's account as essentialist and universalizing. He argues that Heidegger's view of 'technology' reduces it to a force that robs the modern world of meaning by treating nature as mere functional raw materials. According to this perspective, the Heideggerian position is unable to recognize the effects of social and historical contexts, and of political struggles over the design of different technologies and the uses to which they are put. As we will see below, however, Heidegger's thinking on technology cannot be essentialist in this sense as it actually challenges the conventional understanding of 'essence'. Moreover, for Heidegger, it is not meaning, but rather freedom that is most endangered by

modern technology. A second, related misreading of Heidegger concerns the charge of idealism. Feenberg claims that Heidegger identifies modern technology with a rationalistic mindset or cultural form that can be combated only through thinking in a different way, rather than through material changes to technological devices themselves. This, however, is to get Heidegger the wrong way round: modern technology is not defined simply by a way of thinking, but instead is given to us, prior to any distinction between the material and the ideal, as that which calls for thought. To clarify these issues, let us turn to the question of what Heidegger understands modern technology to be.

Heidegger is adamant that technology should not be conceived in instrumental terms as a mere technical means towards achieving a given end. Rather, 'Technology is a way of revealing' (1977a:12). Here, modern technology is drawn back to its origins in ancient Greek *technē*, which is itself one form of *poiēsis* or 'bringing-forth' (the other main form of *poiēsis* is *physis*, which may be roughly translated as 'nature'). For Heidegger, *technē* is also linked to the concept *epistēmē* to the extent that both words denote a form of practical knowing that is simultaneously an opening up and a revealing. It follows that technology is a mode of revealing which involves a particular historical understanding of being. It refers to a certain mode of bringing forth the energies of nature. If ancient *technē* can be said to be a revealing that accommodates itself to the energies of nature in setting them free, then modern technology is a revealing that is more concerned with the regulating and securing of these forces: 'The revealing that rules in modern technology is a challenging, which puts to nature the

unreasonable demand that it supply energy that can be extracted and stored as such' (1977a:14). This revealing is a call to order, a ceaseless program of the ordering of nature, so as to maintain a closed system that continually reproduces itself.

Heidegger does not locate the source of this ordering impulse, as might be expected, in the methods or practices of modern science. Indeed, he rejects the suggestion that human activity controls the way in which nature appears in the world. Rather, humanity is set forth on this path by a 'challenging claim' that issues from being or nature itself as it emerges into unconcealment. Heidegger's term for the way in which human beings find themselves so challenged is '*Ge-stell*', which is generally translated as 'enframing'. Here, 'Enframing means the gathering together of that setting-upon which sets upon man, i.e., challenges him forth, to reveal the real, in the mode of ordering, as standing reserve' (1977a:20). It is *Ge-stell*, insofar as it gives a historical framework through which the world may be known, that provides the 'essence' of both modern technology and modern science, and which does so as a technic *of nature*. The coming-to-presence of nature calls forth an originary technic, such that modern technology cannot be regarded merely as the imposition of a foreign element. Samuel Weber makes a similar point in commenting on the relationship Heidegger posits between *technē* and *physis* as intertwined forms of *poiēsis*: 'Accordingly, the innermost principle of "nature" is its impulse to open itself to the exterior, to alterity. Thus, it begins to look as though the "truth" of *physis* is nothing other than *technē*, which, by virtue of its very heteronomy, emerges as more natural

than nature itself' (1996:67). In other words, there is no pure origin of nature 'in itself'; rather, nature is always already open to technology.

Typically, we think of modern technology as being the result of scientific advances, or as the tools of scientific investigation. For Heidegger, however, 'modern technology, which for chronological reckoning is the later, is, from the point of view of the essence holding sway within it, the historically earlier' (1977a:22). Modern science not only employs technology, but more importantly, it is technological in its very essence. This returns us to the fact that technology is here not primarily understood to refer to mechanical devices, but to a particular mode of understanding and revealing beings. Modern technology is a response to the ways in which the energies of nature present themselves, and for any specific technology, it will always be a question of how this process is informed by social, cultural, political, or epistemological contexts.

For an illustration of what Heidegger means by modern technology we can return to chapter one's analysis of the production of (hetero)sexual difference in the scientific thought of the eighteenth century. The establishment of fundamentally oppositional categories of (hetero)sexual difference, which are, in turn, socially and visibly expressed through the gender categories of masculine and feminine (and which eventually, in the nineteenth century, generate the concepts of masculinity and femininity), can be understood in Heidegger's terms as products of modern technology. 'Sex', as a concept representing (hetero)sexual difference, is central to the way that the energies and forms of nature are revealed and ordered during the Enlightenment. We might say that the body is

enframed by the technology of sex, its forces challenged forth, regulated, and secured within a putatively natural order that seeks only to reproduce the same. Here, sexual energies are held in reserve, to be released only in conjunction with predetermined objects, and according to a plan that has been set out in advance. (Hetero)sexual difference would thus be a modern technological response to the challenging claim of enframing. In more contemporary terms, we might say that gender is the modern technological revelation of the life forces of the body.

This example can also be used to illustrate what Heidegger refers to as 'the danger' held within modern technology. Thought through to its culmination, enframing is a danger to freedom. In presenting itself as the only possible mode of revealing, enframing acts to block other possible disclosures of being, and thereby threatens human beings' ability to dwell in the freedom of nature's coming-to-presence. Moreover, it blocks our ability to recognize complexity and difference within being. Sex and gender are technological categories that enframe natural energies and endanger the freedom of our relation to nature. In a similar way, technoscience may be regarded as dangerous insofar as it presents itself as sole guardian of the 'truth' of life and of natural bodies. Yet, for Heidegger, 'What is dangerous is not technology. There is no demonry of technology, but rather there is the mystery of its essence' (1977a:28). And, to a large extent, the mystery of the essence of technology is the mystery of 'essence' itself.

If there is an originary technic involved with the coming-to-presence of nature, if that which is most natural does not exclude the technological, then how

are we to understand the 'essence' of either nature or technology? For Heidegger:

The challenging revealing has its origin as a destining in bringing-forth. But at the same time Enframing, in a way characteristic of a destining, blocks *poiēsis*. Thus Enfaming, as a destining of revealing, is indeed the essence of technology, but never in the sense of genus and *essentia*. If we pay heed to this, something astonishing strikes us: It is technology itself that makes the demand on us to think in another way what is usually understood by 'essence' (1977a:30).

The term 'essence' here translates the German noun *Wesen*. As Heidegger writes elsewhere, 'The substantive "Wesen" did not originally mean "whatness", quiddity, but enduring as presence, presence and absence' (1959:72). Here, the etymological link between *Wesen* and the old Germanic *wesan*, meaning 'to dwell' or 'to sojourn', is emphasized. Heidegger points out that *Wesen* is derived from the verb *wesen*, which itself has the same meaning as *währen*: to last or endure. In our rethinking of 'essence', therefore, we are directed, by that which speaks silently through our language, towards the temporality of things as they present themselves to us. It is a matter of a coming-to-presence and an enduring – to be is to be in time. For Heidegger, such an enduring can never concern an object that is dependent upon the representation of a subject; rather, 'Only what is granted endures' (1977a:31). 'Essence', then, must be rethought in terms of that which is given and which remains through time, rather than as an ahistoric or universal property of a thing in itself. In responding to this grant, what is of crucial

importance is the safeguarding and preserving of the *act of giving* which brings beings forth into unconcealment and allows them to endure in their 'essence'.

The essence of technology is thus a matter of the historical production of different ways of knowing and revealing the natural world; and this is where science comes in. Scientific representations, as the dominant form of knowing within modernity, are worthy of examination for the way in which they express and shape our understandings of nature. For Heidegger (1968), most notoriously, 'science does not think'. The reason for this assessment is that, 'Scientific representation is never able to encompass the coming to presence of nature' (1977b:174). As Trish Glazebrook (2000) has shown, Heidegger identifies the mathematical projection of nature as the key aspect of modern science, and claims this to be decisive for the experience of Western modernity². His point is that natural energies and matter are only admitted into scientific contexts insofar as they conform to pre-established, standardized categories. 'Thinking', on the other hand, involves a *response* to being that is open to difference, and which frees us from the desire to represent and control objects. When one thinks, in Heidegger's sense, precedence is turned over to the time and the being of that which is given to be thought.

From a different perspective, Don Ihde (2001) has recently suggested that Heidegger's most prescient insight in his work on science and technology concerns the formation that we now describe as technoscience. Even in his early work from the 1920s, and especially in *Being and Time* (1996), Heidegger always displayed a certain sensitivity to the way in which 'equipment', tools and

machines, are inextricably involved in the disclosing of different worlds. Later, his claim that the essence of modern science is to be found already in modern technology draws upon a recognition of the technological character of scientific experimentation and observation. He notes, for example, that 'Modern physics, as experimental, is dependent upon technical apparatus and upon progress in the building of apparatus' (1977a:14). Implied here is the importance of technologies insofar as they constitute scientific objects as observable entities that can be brought under control through representational practices.

In this regard, William McNeill (1999) provides us with an illuminating account of Heidegger's analyses of modern science and technology in terms of 'enframing', which argues that this trait is best understood as a specific transformation of the desire *to see*. He notes that, for Heidegger, the priority of vision in Western philosophy and culture stretching back to Plato and Aristotle, is a result of the constancy of presence that it bestows upon things: 'For only sight grants the simultaneity of what is present and what has been... [and] holds them together in one vision, as opposed to the more sequential apprehending that occurs through the other senses' (McNeill, 1999:8). Even before photography, sight slows things down so that they may be grasped and known. According to McNeill, modern technology transforms the desire to see such that it becomes a desire for a certain absence, for the withdrawal from temporality and finitude; thus, 'The problem or paradox of technology is not a desire for presence, but its very flight from any worldly presence' (1999:165). This is a complicated thought, but if we again take (hetero)sexual difference as our example of modern

technology, then such a desire for absence would express itself through a denial of the singularity or uniqueness of natural bodies in time, a rejection of the event of coming-to-presence, and a refusal to acknowledge the complexity and multiplicity of nature. The employment of gender categories would thereby mark a 'presence' that is never really allowed to come to presence. It is a form of vision marked by what it is unable to see. Through gendered lenses of perception, sexual differences are reduced to a (hetero)sexual difference marked only by the visual presence of opposing categories. We see, but our vision is unable to dwell *with* the thing that it approaches. In contrast, for Heidegger, the *Augenblick* refers to a type of (in)sight that is able to apprehend the limits of its own vision in the moment of seeing. As McNeill characterizes it, 'the "glance of the eye" already sees something else, something nonsensible: the finitude of its own presencing' (1999:243). In contrast, the technovision of modern science obscures this (in)sight through its desire for plenitude, security, and control of the time and space of its objects. This latter mode of seeing (which we might in anticipation name as 'photographic') is directed towards removing the object from time, and fixing it in place within a systematic network of representations. In what follows, following McNeill's reading of Heidegger, I will define modern 'technovision' in terms of an epistemological mode of representation that desires the absence of difference, complexity, and time.

It may seem as though the path that leads to a freeing of vision, or to the *Augenblick*, would of necessity turn away from technologically enhanced modes of seeing. Yet, this is not what Heidegger advocates. On the contrary, he claims:

It is precisely in Enframing, which threatens to sweep man away into ordering as the supposed single way of revealing, and so thrusts man into the danger of the surrender of his free essence – it is precisely in this extreme danger that the innermost indestructible belongingness of man within granting may come to light, provided that we, for our part, begin to pay heed to the coming to presence of technology. Thus the coming to presence of technology harbors in itself what we least suspect, the possible arising of the saving power (1977a:32).

One could say that, for Heidegger, modern technology still allows the call of *physis* to be heard, if only we listen closely enough. As McNeill puts it, ‘Technology itself thus opens us to its “essence”, to the concealment of finitude, and thereby frees us even as it claims us, bringing us into the realm of freedom, the realm of “destiny”’ (1999:212). Even though technovision conceals the gift of being, it reveals it to us *as concealed*. It thereby silently calls for another type of vision, a different way of seeing that is more attuned to the temporality of the world’s presencing.

To think of gender as an example of modern technology is to go somewhat beyond Heidegger’s own thought. Indeed, nor have contemporary commentators ventured along such a path. Nevertheless, in McNeill’s claim that, ‘the fundamental feature of technological desire is its desire for self: for self-regulation and self-control, self-security in self-legislation’ (1999:199), we are perhaps drawn in this direction. For what is sex or gender identity if not the technological manifestation of a fundamental *technē* of the self, a means of attempting to regulate the energies of the body, to control them and regulate them in the effort

to legislate a ground for self-identity? Here, we can also note that critiques of Heidegger's position, which argue that he unjustly taints all technologies with a universalizing brush, are off the mark. Where these critics go wrong is in presuming that there is a separate domain of 'technology', as embodied in mechanical devices, to which Heidegger's work applies. In fact, the relevant question concerns the technic by which the dominant character of the modern world is revealed, and which also gives access to alternatives. My argument here is that (hetero)sexual difference is a – if not *the* – fundamental form that modern technology has taken over the past few centuries. As a ground for the natural order of things, and as a means of controlling natural energies within the space and reproductive time of the organism, the modern concepts of (hetero)sex and gender represent a technological mode of revealing. It follows, if we are following Heidegger, that they are both a source of danger *and* the repository of a hidden power of freedom. This, in turn, would suggest that if (modern) technology bears an association with masculine ways of being, it is insofar as 'men' are those subjects positioned as being in control within this technological framework of natural organization and order. Or, perhaps better, we might say that masculinity is structured by the same desire that informs modern technovision – both aim to establish a secure relation of control over the world. This technological understanding of being or nature reveals a world in which authority and meaning is unconsciously generated through the (hetero)sexual opposition of masculine to feminine, both through the differences between these categories and through the sameness within them. That is to say, gender is technological from the start; men

do not merely engage in an ideological conspiracy to appropriate technology, they first appear in a technological position. The same, of course, holds for women; but the feminine is positioned in a different relation to technology, as representative of the natural dimension that is to be known, secured, and controlled (and yet, despite this, the feminine is still figured as the repository of an inviolable authority — thus exposing the ambivalence of this technological desire). In these terms, I argue that what Heidegger refers to as modern technology can be profitably understood as a historically specific response to the way in which nature had come to present itself by the eighteenth century, and which is maintained through the reproduction of modern sex and gender categories as placeholders for the organization of natural energies and material forms.

We will come back to Heidegger's account of modern technology and its relation to (hetero)sexual difference again below. First, however, I wish to turn to nineteenth-century photography and to consider it as a more conventional example of technovision in relation to the temporal 'essence' of technology, or enframing. Photography, involving as it does a technic of vision and of time, serves as an exemplary site in which to further pursue our reading of Heidegger's concept of modern technology. Photography, like gender, is a modern technology which gives shape to our relation to nature. Moreover, both enter into the 'origin' of genetic science.

The Science of Photography

From the moment it was first presented to the world in 1839, photography appeared destined to play a significant role in the development of nineteenth-century science. As a technological medium that appeared to generate objective representations of nature, photography's potential scientific value was quickly grasped. The great debate that arose in the latter nineteenth century over whether photography could rightfully claim the status of art implicitly presumed that the inherent scientificity of its vision was not in question. Yet, the very fact that photographers could claim artistic status for their craft spoke to the fact that the boundary line between art and science had not yet congealed into the impermeable border it was commonly taken to be in the twentieth century. Indeed, it may well be the case that photography is one of the crucial sites through which art and science come to take on their distinctly modern identities. For this task of boundary setting is in no small way a matter of how one sees, and of the limits of vision.

As Crary's work has shown, photographic technology emerged out of a period in which the lucidity of human vision was challenged as never before. In the post-Kantian epistemological landscape, the act of seeing had become inextricably contaminated by the vicissitudes of subjectivity. Most notably, the corporeality of the observing subject weighed heavily upon all attempts to grasp the visual object with any certainty. Embodied within the natural world, at precisely the moment in which the eternal order of nature was giving way to proto-evolutionary notions of historical change, vision was thrown into the flux of

life unsure of its ability to keep up with the pace. The temporal quality of seeing became an issue of some urgency, tied as it was to the time of the body. Early photography, as a technology of time, spoke immediately to the challenge of knowing the natural world as it passed by and through the human body. If writing has always been in some sense against time, then the photo-*graph* was no exception³.

Photography's appearance in the world roughly coincides with the constitution of a number of peculiarly modern sciences, most notably biology, anthropology, and psychology. The fervor with which these nascent sciences embraced the photograph highlights their standing as *technosciences* from the start. Our question here is whether photographic *technē* is more properly described as a modern technology in Heidegger's terms. That is to say, does photography participate in the revealing, ordering, and controlling of the energies of the natural world in such a way that it threatens to block our recognition of the originary freedom in which they are given? Critical studies of the relationship between photography and science in the nineteenth century have frequently focused on the use of photographs for classificatory purposes in anthropology and psychiatry, and these practices have often been understood in terms not dissimilar from Heidegger's concept of enframing.

Indeed, it may be that there exists something like an intuitive sense of the violent 'enframing' that accompanies any photograph. In her influential and trenchant critique of photography, Susan Sontag writes, 'There is an aggression implicit in every use of the camera. This is as evident in the 1840s and 1850s,

photography's glorious first two decades, as in all the succeeding decades, during which technology made possible an ever increasing spread of that mentality which looks at the world as a set of potential photographs' (1977:7). For Sontag, the aggression of the photograph is to be found in the way in which it takes something from its object, and in the power that is thereby conferred upon the person doing the taking. Her quote further suggests that the 'eye' of the photographic camera, and the surfeit of images that it produces, has been instrumental in instituting a pervasive new mode of 'aggressive' seeing – a framing of the world according to the dictates of technovision. The claim would be that the technic of photography is involved in our apprehending of the world irrespective of whether we employ a photographic device or not.

This taken-for-granted character of the photographic image perhaps speaks to the ability of photography to efface itself in the production of its images – its ability to withdraw itself from the frame. As a supplement to nineteenth-century science, photography's success appeared to turn on its ability to deflect all suspicions of artifice, and to thereby provide an alibi for the uncertain vision of the observing subject. Yet, as it was to turn out, it was the very passivity of the camera – its dependence upon the concrete singularity of its object – that was to call into question its adequacy for scientific representation.

It is the human sciences that have attracted most critical attention in studies of how photography was taken up by science in the nineteenth century. John Tagg (1988), drawing heavily on Foucault's work on disciplinary power and the concept of power-knowledge, has analyzed the ways in which photography was

employed by the State to produce knowledge of those on the margins of society, such as prisoners or the insane, in order to exert greater control over them. Through the imposition of a standardized visibility, photography is implicated in the production of a normalizing power and a generalized culture of surveillance. This was not only the case within European societies, but applied especially to the bodies of colonized peoples. Photography, in connection with the new discipline of anthropology, was quickly drawn into the politics of colonialism. The construction of racial differences through exotic images of otherness served to bolster Europe's self-justification for colonial power. In a world that appeared to be changing fast, where the natural order of things was increasingly unsettled by contact with the foreignness of cultural differences, and at a time when the place of humanity in regard to nature was the subject of much debate, photographic images seemed to offer some sense of stability and knowability. As was the case with eighteenth-century science, classification was a means of producing both order and meaning for the world, and for one's place in it. Writing of the tradition of ethnographic photography running from the mid-nineteenth century up until the present, David Green presents a critique common to many in claiming that '...[such photographs] can offer cultural phenomena only as characteristics, curiosities or things, never as active or living processes' (1984:37). Withdrawn from time, from their own time, colonial subjects are reduced to simple objects of spectacle. Classified according to a European logic, they are placed within a system of knowledge that can accommodate them only to the extent that their

otherness – the vitality and creativity of life that they express – is in fact implicitly denied.

Yet this is, of course, to overstate the case for the success of such endeavors. Just as Foucault's *Discipline and Punish*-era work was somewhat one-dimensional in its emphasis on the workings of power, much early photographic social criticism is guilty of overemphasizing the dominance of photography over its objects. This is a point made by Elizabeth Edwards (2001) in her account of a project undertaken in 1869 by the British Ethnological Society, under the direction of Thomas Huxley, which sought to produce a photographic record of all the races of the British Empire. Despite the detailed instructions regarding how the photographs were to be taken, and how bodies were to be placed before the camera, the resulting images that flowed back to the Colonial Office turned out to be anything but standardized, scientific representations. The micropolitics of specific colonial locations and their unique cultural factors combined to introduce considerable heterogeneity into the photographs. Hence:

The dehumanising nature of the photographs is accentuated through the intrusion of humanising, cultural detail and the subjectivities of the photographic act itself – elements of subjectivity that the project was attempting to remove. They provide a productive dissonance that interferes with the communication of the truth value of science (2001:144).

By highlighting 'the indiscriminate nature of photographic inscription', Edwards points to one of the aspects of photography that most troubled nineteenth-

century scientists: its openness to the contingent detail. The presence of the accidental within the image not only disrupts the scientific desire for order, it complicates the purity of photographic vision and suggests that photography itself may perhaps be thought of more as an expression of life than as a mere representational tool of science.

This same difficulty with the detail was to manifest itself almost everywhere that photography traveled in the nineteenth century. One of the factors driving the desire to classify photographically was a resurgence of interest in the practice of physiognomy (the judging of a person's inner nature according to facial characteristics) and its offshoot phrenology (the judgment of mental capacity according to cranial features), which both promised a type of direct visual access to what lay beneath the surface⁴. It is perhaps not surprising, at a time when European societies were undergoing extensive urbanization, much of it driven by capitalist industrialization, along with increased contact with peoples from other cultures, that the unfamiliarities of others would generate a desire to simplify and reduce the complexity and apparent disorder of reality. As people were presented with experiences and images that they were unable to comfortably assimilate to preexisting categories, anxieties over the legibility of social life were produced. Robert Ray (1997) draws an intriguing parallel between such anxieties and photography by locating the initial emergence of each in the urban environments of Paris and London. The pace of life in these rapidly expanding cities reduced people's time for judgment, and compelled them to rely more upon the visual dimension of experience. Ray points to the advent of the first mass-

market paperback books, entitled *Physiologies*, which appeared in Paris in the early 1840s. These books, which offered 'psuedo-scientific portraits of social types' and were intended to make urban life more legible for city-dwellers, may perhaps be seen as expressing a certain 'photographic' desire. Indeed, the advent of photography itself must have seemed a tremendous boon to the physiognomic project, but this confidence was soon to evaporate. The problem, as Ray notes, was that the photographs '...swarming with accidental details unnoticed at the time of shooting, continually evoked precisely what eluded classification – the distinguishing feature, the contingent detail' (1997:297). The camera eschewed the inherent selectivity of human vision, but this was not necessarily the path to truthful and orderly representation.

The more reputable physiological studies carried out under the aegis of psychology or psychiatry were no less immune to this difficulty. The burgeoning field of medical photography in the nineteenth century was stymied both by the excessive level of detail that the camera generated, and by the incorporation of stylistic poses derived from the popular social practice of photographic portraiture. While the posing of the patient's body was intended to produce a readable scientific image, the result tended to be a picture that revealed more about the social (especially gender) and artistic conventions of the period than it did about the medical condition which was ostensibly its subject (Amirault, 1993-94). At least, this was the case for the medical and human sciences that dealt in images which respected the individual integrity of the person represented. But what of the natural sciences? What of biology and photography?

Despite the fact that the daguerreotype, with its capacity to precisely mirror its object, was quickly taken up by natural scientists, this genre of photography has received relatively little attention from photo-historians. Scientific uses of daguerreotypes were especially embraced in France, where its employment in the field of astronomy was perhaps its most well known application amongst the general public (Buerger, 1989:89). Indeed, photography was most immediately relevant to the natural sciences through its ability to supplement the powers of the telescope and the microscope. These were technical devices that had extended human vision to spaces hitherto unreachable with the naked eye, but the knowledge gained via these devices was still limited by its reliance on reproduction through the hand of the observing subject. Astronomy, of course, had a long history, but biology (like anthropology) may be said to emerge as a scientific discipline during the same period in which photography was invented.

Is this coincident birth a matter of mere chance, or is there something about the epistemic situation of the early nineteenth century that calls forth both photography and biology? Do they both respond to the same presentation of nature? Writing of the conjunction of photography and the biological sciences, Georges Didi-Huberman notes that, 'The results were spectacular. The "unsuspected world" – as it was often called at the time – of histology, cytology, bacteriology, and crystallography, this whole invisible world acquired a new value now that it could be put on show and used to transmit knowledge' (1987:71). Paradoxically, the formerly invisible workings of *life* – the new dynamic object of biology – were sought through a visualizing technology that withdrew its objects

from the temporal flow of nature in order that they might be translated into scientific knowledge. While it was to be some years before the speed of the photographic process was adequate to many of the movements of life, by 1865 London's *Evening Standard* newspaper was ready to declare, 'Allied with chemistry and the microscope, photography seems destined to give us what we might almost style a new sense – certainly a second sight' (Cited in Ewing, 1996:8). Together, photography and modern science seemed to offer a new vision of the natural world.

Photography thus provided biological science with new objects and with a new way of seeing, but there were also significant continuities with eighteenth-century natural history. Botany, the preeminent natural science of classification, experienced significant advances in the understanding of plant structure and organization during the period of photography's emergence, and the potential of the new image-making process was quickly and enthusiastically embraced (Thomas, 1997:91-2). That botanists should have been among the first to take up photography is no great surprise given the centrality of visual nomination to botanical practice. As Foucault characterizes it, 'The plant is thus engraved in the material of the language into which it has been transposed, and recomposes its pure form before the reader's very eyes' (1994a:135). The eighteenth-century ideal was for the visibility of the plant to be reconstituted in the discourse of the botanist. Now, in the nineteenth century, the question is whether photography is the form of writing that can prove adequate to the changing appearance and temporality of nature.

William Henry Fox Talbot, one of photography's many inventors (and amateur botanist), is commonly thought to have produced the first photographically illustrated book. A few months before Talbot's *The Pencil of Nature* appeared in 1843, however, an acquaintance of his, Anna Atkins, issued the first part of her *Photographs of British Algae: Cyanotype Impressions*. Larry Schaaf has claimed that this makes Atkins both 'the earliest woman photographer and also the first person to print and publish a photographically illustrated book' (1985:7). The truth of these assertions, like so many others in regard to the early history of photography is a matter of interpretation and dispute. Yet, it is perhaps appropriate to regard botany as the site of photography's first published contribution to science given the close relationship between natural history and visual technologies. For Schaaf, 'Atkins's production was the first realistic attempt to apply photography to the complex task of making repeatable images for scientific study and learning' (1985:8). The repetition of the photographic process promised a reproduction of natural order. Atkins intended her photograms – photographic images produced without a camera by placing the algae specimens directly onto light-sensitive paper, which was then exposed to the sun – to form a complement to William Harvey's 1841 *Manuel of British Algae*, but they could hardly be judged a success on such terms. Aside from the limited blue and white tonal range of the pictures, and the incomplete selection of specimens, there was the problem of the deterioration of the algae upon exposure to light and air. In this sense, the photographic reproduction of life participated in the same dialectic with death that animated biology.

Assessing the impact of Atkins' photograms on botany, and that of photography on nineteenth-century science more generally, requires some consideration of the way in which natural science approached nature during this period. This, in turn, requires a brief consideration of the positivist philosophy of Auguste Comte, which was perhaps the greatest influence on scientific method and practice in the early nineteenth century. Comte argued that science should give up on metaphysical speculation and, instead, proceed to uncover the laws of nature solely on the basis of reason in combination with that which is observable in the world. Moreover, as Carol Armstrong notes, 'Comte describes the classificatory mode of the "botanists and zoologists" as a crystallization of the positivist method' (1998:180). Photography, too, might well appear to be the exemplary positivist tool insofar as it enables nature to represent itself independent of subjective interpretation. For Armstrong, however, there is an anxious underside to positivism as it methodically attempts to keep chaotic disorder at bay. Here, Atkins' images with their paucity of textual accompaniment, far from confirming the visual order of nature, unleash the unclassifiable heterogeneity of the world:

Less botanical illustrations per se than they are illustrations of what kind of illustration a photograph is, they bring the discursive fields of botanical science and photography together to strip both of the power to organize the world and make it yield meaning from within itself. In this, they are the photographic negatives of positivism, of the positively illustrated book, and of its construction of meaning out of succession and resemblance (1998:269).

As expressions of the energy of life that nevertheless conjure up the specter of death, and as unique impressions of the singularity of each specimen, the photograms offer up both too much and too little for the positivist model. Like the photographic images of the human sciences discussed above, the algae are presented in a manner that accentuates the detail of their particularity. At the same time, the visual information given is incomplete from the point of view of a botanical system of classification that requires standardized representations. Indeed, precisely through that which is withheld, Atkins' photographs manifest a rather striking (and perhaps somewhat Kantian) beauty that resists the reductive classificatory tendencies of scientific discourse.

Rather than seeing Atkins' photograms as a deficient mode of photography, however, Armstrong suggests that they exemplify something important about the nature of the photographic image itself. Although it is an indexical sign, which is touched by its referent, it possesses no clear signified: 'A sign, in short, that authenticates but does not signify' (1998:269). A photograph conveys information, but not necessarily meaning. Geoffrey Batchen makes a similar point in drawing a line from Atkins right through to contemporary digital photography. He suggests that her work is in many respects not so different from today's computer-generated images. Because each plate was printed afresh for every edition of *British Algae*, Batchen argues that, 'Atkins presents her images as data, as precisely repeated, invariably differentiated information derived from a common code and disseminated in image form' (2002:158). For both Batchen and Armstrong, the photograph is constituted by a trace of the object, which

conveys data or information, but at the same time withdraws signification, giving, of itself, no immediate access to meaning. The photographic image opens up what we might call an affective economy whereby information is allowed to circulate beyond the organic body and to make new connections. Hence, the ultimate uselessness of photography to botany — its lack of impact on the science — might be explained by the fact that it cannot reveal a meaningful order to nature. As Thomas has noted of the photogram process, 'botanists whose interests lay in plant sexuality, a key aspect of cryptogamic classification, would have searched in vain for the hidden reproductive organs' (1997:92). Linnaeus had, one hundred years before, set botany on its quasi-teleological, divine quest to uncover (hetero)sexual difference as the essence of plant life, but photographic technology was unable to provide the signification or meaning sought by botanical science.

The coalescence of photography and botany also disrupts the positivist picture by introducing a natural presence that is always deferred, and which continually opens the image up to that which is beyond the frame. The information provided by the photogram eschews botanical meaning, but also frustrates the desires of positivism for the full presence of the object. Again, this suggests something about the ontology of the photographic image itself. As Batchen puts it, 'The contact print, then, like the digital image, represents a visible convolution of the binary relationship of absence/presence, nature/culture, real/representation, inside/outside, time/space, that seemingly constitutes the very possibility of photographing of any kind' (2002:161). In this light, early

photography may be seen as ambiguously positioned in regard to the 'enframing' of nature. Its desire to enframe is excessive, and thus always remains frustrated. It seeks to capture and secure the very coming-to-presence of nature itself, but must inevitably defer to the elusive temporality of its object. Furthermore, as a medium for the energies of nature, neither quite in control nor entirely passive, we might well say that photographic *technē* also expresses a similar convolution of masculine and feminine desires. It follows that the identity of photography with masculinity, and with scientific vision, may not be as complete as often appears. The desire for control over nature is never fully realized in the photographic image. Perhaps, then, it is to the forces which shaped photography's emergence that we should turn in search of a better understanding of both its constitution and its relation to gender and biological science.

Romanticism and Photography

The early nineteenth century was a time in which people became aware of their time as perhaps never before. The passing of time appeared to force itself into the consciousness of those who sought knowledge of life and of the world. This was not merely apparent in the works of philosophers such as Hegel, for an urgent need to engage with the past was felt by many. As the historian Eric Hobsbawm characterizes it, 'an epidemic of history-writing overwhelmed Europe in the first half of the nineteenth century. Rarely have more men set down to make sense of the world, incidentally often for the first time' (1996:285). This activity of recuperation was also reflected in the construction of the first great

public museums of art and of history. As monuments to the past, and to the desire to preserve its influence upon the present, museums established a prominent position for themselves within a public imaginary that sought the security of a historical order. Thus, Hobsbawm notes that, 'To collect the relics of the past, written or unwritten, became a universal passion' (1996:285).

For Hobsbawm, this historical awakening reflects the importance of nationalism in the wake of the French Revolution, and the advantage to European states of establishing the authority of nationalist cultural traditions. In a move that was surely intensified by the colonial relations of the period, and by the anxieties that drove Europeans both to distinguish themselves from the colonized other and to affirm the superiority of European culture, art and history were employed to shore up national identities. It may also be suggested, however, that consciousness of societal change and the increasing speed of life plays into this concern with history. The Industrial Revolution with its machine-powered technological advances, and concomitant pressures towards urbanization and the promotion of a consumerist culture, undoubtedly accentuated the difference between present and past ways of life. Furthermore, with scientific evidence inexorably challenging the belief in an eternal natural order, the period of the early nineteenth century might be characterized as one in which people became more aware than ever of how they inhabited their own time in distinction from the time of others, and of how the passage of time led towards an uncertain future.

In many ways, this is the scene of photography's emergence into the world. Parallels between the museum, the practice of historiography, and the impact of

the photographic image in representing and preserving the past come readily to mind. Hence, it is no surprise to read that:

Loss and its marker, the will to preserve, are of course central to any consideration of photographs.... A photograph is concerned with the way things are but will not remain, or perhaps the way we wish they were, or the way we wish they might have been. The perceived threat that this state will be lost is inherent to the act of photographing (Green-Lewis, 1996:17).

Casting our vision backwards, the suggestion here would be that photography is born out of an experience of loss. We might say that the desire to photograph represents an attempt to regain a solid grasp on the diminishing order of a world set free by the withdrawal of the divine, by the insistence of diversity and heterogeneity in expressions of nature, and by the concurrent clouding of vision generated out of humanity's new position within the material flux of existence. Photography might be said to mourn the visible presence of the infinite in things. Or, might this perhaps be better described as a melancholic condition? Is there a certain historical loss that photography is unable to avow, but which nonetheless continually threatens to return and disrupt the framing of the image? Is it from an experience of loss that the desire to photograph is born, or is it that photographic desire is the product of a world in which knowledge is conceived in terms of the negation of loss (to time)?⁵

As we saw above, photography was quickly embraced by positivist science in the 1840s as the realization of its own vision. From this perspective, the

photographic image appeared to restore a stable image of the natural world, such as that which had underwritten the bulk of eighteenth-century science, albeit now framed in more secular terms. The authority of nature stood undiminished. The period of photography's emergence – that is, of its gradual and multiple 'inventions' from the 1790s through the 1830s – was, however, more notable for the influence of Romanticism. As a multifarious response to the excessive rationalism and mechanical materialism of the Newtonian worldview, and to the alienation from the natural world inherent in the spread of industrialization and commercial society, Romanticism turned back towards nature in an expression of longing for an original harmony and sense of unity. Romantic thought reinvigorates Rousseau's belief that social arrangements should allow people the space in which to develop their natural inclinations, thus allowing them to embrace their belongingness within nature.

Nature, however, was anything but a stable concept at this time. In reaction to the limitations of the mechanistic conception of nature, attention was turning away from physics and towards the emerging disciplinary formation of biology, with the dynamic force of organic life as its object. Indeed, Oppen points out that a similar move can be traced '...in such domains as philosophy, historiography, literature, and the arts in general, the metaphor of the living, evolving organism begins to replace the metaphor of the mechanical, nonevolving clock' (1973:35). The German poet Goethe, one of the most influential writers of the Romantic period, was among the first to evince a keen interest in a biocentric concept of organic nature. As Oppen describes it, 'Goethe devoted himself to establishing a

view of reality where life, growth, metamorphosis, and the vivid experience of the phenomenal world were central' (1973:37). Goethe's opposition to the Newtonian theory of nature can be seen in a poem written in 1812, where he ridicules the reduction of God to a mere first cause, and evokes instead the existence of immanent organizing forces of nature:

What God would nudge his world but not be in it
 And only round his finger twirl and spin it!
 He moves the world by inwardly impelling,
 And he is nature's, nature His, indwelling
 So that what in Him lives and works and is
 Can't lack the power and spirit that are His.
 (1998:119)

Goethe believed strongly that not only was God present within the natural world, but that the essence of humanity was also to be found in organic nature. This reflected a prevalent belief within the Romantic period that humanity should embrace its position within nature in order to gain a fuller understanding of the latter. Indeed, Goethe's interest in botany was premised upon his belief that the true nature of all life could be discovered through the study of plants. In his 1798 poem, 'The Metamorphosis of Plants', the influence of Linnaeus is apparent: 'Twinned they push themselves through, destined and made to unite./Harmoniously they stand, the gracious couples, together,/Numerously arranged all round the altar divine.' (1998:79). Again, it is (hetero)sexual relations

that serve to express divine force in the natural world. 'Life' reiterates the character of eighteenth-century natural history even as it becomes historical and immanent to nature.

This allusion to (hetero)sexual coupling and marriage also finds resonance in another of the key fields opened up by physical science in the late eighteenth- and early nineteenth centuries: electricity and electro-magnetism. Based in the opposition and mutual attraction of somewhat mysterious positive and negative forces, the organization of the electric field reprised the polarized relations of (hetero)sexual difference that were presumed to ground the dynamism of the natural world. The polar relations driving electricity also bore affinities with the dialectical German philosophy of the day, and with developments in chemistry – most notably in the work of Humphry Davy, who was an important figure in the development of the chemical process of photography. To a certain extent, then, the emerging science of the early nineteenth century shared much with Romantic thought. In this light, the still widely held view that Romanticism was anti-science requires some revision. As Mark Lussier points out, 'the disinterest of Romantic poets is not to science *per se*, but towards a science incapable of envisioning the type of events they perceive recurring in the mind's engagement with, and emergence within, material reality' (2000:18). At a time in which the definitional boundaries of modern science had not yet been fully established, Goethe's writings challenge the emerging paradigm of positivism, and can be understood as part of a movement giving voice to an alternative 'Romantic science'. As Astrida Tantillo notes, 'Throughout his scientific works, Goethe emphasizes how

polarities work together to comprise a kind of whole.... His idea of polarity emphasizes that two contradictory forces may not only simultaneously coexist and be reconciled, but that their very coexistence gives the universe its structure and life' (1998:124). Moreover, there is little doubt that these polar forces of nature are expressed most primally through the workings of (hetero)sexual difference: 'According to Goethe, the masculine and the feminine are no longer confined to the sexual organs, but are linked to two separate and opposing life forces of the plant. These two tendencies, or two vital systems, are the principles behind the metamorphosis of plants' (Tantillo, 1998:131). From the individual living organism, through the play of polar forces driving the physical world, to nature conceived in terms of an organic whole, writers of the Romantic period understood the unity of the natural world to be a product of oppositional forces that came together to give it movement and direction. Born within this context, perhaps it is not surprising that the photographic process would come to be characterized in terms of positive and negative images.

This Romantic conception of science should also give us further pause in subscribing to the line of thought that maintains photography to be the privileged vision of objectivism. Reece Jenkins, for instance, claims that many of the pioneers of photography operated in both the worlds of Romanticism and positivism: 'They were epistemological positivists and ontological Romantics. The positivist scientists were empiricists in the methods of acquiring knowledge, but often they were unable to shed their Romantic views of nature' (1986:20). This suggests, then, that too strict an opposition between positivism and

Romanticism here may lead us astray. Indeed, both respond to the becoming-historical of nature by seeking to return to a certain wholeness of presence, and to the reproduction of a natural order that will secure either unity or universality. Hence, to the extent that photography introduces absence into presence, it cannot be said to fit seamlessly into either the Romantic or positivist worldviews.

The difference between the positivist and Romantic worldviews may be said to turn, most aptly here, upon the value attributable to the visible. While positivism sought to limit the knowable to that which was rational and observable, the spirit of the Romantic period drew it towards the more intangible and invisible aspects of reality. The result, as William Galperin notes, is that 'the Romantics seem virtually united in their suspicions regarding the world viewed as against a world of imagination' (1993:19). Rejecting objective determination, Romantic writers emphasized the subjective impression, or feeling, of the knower as a part of the natural world that was to be known. Thus, for Galperin, 'to the extent that there was a photographic impulse early in the nineteenth century, it was an impulse *opposed*... to the intentional structures of romanticism' (1993:224). The visible as captured by photography, in its contingency and singularity, offers up resistance to an imaginative appropriation by the observing subject. At the same time, however, (as we have already noted) neither does photography present nature in the orderly manner required by the positivist project of uncovering laws of succession and resemblance. While it may express the common desire of Romanticism and positivism to secure the truth of nature in itself, photography can satisfy the longings of neither.

Photography, we might say, is born of mixed parentage. As an articulation of the energies of nature with a technology of time, photography emerges from out of the Romantic milieu only to find that it is already given over to a scientific method with which it is not fully congruent. What both approaches to knowing the world share, however, is respect for the authority and agency of nature itself as the ultimate source of knowledge (even as science seeks to dominate and control it), and this is also central to the conception of photography. Nature still held divine power and authority, but previous means of representation were no longer adequate to its historical condition. The intermingling of the natural world and human mind, already opaquely registered in Kantian philosophy, along with the immersion of human vision within the unstable materiality of life, meant that the secrets of nature appeared all that more elusive (especially to mechanistic natural philosophy), thereby stimulating the desire for a form of vision adequate to the dynamic self-presentation of nature. As Batchen has documented:

From Henry Brougham to Louis Daguerre, photography's many inventors, or 'proto-photographers', described their aspirations in a remarkably uniform fashion. Almost all spoke of wanting to devise a means by which nature, especially those views of it found in the back of a camera obscura, could be made to represent itself automatically (1997:56).

This implies a level of dissatisfaction with the limitations of subjective vision within the new temporal and material economy of life. It was the time of nature that most troubled poets, scientists, and photographic experimenters alike.

Batchen argues that in the work of Romantics such as William Cowper and Samuel Coleridge we can glimpse a reworking of the metaphor of the camera obscura in terms of ‘...this new problem of faithfully representing what one sees in the face of passing time’ (1997:84). If the light of the sun provides photography with its energy, then, from its earliest days, it may be said to be haunted by the shadows of its objects. In announcing the invention of his own photographic process, Talbot, one of the most well known of the early photographers, commented that, ‘The most transitory of things, a shadow, the proverbial emblem of all that is fleeting and momentary, may be fettered by the spells of our “natural magic”, and may be fixed for ever in the position which it seemed only destined for a single instant to occupy’ (1980:25). As Batchen puts it, ‘Photography was, for Talbot, the desire for an impossible conjunction of transience and fixity’ (1997:91). The image appears to halt the passing of time, but only insofar as it defers to the temporal agency of nature. Photographic technology allows nature to come forth and present itself in its own time, yet, *at the same time*, it withdraws living nature from that very time.

What of the technic of photography then? Often seen as exemplary of modernity, does it manifest the essence of modern technology in Heidegger’s sense? On the one hand, the photographic process might be said to ‘enframe’ the energies of nature insofar as it makes them available for representation, ordering, translation, and control. It calls nature forth, out of its own time, and captures its impression, whether it be on paper or, increasingly today, in a digital, computer-based form. On the other hand, however, the openness of photography

to nature, its dependence upon what is given to it, on what is left through the withdrawal of nature, means that it cannot simply be characterized as 'enframing'. In Heidegger's terms, it attempts to enframe, but is always called back to the gift that sends it on its way. It is a technic *of nature*. Thus, photography is somewhat uncertainly located in the space between (Romantic) nature and (scientific) technology. Or, better still, it may in fact be exemplary of 'modern technology' in Heidegger's sense, precisely because in extending technological desire to its limit in the representation of nature, it calls forth the freely given exuberance of life which undoes the secure framing of the image. Thought through to its essence, photography disrupts the enclosed identities of the natural and the technological by showing that each is already present within the other.

As we look towards the future, I suggest that nineteenth-century photography can provide us with a model for the mode of 'technovision' that emerged alongside modern science. If photography is exemplary of modern technology in the Heideggerian sense, then it would follow that it should also bear an 'essential' relationship to modern science. Early photography, I suggest, expresses the desire for a certain relation to the natural world that is characteristic of modern science. It is a desire to reveal nature 'in itself' in such a way that it can be known despite its changing condition through time. 'Life' is called to presence via a self-effacing technology that wishes to overcome historicity and time. This may be seen as a desire for control over the natural world in order to secure a place within it. More specifically, we might say that photography shares

with biology an uncertain location between Romanticism and positivism. Both seek objective truth, but are haunted by something that is fundamentally unknown and unseen, and which structures the historical condition of nature (to which they ultimately submit). In this context, we should not be surprised if we find that photography, like biology, is drawn to images of death and sex.

Death, Sex, and the Trauma of Photography

This is the way in which our time assumes Death: with the denying alibi of the distractedly “alive”, of which the Photographer is in a sense the professional. ...For Death must be somewhere in society; if it is no longer (or less intensely) in religion, it must be elsewhere; perhaps in this image which produces Death while trying to preserve life. Contemporary with the withdrawal of rites, Photography may correspond to the intrusion, in our modern society, of an asymbolic Death, outside of religion, outside of ritual, a kind of abrupt dive into literal Death (Barthes, 1981:92).

As a technology of life, photography maintains a structural relation to the (sometimes unconscious) specter of death. If religion may be said to be the site in which premodern humanity confronted death and endowed it with meaning, Roland Barthes provocatively suggests that photography is exemplary of modernity's need to find a place for death while, at the same time, diminishing the threat of dissolution that it brings — insofar as death now appears to represent the very absence of meaning. For Barthes, the dead return in every photograph. As an impression made by life itself, as a trace of life left behind in

the material of the image, the photograph announces the presence of someone or something that is no longer, insofar as it has seemingly been withdrawn from its own time.

This is the same dynamic relationship between life and death that Foucault uncovers in early nineteenth-century biological thought and medical perception. The ongoing conflict of these antagonistic forces within the organic body produces a discourse in which 'health replaces salvation'. The suggestion is, then, that biology and medical science take on implicitly theological motives. In a passage that could have also been written about photography, Foucault explains, 'This is because medicine offers modern man the obstinate, yet reassuring face of his finitude; in it, death is endlessly repeated, but it is also exorcized; and although it ceaselessly reminds man of the limit that he bears within him, it also speaks to him of that technical world that is the armed, positive, full form of his finitude' (1994b:198). Under the bio-medical gaze, just as in the photograph, life is technologically revealed through the visual appearance of organization in the face of death.

Both Barthes and Foucault draw attention to the culture of death that enveloped the early nineteenth century, and which was to mark the birth of photography. The broad outlines of this transition have been laid out by Philippe Ariès in his *Western Attitudes Towards Death* (1974). Although his work has been criticized with regard to its somewhat stark characterizations of the differences between premodern and modern attitudes towards death, it seems clear that European societies in the nineteenth century exhibited greater difficulty

in conceptualizing death, and that they cultivated ever more elaborate ways of mourning and of remembering the dead (not least through photographs). This would make sense in terms of the era's increased historical consciousness and widespread feeling that the present was endangered by the passing of time. According to Ariès, death at this time lost its sense of continuity with life and, instead, became conceptualized in terms of a rupture or radical break with life. Death became the defeat of life, the victory of time over the organizing force of the natural body.

Photography finds its place within this generalized anxiety over death. Its import here, for Barthes, is ontological: 'in Photography I can never deny that *the thing has been there*' (1981:76)⁶. The image concerns the being of its objects. At minimum, this is the knowledge conveyed by a photograph: 'The important thing is that the photograph possesses an evidential force, and that its testimony bears not on the object but on time' (1981:89). Hence, the photographic image is not primarily a representation that establishes a historical identity or meaning. Rather, it is a repetition of presence, and of affect, which bears within itself a renewed desire for the object to which the photograph refers but can never reach. The spectral presence of the photograph reveals an ontology in which presence is never entirely present, rather, it is always already given over to the time of its passing. The effect generated is that of an intensity of time, or what Barthes refers to as the *punctum* of a photograph – a pure representation of time that breaks the boundaries of the image and lifts the viewer out of the linear

relation between past and present, and into the immediacy of a temporal opening that is experienced as both 'wound' and 'ecstasy'⁷.

Barthes' insistence that photography produces a temporal wound in the observing subject may be thought of in terms of an implicit trauma that perhaps accompanies every photograph. If traumatic events are understood to be affective experiences that are unable to be fully processed and cognitively known at the time of their happening, and which maintain an unconscious presence until the time of their return, then they effect a temporal disruption not unlike that of the photograph; for the camera is a device that produces an imprint and later re-manifestation of that which escapes the human eye in its own time. As Ulrich Baer notes, 'Because trauma blocks routine mental processes from converting an experience into memory or forgetting, it parallels the defining structure of photography, which also traps an event during its occurrence while blocking its transformation into memory' (2002:9). In both cases, the time of the experience, or of the object, is deferred. It maintains only a spectral presence that cannot be definitively situated in past, present, or future.

Although he is concerned primarily with photographs of traumatic experiences that resist integration into larger contexts, Baer also claims that there is a 'constitutive breakdown of context that, in a structural analogy to trauma, is staged by every photograph' (2002:11). In the abstraction from context, meaning is lost, turned over to the vision of the camera. As in Barthes' account, the essence of the photographic thus lies in the transmission of temporal information, and with the repetition of an affective moment which can never be remembered

as such. Baer's point is that photography should not be understood as the cause of temporal disruption however; rather, he claims that the photographic image functions to reveal to us the way in which time is. That is to say, the photograph is exemplary of temporal affect – of the way in which time does not merely exist in a ceaseless flow from beginning to end, but, rather, presents itself in moments of intensity and expanses of duration. Photography reveals to us a nonlinear ontology of time.

At this point, we might pause and observe that we ourselves have staged something of a return, back to the melancholic structure of (hetero)sexual difference with which we began chapter one. There, we encountered Butler's theory of the way in which the gendered subject is constituted via the foreclosure of homosexual desire, thus marking a loss that cannot be known – for it occurs outside of the time of the subject – but which nonetheless maintains a haunting presence, forever threatening to return and to dissolve the integrity of self-identity. Could it be that photography, like gender, is a melancholic technology? Might photography and gender share a certain technological 'essence'? A curious thought, no doubt. Yet, both photography and modern gender categories produce a certain reproductive, static time of nature in which a constitutive loss cannot be avowed for it is that which gives agency or image. Barthes, for his part, certainly seems drawn towards the photography of sex.

Like Bataille before him, Barthes is intensely interested in the erotic as an excessive force of life. This dynamic is explored most notably in works such as *The Pleasure of the Text* (1975) and *A Lover's Discourse* (1978), but it is to his

1970 essay 'The Third Meaning', which stands as a direct forerunner to the analysis of the photographic image found in *Camera Lucida*, that I turn here. Of central interest is the oft-noted parallel between that essay's notion of the 'obtuse meaning' and Barthes' later concept of the *punctum* in photography. I wish to consider what the 'obtuse meaning' can tell us about the affective force of the *punctum*. In 'The Third Meaning', Barthes analyses photographic 'stills' from an Eisenstein film in order to distinguish between the 'obvious' meaning of the images (or what is referred to as the *studium* in *Camera Lucida*) and the 'obtuse' meaning that adheres in the detail and disrupts the conventional reading by withholding the full presence of the signifier. He describes the obtuse meaning as '...the one "too many", the supplement that my intellection cannot succeed in absorbing, at once persistent and fleeting, smooth and elusive...' (1988:54). Echoing Bataille's concept of the 'accursed share', Barthes claims:

Finally, the obtuse meaning can be seen as an *accent*, the very form of an emergence, of a fold (a crease even) marking the heavy layer of informations and significations. ...This accent... outplays meaning – subverts not the content but the whole practice of meaning. A new – rare – practice affirmed against a majority practice (that of signification), obtuse meaning appears necessarily as a luxury, an expenditure with no exchange. This luxury does not *yet* belong to today's politics but nevertheless *already* to tomorrow's (1988:62-3).

Like the *punctum*, there is an ecstatic quality to the obtuse meaning that lifts the viewer out of the linear temporality associated with the reproduced image. For

Barthes, the obtuse meaning carries an emotive force, evocative of love, and of an excessive eroticism that always threatens to break down the established order of things. Beyond the beauty of form, 'There is in the obtuse meaning an eroticism which includes the contrary of the beautiful, as also what falls outside such contrariety, its limit – inversion, unease, and perhaps sadism' (1988:59). Barthes' account suggests that there is, potentially at least, a certain disruptive 'sexual' energy within the photographic image that does not respect established identities or social order.

Turning to *Camera Lucida*, and moving from the obtuse meaning of the film still to the *punctum* of the photograph, it is notable that the sexual dimension of the image is foregrounded more explicitly. In elucidating the distinction between *studium* and *punctum*, Barthes is drawn into a discussion of pornographic and erotic photographs. He characterizes *studium* as '...that very wide field of unconcerned desire, of various interest, of inconsequential taste: *I like / I don't like*. The *studium* is of the order of *liking*, not of *loving*' (1981:27). Searching for an exemplar of the banal 'unary' photograph distinguished solely by the quality of *studium*, Barthes suggests that, 'Nothing is more homogeneous than a pornographic photograph'; for 'it is completely constituted by the presentation of only one thing: sex: no secondary, *untimely* object ever manages to half conceal, delay, or distract...' [emphasis added] (1981:41). Thus, there is no obtuse meaning in the pornographic image; desire is restricted by the limits of representation and narrative. As Barthes writes:

For me, there is no *punctum* in the pornographic image; at most it amuses me (and even then, boredom follows quickly). The erotic photograph, on the contrary (and this is its very condition), does not make the sexual organs into a central object; it may very well not show them at all; it takes the spectator outside its frame, and it is there that I animate this photograph and that it animates me. The *punctum*, then, is a kind of subtle *beyond* – as if the image launched desire beyond what it permits us to see (1981:59).

We must note the use of personal pronouns here. Barthes is not engaged in the impossible task of laying down rules for the distinguishing of erotic from pornographic images. Rather, it is in the relation *between* photograph and viewer that we find the *punctum*. The erotic reveals a concealed dimension that draws the viewer out of the image and back into the time of life. In the form of *punctum*, it disrupts photographic order and evokes an unseen future.

What I wish to suggest is that Barthes' intuition regarding the relation of sexual desires to the ontology of the photographic image is something that bears further thought. It may even be that pornographic photography is exemplary of the way in which modern technology reveals being. Like gender concepts, the pornographic image seeks to enframe and control natural energies through the representation of sex. It aims to show everything, to allow the spectator to possess through *seeing*. At the same time, Barthes' characterization of the erotic photograph alerts us to the fact that technological representations of sex are never guaranteed to *reproduce* a systematic natural order of desire. Photographic technology, like modern technology more generally, is ambiguous in its

relation to nature. The provocation of Barthes' work is to suggest that photography is drawn to sex — insofar as an 'erotic' force is unconsciously at work in its images, even if this affective force strains the limits of what we understand to be 'sexual'.

Indeed, although it scarcely features in conventional histories of the medium, photography, from its earliest days, has always manifested a strong desire for sex. Plentiful evidence of the proliferation of pornographic photography from the 1840s onwards is available to those who look for it (Ovenden & Mendes, 1973). This is roughly contemporaneous with the emergence of the word 'pornography' into the English language as a discrete conceptual category (Sigel, 2002:3), and it obliquely raises the question of whether *photographic* pornography bears an intrinsic, technological relation to the establishment of distinct identities grounded in the concept of (hetero)sexuality⁸. Certainly, one can argue, as Abigail Solomon-Godeau does, that 'the invention of pornographic or erotic photography cannot be adequately considered merely as an extension of a pre-existing genre' (1991:232). Pornography may predate photography, but insofar as the photographic image is associated with a new way of seeing, we must consider the different affective force generated by photographs of 'sex'. For Solomon-Godeau, as for Barthes, the difference here is ontological. Thus, 'Insofar as the photographic picture is the trace of a once-present person or object, the spectator is inevitably situated in a certain — however ambiguous — relation to the real' (1991:232-3). The 'real', here, may perhaps be understood as a relation generated by the ability of nature to 'present itself' to the camera lens:

the photographic ideal. The authority that is thereby extended to representations of (hetero)sexual difference is profound; for the early pornographic photograph draws together sex, death, and nature, which all bear the mark of the absent God.

Solomon-Godeau also raises the issue of a 'sexual economy of looking'. The situating of women as the objects of visual representation, and of men as the subjects who gaze, is a topic which must be considered in any discussion of nineteenth-century pornographic photography. Moreover, this returns us to the question of whether modern technology should be thought of as manifesting a peculiarly masculine form of vision. Solomon-Godeau's claim is that pornographic photography must be understood as invoking a broader, '*systemic* quality of objectification and fetishism in the representation of women' (1991:237). At issue, I would suggest, is the way in which the dominance of the visual in knowledge production unconsciously articulates with a gender system that produces authority for ways of knowing that succeed in displacing the fundamental contradiction of technoscientific knowledge in relation to nature — the need both to control, and to ultimately defer to natural authority. If photography in general holds the promise of epistemological clarity, then the pornographic photograph seems to offer men the ability to know and control nature via women's bodies — which they both desire and 'worship' — and thus to be secure themselves in their fundamental difference from the other sex. When one's identity is dependent upon another through (sexual) opposition, there is perhaps a tendency towards the generating of a desire to know and represent

that other (sex) in order to find oneself (and, no less, to find God). From this perspective, the pornographic photograph, like gender, is a technology of (hetero)sexual difference.

Yet, what of the *punctum*, what of the ecstasy of the erotic photograph? Jane Gallop points out that Barthes' account of photography does not presume that the viewer is active while the represented object is necessarily passive. Only in the self-enclosed image, where all is *studium*, may this be said to be true. When there is *punctum*, on the other hand, it is the spectator who is delivered over to a certain passivity in being pierced by the otherness of the image. Hence, for Gallop, 'The *punctum*, by breaking open the *studium*, breaks open a sterile enclosure which does not allow anything to pass through, and allows what Barthes calls "life" to pass through, to permeate the frame' (1996:397). The 'life' that passes through the photograph, as Gallop recognizes, is intrinsically connected to what Barthes refers to as 'eroticism'. The affective force that appears via the *punctum* bears a 'sexual' energy that cannot be contained within the limits of the representational image. We might say that the photographic *punctum* allows a mode of sexual desire that is neither wholly natural nor technological to appear within the image.

In her effort to think the relation between photography and erotic sexuality, however, Gallop does not go on to consider the fact that, for Barthes, it is the intensity of time that provides the fundamental experience of the *punctum*. Life flows through the frame in the form of a nonlinear temporality. Photographic ecstasy, the madness of the image, is to be found in the erotic desire that bursts

open the reproductive temporal economy of (hetero)sex with its ordered repetitions of the same. The *punctum* thereby provides an opening to an unconscious desire that runs beyond the bounds of the (hetero)sexual subject. Ecstasy is here the death of the self insofar as it is understood as a self-enclosed organism, and the erotic photograph may thereby be said to produce something like a traumatic affect that threatens the coherency of both the (masculine) subject and the (feminine) object of (hetero)sexual desire.

From a Barthesian perspective, there may be something potentially 'pornographic' about every photograph insofar as it withdraws being from the time of life, and makes it known through its emplacement and circulation within a network of images. For what is 'pornography'? Literally, it is the writing of prostitutes. To prostitute, in turn, is to offer up instead of or in the place of another – perhaps an apt definition of the photographic process. Both photography and pornography act to supplement the presence of nature, and the fact that 'prostitution' has come solely to denote a form of sexual substitution suggests that 'sex' is a crucial factor in assuring the boundaries of representation and the translation of nature into culture. Photography is pornographic in the mode of modern technology, but between the viewer and the image sexual energy is never entirely enframed, and thus constantly threatens to generate an 'erotic' and excessive image.

It follows that, if the technovision of biological science may indeed be characterized as 'photographic', there may be unrecognized productive moments of tension and ambiguity in relation to the discourse of (hetero)sexual difference.

The suggestion is that biological 'life' is inaugurated through a traumatic relation to death, which expresses itself only partially in the images generated by technoscientific representation. By examining biological science in terms of photographic vision, we may be able to catch a glimpse of an opening to alternative understandings of sex and life.

The God of Technology

Finally, in this chapter, I wish to return to Heidegger's account of modern technology, to take up the question posed by Barthes' allusion to a homology between the social role of photography and that of religion in relation to death. Rarely noted in commentaries on 'The Question Concerning Technology' is the discussion of causality that comprises the first part of the essay. In seeking to undermine anthropologic and instrumental understandings of technology, Heidegger contrasts the modern emphasis on efficient causes (i.e. that which brings about an effect) with the Aristotelian understanding of the fourfold nature of causality (material, formal, final, and efficient), which he characterizes as co-dependent ways of being *responsible* for something. His claim is that modern science and technology operate with diminished notions of causality, especially in regard to the perceived absence of a final cause (i.e. an end). Heidegger's example is a sacrificial chalice, which is a product of matter (i.e. the material cause), of the idea of chaliceness (i.e. the formal cause), of the religious context in which it is used (i.e. the final cause), and of the work of a silversmith (i.e. the efficient cause). He writes, 'the four ways of being responsible bring something

into appearance. They let it come forth into presencing' (1977a:9). To be responsible is, first and foremost, to *respond* to nature as *physis*, and to allow a thing to come forth and to be in its singularity and its difference. It is a mode of revealing that gives 'occasion'. In contrast, the 'enframing' of natural materials and energies produces only equivalent resources, which can then be exchanged for one another within a closed system that *endlessly* reproduces itself.

By choosing a chalice as his example, Heidegger gives a hint that the absence of the *causa finalis* from modern notions of causality must be thought in terms of what Nietzsche refers to as the 'death of God'. Another such hint can be found in Heidegger's essay 'The Thing' (1971), in which he contrasts the scientific definition of an *object* with the poetic letting-be of a *thing* by way of an analogous fourfold mode of revealing. There, Heidegger speaks of allowing the 'thingness' of the thing to appear as the gathering together of 'earth, sky, gods, and mortals' (which can be understood as nonmetaphysical or poetic reconceptualizations that correspond to the material, formal, final, and efficient causes). By giving up scientific representations in favor of a thinking that 'responds and recalls', he believes that we may enter into the becoming of the 'thing *qua* thing', and thereby experience the 'thingness of the thing'. In Heidegger's words, 'The thing things. In thinging it stays earth and sky, divinities and mortals. Staying, the thing brings the four, in their remoteness, near to one another' (1971:177). The poetic nature of Heidegger's writing in this essay makes his thinking inevitably opaque, but the point to notice is simply that both the difficulty of understanding the fourfold nature of causality, and the difficulty of

experiencing the fourfold presencing of a thing, turn upon the temporality of experience and the absence of the *causa finalis* — that is, on overcoming the absence of the gods within mundane existence under the sway of a modern technovision that is unable to ‘stay’ with things. From Heidegger’s perspective, the gods provide the dimension of ‘farness’ that is required if we are to experience the intimacy or ‘nearness’ of things. Hence, at the end of the ‘Question Concerning Technology’ essay we read:

Thus where everything that presences exhibits itself in the light of a cause-effect coherence, even God can, for representational thinking, lose all that is exalted and holy, the mysteriousness of his distance. In the light of causality, God can sink to the level of a cause, of *causa efficiens*. He then becomes, even in theology, the god of the philosophers, namely, of those who define the unconcealed and the concealed in terms of the causality of making, without ever considering the essential origin of this causality (1977a:26).

In the age of modern technology, God is no longer an unknowable other, but rather, merely the unthought first term in the logic of a closed system. The understanding of being inherent in modern technology (for example, of gender as the effect of the cause that is sex) thereby compels us to engage with what Heidegger refers to as ‘onto-theology’. For when we begin to question the operative notion of technological causality, the granting of the taken-for-granted ground beneath the endless activity of regulating, ordering, and securing becomes more questionable to us. ‘Onto-theology’ is Heidegger’s term for the

essential character of metaphysical thinking insofar as it represents beings in terms of both 'the ground that is common to all beings as such' (onto-logic) and 'with respect to the highest being which accounts for everything' (theo-logic) (1969:70).

In a thoughtful explication of this concept, Merold Westphal points out that Heidegger's critique of onto-theology is not directed towards the God 'before whom people do fall on their knees in awe, pray, sacrifice, sing, and dance', but towards the God of the philosophers and scientists, and towards fundamentalist theistic discourses that, 'have sold their soul to philosophy's project of rendering the whole of reality intelligible to human understanding' (1999:148). Hence, the onto-theological gesture 'consists in positing such a God as an excuse for making the claim that we can occupy the divine perspective on the world, or at least peek over God's shoulder' (1999:149). Here, God as *causa sui* and as *causa prima* provides the underlying ground or reason upon which the great logical edifices of calculative-representational thinking are built. Yet, it is not only, or even primarily, discourses that explicitly reference God which are onto-theological. Rather, Heidegger's point is that onto-theology inhabits all forms of modern technology.

It is apparent that Heidegger, as characterized by Westphal, is referring, first and foremost, to the science and philosophy that emerged in Europe in the seventeenth and eighteenth centuries. Onto-theology is easily recognized in the work of figures such as Linnaeus who explicitly posit the deity – mediated by (hetero)sex – as guarantor underlying the natural order (theo-logic) and for the

mechanical workings of nature as a system (onto-logic). But what of the nineteenth century and beyond? What of 'secular' science after the 'death of God'? Clearly, it would be a mistake to suppose that contemporary science has freed itself from onto-theology merely because it purports a strictly materialist and experimental basis. Heidegger claims that:

The god-less thinking which must abandon the god of philosophy, god as *causa sui*, is thus perhaps closer to the divine God. Here this means only: god-less thinking is more open to Him than onto-theo-logic would like to admit (1969:72).

By abjuring the discourse of God as the causal ground of nature, modern science, somewhat paradoxically, reinvokes a more mysterious, unseen 'god' that withdraws as it gives the presence of things, and thus provides a concealed opening unto the absolutely other. The bracketing of metaphysical questions by the positivists of the nineteenth century covered over but did not resolve the question of God, or of his 'death'. Hence, at the limit of the technoscientific representation of life, we can perhaps uncover a dim awareness of another revelation of being that still bears the mark of the holy. At same time, however, modern technology enframes nature in such a way that potential openings to difference and complexity are continually threatened with closure. This mode of technovision is onto-theological insofar as it surreptitiously allows for the inhabiting of a subject position identified with a divine perspective – a position that generates a feeling of great power through the ability to seemingly know and control life itself. Today, onto-theology might be most easily understood in terms

of any representational system that, explicitly or implicitly, infers both the fundamental nature and ultimate source of beings on the basis of the visible realm of presence. According to Heidegger, such technological revealing denies the interplay between unconcealment and concealment in the 'fourfold' coming-to-presence of the world, and does not allow us to catch a glimpse of the freedom involved with the becoming of nature as event. It is in terms of this onto-theological gesture that we will continue to trace out the historical relations between sex, gender, and the ongoing 'death of God' through into contemporary genomics and biotechnology.

As we reach the end of chapter two, we have identified three interrelated discourses that will be key in the analysis of genetic technoscience to follow. First, we have traced the historical emergence of *(hetero)sexual difference* to the eighteenth century, and elucidated its connection with a divine concept of natural order, and with the 'death of God'. Secondly, the latter has now been reconceived in terms of *onto-theology* to reflect the fact that God has withdrawn from technoscientific knowledge. Finally, we have considered the emergence of photography as a model for scientific *technovision* in its response to the becoming-historical of nature, to the immersion of humanity within history and nature, and to the desire for the securing of a renewed temporal order. Nature is the central term in this confluence, overdetermined as it is by (hetero)sex, by onto-theology, and by technovision. The positioning of nature in biotech discourses, of its reproduction and repetition through time, will be of prime

interest to us in the remaining chapters, and it is in this direction that we now turn.

Notes

¹ See chapter one for further discussion of this point.

² Heidegger considered seventeenth-century physics to provide the basic ground of modern science. The question of to what extent contemporary science and, especially, biotechnology still rely upon this framework is one to which we shall return in the later chapters of this dissertation.

³ This is not to imply that time itself exists in opposition to technology. Rather, time is always already a technological relation to nature.

⁴ It is perhaps worth noting here that the Human Genome Project is conceptualized according to a very similar logic insofar as complex psychological and social attributes are reduced to physical markers.

⁵ In raising such questions, I am taking for granted the fact that the invention of photography was not merely a matter of the technical and chemical conditions of its emergence. For an extended elaboration of this argument see Batchen (1997).

⁶ This situation is somewhat complicated today with the advent of digital photography, especially when it comes to computer-generated images. I think, however, that Barthes basic point still holds at an experiential level. 'Photographic' effect persists because it expresses a certain relation to the world that is still an object of desire.

⁷ On time as *the* photographic *punctum* see Shawcross (1997), upon which my account here draws.

⁸ It is also interesting to note that Laqueur (2003:330) claims commercial pornography to have emerged just prior to the beginnings of moral panic over masturbation in the eighteenth century. His claim that these two phenomena are linked gives us another reason to look more closely at the relationship between pornography and the production of (hetero)sexuality.

Chapter 3 – A Short Genealogy of Biological Information

If one wanted to use the strictest definition of species, by which only those individuals that display identical traits under identical conditions belong to a species, then no two could be counted as one and the same species. ...In any event, the rank assigned to them in a classification system is completely immaterial to the experiments in question (Mendel, 1966:5).

Gregor Mendel's nineteenth-century experiments on the breeding of hybrid pea plants are generally acknowledged as marking the birth of genetic science. His results revealed the rules by which genetic recombination and transmission typically occur across generations. The extent to which Mendel can be seen as engaging in the study of heredity, however, is subject to much dispute. His work is most clearly situated within a tradition of plant hybridization experiments running back at least as far as Linnaeus in the eighteenth century. Yet, at the same time, Mendel breaks with the work of his predecessors in important ways. He is not primarily concerned with classifying individuals and species. Nor is plant sexuality on his mind. Instead, Mendel directs his attention to the subindividual level in an effort to uncover universal laws of nature and of life. The traits he finds there do not confer meaning upon organic bodies, but, rather, express natural energies unbound from the organization of the individual body. Mendel implicitly effects a move from the organic to the inorganic, from the molar to the molecular, and in so doing, I will suggest, he initiates a new understanding

of nature – a mode of revealing natural energies – whose force is not entirely felt until the second half of the twentieth century.

It is commonly held that molecular biology has been enamored with the discourse of ‘information’ from its earliest days in the 1950s. The notion that the stuff of life is information, especially as found in the form of DNA, is common biological parlance today. Equally common, in critical theory, is the belief that biological science has lost purchase on the corporeality of life as a result, and that this generates a disembodied and implicitly masculine conception of life that is most fully realized in contemporary genomics. In this chapter, however, I will argue even before information theory and cybernetics coalesced with molecular biology in the 1950s, Mendel’s work had already prefigured the existence of proto-genetic traits that are implicitly conceived in informatic terms as amenable to biotechnologies. Although Mendel has considerable interest in the stability of life forms, Mendelian factors, in and of themselves, do not *reproduce* a meaningful order of nature; rather, they *inform* the bodies in which they are present. Moreover, just as metaphoric relations with the new computing machines of the mid-twentieth century fostered the entry of an explicitly informational discourse into biology, Mendel’s methodological approach also draws upon a computational technology that casts biological information in digital terms. This move can perhaps be read as silently inaugurating a new stage in the process – ongoing since at least the seventeenth century – of translating life into machinic terms. Furthermore, I suggest that Mendel’s work allows us a sense of how the political implications of informatic discourses have always been

ambiguous within biological science, especially when it comes to issues of sex and gender. While Mendel's experiments may have been largely unappreciated in the nineteenth century, his work is untimely in the sense that it draws together both the prehistory and the future of biological science. Indeed, it may be that certain latent possibilities, which remain unthought in Mendel's own time, return to disrupt conventional understandings of contemporary genomics in ways that are not yet fully resolved.

In explicating these claims, this chapter will delve first into the context of Mendel's work, seeking to situate it in respect to the botanical tradition of investigations into plant sexuality and hybridization. Mendel's background in the physical sciences will also be of interest to us insofar as it opens up a path leading to questions concerning 'technology' and 'technovision' in his experiments. Taking an approach eschewed by almost all of Mendel's commentators, we will then draw his religious calling into the conversation about the beginnings of genetic science. I will suggest that the scientific purity of this 'origin' has been somewhat overstated, and that Mendel's work is marked by more than a hint of onto-theology. Our discussion will then turn to the key concepts of sex and species in nineteenth-century biological thought, and to the role that they play in defining the organic bodies of living organisms. Here, a comparison will be drawn between Mendel's work and that of Darwin that will allow us both to experience something of Mendel's divergence from the current of nineteenth-century biology, and to appreciate the ways in which his thought may be said to anticipate genomics and molecular biotechnologies.

Taking off from this point, the second half of this chapter will leap forward to the 1940s, when Edwin Schrödinger's essay 'What is Life' renewed the conversation between physics and biology and set the scene for information theory and cybernetics to enter into the fray. I argue that these new technological approaches to understanding life are not as gender-neutral as they may first appear, rather they contain divergent tendencies when it comes to either affirming or challenging the onto-theological centrality of (hetero)sexual difference in life. We will also consider the economic and political context of the post-war period, and the ways in which it shaped the emergence of molecular biology. In many ways the groundwork for the Human Genome Project was laid out at this time, and I will suggest that certain unresolved questions of sexual propriety inhabit not only Mendel's project, but are also to be found in contemporary genetics and biotechnology.

Plant Hybridization and the Question of Species

Mendel's standing as the founder of genetic science is regarded as self-evident by most commentators, and this is particularly the case in popular texts on the history of genomics. The story is usually told of a brilliant, unique scientist whose discovery of the laws of genetic inheritance in experiments with *Pisum* pea plants went unrecognized in his own time due to the ignorance of others, with his insight finally being appreciated at the dawn of the twentieth century when several researchers independently happened upon the same discovery only to then realize that they had been preceded by an obscure Austrian monk in

1865. No doubt this is an attractive tale. Yet, ever since the publication of Robert Olby's *Origins of Mendelism* (1985) in 1966, a number of historians and sociologists have sought to relocate Mendel and his work more firmly within the constellation of questions and concerns that informed mid-nineteenth-century biology. These scholars emphasize Mendel's positioning within the botanical tradition of plant hybridization that derives largely from Linnaeus' later work, which itself develops out of a growing uncertainty regarding the stability of plant species within the natural order. The key question in this context concerns whether or not new species can arise, either naturally or through human intervention – an issue that had taken on increasing importance in concert with the development of evolutionary ideas since the late eighteenth century.

From a hagiographic perspective, then, Mendel is supposed to be a scientific genius who saw clearer and further than those around him, and who answered questions that others were unable even to pose. From the point of view of social history, however, he is brought back down into the dim light of nineteenth-century botany, wherefrom he was unable to recognize the real significance of what he had discovered. Out of this debate over intentions and cognizance, we get two opposing pictures: Mendel as mere seeker of laws of hybridization vs. Mendel as pioneer of the science of heredity¹. It is not my goal, however, to try and determine the 'truth' of Mendel's work. Rather, I wish to take both sides of the debate seriously, and to consider what they may offer to an approach that seeks to critically examine both the 'origin' and the future of genetic science.

As a starting point, let us take Georges Canguilhem's claim that Mendel's work marks the emergence of a new scientific object:

The facts that Mendel studies are not those gleaned by a casual observer; they are obtained through systematic research – research dictated by the nature of Mendel's problem, for which there is no precedent in the pre-Mendelian literature. Mendel invented the idea of a *character*, by which he meant not the elementary agent of hereditary transmission but the element of heredity itself. ...He was not interested in sexuality or in the controversy over innate versus acquired traits or over preformation versus epigenesis. He was interested only in verifying *his* hypothesis via the calculation of combinations. Mendel neglected everything that interested those who in reality were not his predecessors at all (1994:37).

This is a strong claim for the unprecedented nature of Mendel's work. Yet, before we go on to consider the innovation of his approach, we may find it worthwhile to dwell a little longer with the past that appears to fade rapidly before our eyes. For even in this century of evolution and progress, history and tradition may not be thrown off with ease. While the originality of Mendel's work is not in question here – indeed, it is an important part of my argument that Mendel's decomposition of the individual organism in favor of its constituent characters or traits clears a path towards the future of biological thought – there are certain historical discourses (of (hetero)sexual difference and of onto-theology, for example) informing the circumstances in which Mendel is able to pose his problem. The eighteenth century is not so far in the past.

We may note that, right from the start, Mendel explicitly positions his own work within a line of plant hybridization experiments that runs back to the time of Linnaeus. That is to say, he positions his enquiry in relation to a period in which (as we saw in chapter one) the topic of plant sexuality was foremost in the minds of natural historians. Linnaeus' sexual system of classification had sought to lay out the eternal order of nature. The sex of a plant testified to its place within a greater whole animated by divine purpose. Delimiting the whole proved to be too greater task, however, and when faced with increasing evidence that forms of animal and plant life had changed over time, Linnaeus was forced to propose a mechanism to account for this phenomenon. His solution was to argue that new species could arise from hybrid crosses, although he refused to allow that this challenged the God-given eternal order established at the higher level of genus. Hybridization was a matter of sexual propriety, of couplings legitimate and illegitimate, and of an order to be discerned with the correct depth of vision. Interest in plant hybridization feeds off and into concerns about the stability of the natural order, the threat of monstrosity, and the deleterious effects of abnormal sexual relations on the social body in the latter part of the eighteenth century.

The first scientific study of plant hybridization is generally attributed to the German botanist Joseph Kölreuter, who undertook such experiments in the early 1760s. Kölreuter, a contemporary of Linnaeus, was deeply troubled by the suggestion that human action was able to intervene and change the course of nature, thereby disturbing its divine and harmonious order. As Olby notes, 'Such a state of affairs was unthinkable to the pious naturalists of the eighteenth

century, and Koelreuter, who did not doubt that plant hybrids can be produced, was sure that nature has her own ways of preventing them from producing fresh species. The chief aim of his work was to find out these hidden measures' (1985:10). Kölreuter's experimental results purported to establish that hybrid plants do not breed true, and hence cannot be regarded as generating new species. The offspring of hybrids were said to manifest disorder and, if not immediate sterility, a process of sexual degeneration towards inevitable extinction in the near future.

Kölreuter's work was not to be the last word on plant hybridization and the species question however. Notably, the practical application of hybridization technology continued apace with the steady development of agricultural science in the early nineteenth century². Academic research lagged behind, however, and in 1830 the Dutch Academy of Sciences hoped to draw together such knowledge as currently existed by offering a prize for the best essay on the topic of the production of new species via hybridization. It received no entry until 1837, when Carl von Gärtner submitted a lengthy encyclopedic essay that was subsequently published and went on to become the preeminent text on the subject in its time. His work was expanded and translated into German in 1849, some seven years before Mendel is said to have begun his experiments with pea plants, and was evidently a source of inspiration for these experiments. Like Kölreuter, Gärtner argued for the fixity of species, basing his claims upon an 'inner nature' that is attributed to each species in terms of its sexual essence:

The essentiality of the species, therefore, consists in the definite relationship of its sexual powers to other species, which [*sic*] relationship, together with specific form in each species, is a peculiar, special and constant one. Form and essence are in this connection one (Cited in Roberts, 1965:178).

Hybrids can be formed, according to Gärtner, only when there is a harmony of inner and outer natures. Thus, if sexual reproduction is a success, the 'hybrid' offspring are regarded as varieties of the same species, whereas, if hybridization fails to generate viable plants, then this is taken to be evidence that we are dealing with two species. The sanctity of species is ensured either way through a tautological process of identification that equates the inner essence of any particular plant with a quasi-teleological project of (hetero)sexual reproduction. This sexual essence is of the plant as a whole, and represents the organizing force that sustains its organic nature.

Despite the influence of Gärtner's work, other voices were also insistently putting their views forward. Most notably, there was Franz Unger, a Professor of Plant Physiology at the University of Vienna during the time Mendel spent studying there (1851-3). Unger was known for his advocacy of evolutionary thinking and rejected the idea of fixed species. According to Olby, 'This view was at variance with the opinion of Kölreuter and Gärtner and it would appear that Mendel carried out his experiments in order to decide the issue' (1985:97). Orel (1996:69-73) also notes the influence of Unger on the formation and direction of Mendel's experiments, while Mendel himself explicitly positions the concluding remarks of his paper in relation to those of Kölreuter and Gärtner as 'the two

authorities in this field' (1966:39). Clearly, Mendel's 'Experiments on Plant Hybrids' is informed by contemporary disputes over botanic sexual relations and the implications of hybrid bodies for the ontology of species. What is perhaps most remarkable in this respect, however, is the extent to which Mendel fails to resolve the issue. Although he attempts to address it in the final pages of his paper, his whole approach has effectively displaced the question. Hence, we find Mendel left struggling to reconcile his work with that of his predecessors, and instead presenting a confusing conflation of 'species' and 'varieties', wherein the essential identity of the former appears to dissipate when viewed from the perspective of the *Pisum* experiments.

In order to understand how Mendel was led to such a position, we may consider some of the distinctive aspects of his endeavor. From one perspective, Mendel signifies something of a return to eighteenth-century thought. His is a mechanistic view of nature that harks back to the time before biology constituted itself around a new dynamic object known as 'life'. If biology had established itself as a fledgling disciplinary field in the early part of the nineteenth century via the rejection of the Newtonian worldview, and through the embrace of a quasi-romantic belief in distinct qualities inherent to the living organism, Mendel's approach represents a recolonization of biological phenomena by physical science (as recently renewed by the positivist project). This move is reflected in his claim, stated at the outset of his paper, that his work participates in a tradition which seeks a 'generally applicable law of the formation and development of

hybrids' (1966:2), even though it is not clear that this is what previous investigators had in fact sought.

It is notable, as Corcos and Monaghan have calculated, that approximately 70% of the courses Mendel enrolled in at the University of Vienna were in the areas of physics, mathematics, and chemistry. He also studied paleontology, zoology, botany, and the physiology of plants, but after graduating and securing a position in his hometown at the Brünn Modern School, Mendel reportedly considered himself to be primarily a teacher of experimental physics (1993:23-4). We can recognize this orientation at work in the way that he approaches nature. Mendel's experiments are based in a quantitative, statistical methodology that is derived from the physical sciences. His inclination is always to reduce the complex forms of living beings to more basic units of matter and energy. As Canguilhem points out:

Mendel was not interested in structure, fertilization or development. For him, hybridization was not a way of establishing the constancy or inconstancy of a global type; it was a way of decomposing a type, an instrument of analysis, a tool for separating characters that made it necessary to work with large samples (1994:37).

Mendel bypasses the sexual organization of the individual organism — identified by biology as the site of 'life' — and, instead, takes a step towards the molecular, nonorganic level. At the same time, he necessarily dissipates the authority of (hetero)sexual difference as the representative of natural order and purpose at the core of the organism. We might say that what is 'thought' in his paper is the application of Newtonian physics to biological life, but what is latent and

`unthought' within his text belongs to the sexual history of botany. In some respects, his paper is more notable for what it does not say than for its explicit statements. Mendel speaks not of male and female plants or parts, but merely of germinal and pollen cells. There is still an essential opposition at work, but life is effectively reduced to the appearance or nonappearance of particular discrete traits according to a numerical value. Life, we might say, is thereby opened up to modern technology.

Mendel's Technovision

Mendel lived in a time of significant technological developments. Perhaps most notably, as we saw in chapter two, photography had recently emerged into public consciousness, and was the subject of much interest as Mendel was formulating and carrying out his experiments in the 1850s and 1860s. With this in mind, it may again be of interest to take note of what is not present in Mendel's paper. For, at a time when many were eagerly exploring the potential of photography, especially in regard to botany, Mendel's evident disinterest in following such a technological path apparently situates his work in a different space and time. The seemingly nontechnological character of Mendel's experiments allows for the construction of a mythical pure origin for genetic science, as though there was, in the beginning, unmediated access to nature. As we also saw in chapter two, however, this idealized relation to nature is also characteristic of the desire to photograph insofar as it promises to be a

technology that will allow nature to represent itself. In this light, Mendel's relation to modern technology may be more complex than it first appears.

If, following Heidegger, we define the technological character of modern science in terms of its calculative projection onto, and challenging forth of nature, then Mendel may be said to participate in this mode of revealing. Natural energies are admitted into his experiments only on the basis of pre-established, standardized categories. He states:

The experimental plants must necessarily

1. Possess constant differing traits
2. Their hybrids must be protected from the influence of all foreign pollen during the flowering period or easily lend themselves to such protection.
3. There should be no marked disturbances in the fertility of hybrids and their offspring in successive generations (1966:3).

Hence, only traits that can be unambiguously classified in terms of presence or absence ('on' or 'off' in the language of later computer science) will be admitted into the experimental setting. Moreover, the environment of the experimental plants must be strictly delimited and secured, and sexual energy must be channeled solely into reproductive activity. None of this represents 'bad' science, but neither is it 'pure' scientific enquiry that stands apart from social forces and technological factors. Mendel brings the mathematical technology of the physical sciences to bear upon the natural energies of life as they take form within plant matter. This technology is a mode of revealing that understands nature to behave

in a strictly lawful and quasi-teleological manner. It posits an order that continually and invariably reproduces itself within a closed system.

In this regard, my claim is that Mendel's science involves a form of modern technovision — a type of seeing that perhaps may be characterized as 'photographic'. To recall, we said in chapter two that modern technovision was a mode of visual representation that expresses a desire to withdraw from temporality, and from exposure to the finitude, difference, and the complexity of existence, by establishing an objective and stable natural order. Its aim was said to be that of securing, regulating, and controlling the time and space of its objects. In particular, and in keeping with the heightened historical consciousness found in the nineteenth century, I think it is the temporal dimension that is most important here. Let us quote Mendel from the final paragraph of his discussion of the *Pisum* experiments:

The law of combination of differing traits according to which hybrid development proceeds thus finds its basis and explanation in the proven statement that hybrids produce germinal and pollen cells that correspond in equal numbers to all the constant forms resulting from the combination of traits united through fertilization (1966:32).

This statement, repeated a number of times in the second half of Mendel's paper, represents the key finding of his experiments. Here, he implies that the sexual cells of a plant already contain all possible combinations of traits that may appear through hybridization. In the midst of much social change, and of questions

concerning the possibility of evolution in nature, his experiments are designed to explain away the apparent disorder evidenced by the profusion of hybrid forms through recourse to an underlying order that can be expressed in a definite number of combinations. In the context of emerging debates over evolutionism, this amounts to saying that the new is not really new, but rather, merely an expression of that which was originally present although held in reserve:

The distinguishing traits of two plants can, after all, be caused only by differences in the composition and grouping of the elements existing in dynamic interaction in their primordial cells (Mendel, 1966:43).

As was the case with eighteenth-century botanical thought, the event of coming-to-presence is called back to an atemporal order and unity preserved within the sexual nature of all living beings. Mendel's technovision is not attuned to a time that would be proper to life itself as a dynamic or emergent object. Instead, at the origin of genetic science, we find the desire to restore stability to the natural order.

Again, it might be suggested that what Mendel is seeking here is something like a *photograph* of natural order itself, extracted from the time of life. The desire to photograph, which was felt so strongly by so many in the first half of the nineteenth century in Europe, involved an attempt to establish a new relation between technology, nature, and time. Photography was a technology that supplemented the human eye by slowing things down. It seemed to allow natural events to be mechanically captured and ordered even while photographers

simultaneously insisted that nature was presenting itself³. The photographic ideal was a way of seeing untainted by the stain of subjectivity, and this is precisely the model of technovision that we find embedded in Mendel's work. He, too, employs a technology that aims to eliminate time while preserving the appearance of natural traits being freely given by nature itself.

This approach put Mendel's work at odds with the primary current of biological thought in his day. 'Life', as the investigative object of biology, was understood in terms of an organic body that struggled to maintain its organization through time against the forces of death. Yet, the integrity of this bodily dynamic finds no place in Mendel's thinking, which is focused on subindividual factors, an underlying and unchanging natural order, and mechanistic physical laws. At the same time, however, photography in the nineteenth century bore a close affinity with death. Its evocation of one who was absent — no longer present except via the photographic trace — was often experienced as an uncanny harbinger of death. Thus, if Mendel's technovision is somehow 'photographic', we might wonder whether his experiments do not also subtly evoke a realm beyond the living. Indeed, it may be that Mendel's text approaches the metaphysical at precisely the same point at which the scientific ambitions of nineteenth-century photography went astray. In both cases, it is in the translation between the particular and the general that modern technovision loses its focus. Photography's claim to be an inherently scientific mode of vision was based in its unrivalled objectivity. Yet, it was the unique claim of the concrete object itself that drew photography towards the elusive detail and away from the standardized

representations required by modern science. Photography may be said to call forth both excess and absence, thus undoing the secure framing of the image.

In a similar fashion, Mendel appears aware of the limits of his technovision – aware that the ‘photographs’ he has taken of these particular *Pisum* plants may not translate beyond his experimental garden. He comments that, ‘Whether variable hybrids of other plant species show complete agreement in behavior also remains to be decided experimentally’ (1966:43). Nevertheless, he is quick to dismiss this concern, and, as we shall see, the reason he gives will open up the closed system in which he has until now worked. By restricting himself to the visual presentation of his objects Mendel evidently hoped to secure his science from metaphysical speculation. I suggest, however, that this attempt to shore up the scientific ground upon which he stands has the effect of actually drawing his science much closer to his religion than conventional histories have allowed.

The Divinity of Peas

Corcos and Monaghan comment that, ‘Though Mendel was a priest, his scientific papers were free of any religious content’ (1993:34). Indeed, this is the accepted line on Mendel. Typically, historians of genetics make mention of Mendel’s status as a monk only in order to confer an amateurish quality to his scientific ambitions which, in turn, serves to implicitly legitimate the tag of ‘genius’ and, by association, to establish a pure origin for genetic science – as though his naivety allowed him to see clearly into the essence of things, unobscured by the flawed assumptions of those ‘professional’ scientists around

him. Not only does this position understate the extent of Mendel's scientific training⁴, it also ignores the long history of common endeavor between Christianity and science, and the extent to which nature was still conceived in terms of natural theology during the nineteenth century. While scientists exhibited significant resistance to the Church as an institution, and to rigid theologies, the popular belief that there was generalized conflict between science and religion drew little support from the reality of the ongoing accommodation between these two differing perspectives on the true order of the world (Welch, 1996). We can perhaps catch a glimpse of the common ground between scientific practice and religious belief if we return to the problem of the generalizability of Mendel's experimental results and complete the quote given in part above:

Whether variable hybrids of other plant series show complete agreement in behavior also remains to be decided experimentally; one might assume, however, that no basic difference could exist in important matters since *unity* in the plan of development of organic life is beyond doubt (1966:43)

One might read this assertion of the unity and organic quality of life as an expression of Mendel's discomfort with the implications of his implicit undermining of the organism as the fundamental unit of life. From another perspective, it might be seen as a reflection of the need for the imperialistic ambitions of science in relation to nature to be, somewhat paradoxically, grounded in the very same object it seeks to dominate. Yet, the question remains: why is unity beyond doubt? The 'unity' to which Mendel refers may

almost certainly be attributed to his conception of God, who sets in motion the 'plan of development' that guarantees the reproduction of a stable order of life. The way in which Mendel explicitly opposes 'difference' to 'unity' reflects a desire to affirm an unchanging order, even though his proto-informatic approach to nature gestures towards the existence of a more promiscuous and creative potential within the 'unity' of life. As it stands, however, we are again returned to a formulation characteristic of eighteenth-century thought. Mendel's God acts as efficient cause in relation to the world, as the first term which stands outside of a closed system with the sole purpose of setting it in motion. Nature is his divine work, but an interventionist God has no place within a scientific paper; on the contrary, his only function is to serve as guarantor for the laws of nature, for the legibility of the order that may be discerned there, and hence for the universal applicability of experimental findings. At the same time, Mendel's lack of explicit reference to his God has the effect of strengthening the belief that the ways of science are in conflict with those of religion. By abjuring all explicit discussion of the deity, his place only becomes more mysterious, absent yet not entirely dead.

In the previous chapter we discussed Heidegger's notion of onto-theology as a way of conceiving the continued presence of an absent God in an age dominated by modern technology. Onto-theology, we said, may be understood as a representational practice that infers both the fundamental nature and the ultimate source of beings on the basis of that which is present to the observer. The onto-theological gesture is a means of claiming for oneself a privileged vision – a God's-eye view – of reality and truth. God both as *causa sui* and *causa*

prima is implicitly invoked to provide the underlying metaphysical ground or reason upon which scientific knowledge can be secured. Our question here is this: Is Mendel's invocation of a '*unity* in the plan of development of organic life', as that which is 'beyond doubt', an onto-theological move?

My claim is not only that Mendel makes such a move, but also that his onto-theology implicitly depends upon the (hetero)sexualized tradition of natural history. It is perhaps useful to recall that Mendel is working on a specific problem – that of trying to ascertain the laws of plant hybridization in the context of a dispute over the stability and provenance of species – which derives from Linnaeus' work in the mid-eighteenth century. For the latter, evidence for the divinity of nature could be found in the heterosexual relations that he found all around him in the natural world. Linnaeus sought to classify all living beings according to this sexual criterion in an onto-theological gesture that was plain for all to see. Mendel, on the other hand, is more discreet. Infused by the scientific spirit of positivism, his discourse strives to avoid anthropomorphizing the pea plants under his gaze by attributing human genders and sexual relations to them. As a scientist, he seeks to confine this discussion to the empirical facts that he finds before him. Nevertheless, the weight of tradition is not easily thrown off, and in seeking to propel his experimental results into the broader ongoing conversation, Mendel is forced to implicitly fall back upon a (hetero)sexual onto-theology. For on what basis does he presume that a '*unity* in the plan of development of organic life is beyond doubt'? If we recall that Mendel's work is situated within the natural history tradition, which views (hetero)sexual difference

as evidence of divine presence in the world, then the answer is apparent: unity is given through the dual (hetero)sexual forces and relations that come together to drive the reproductive activity of plants and other living beings. Although unspoken in Mendel's paper, modern gender categories and normative sexual relations provide the framework within which he may attribute a unified plan and purpose to the manifestation of life in its different forms. They constitute the unthought basis upon which a stable natural order is asserted and other potential forms of natural expression are foreclosed. This latent ground remains unthought because, for Mendel, the unified organization of life is 'beyond doubt'. Or, better put, faith (in an unchanging unity) is that which underlies all possibility of doubt. Read this way, Mendel's comment opens up the closed system that had, up until this point, constituted the unitary logic of his botanic economy. His technovision, pushed to its limits, reveals an opening onto the 'outside' of the system, which his scientific discourse had strived to conceal. A trace of the absent God enters the picture. Or, more precisely, it is found to be already within, hiding in the quasi-teleological (hetero)sexual energies that are charged with ensuring that a particular natural order is reproduced. This appearance of the divine is perhaps somewhat of an embarrassment for genetic science to discover at its 'origin', given that the purity of its endeavor has been, and continues to be, established through an almost obsessive denunciation of the mysterious God-like forces of 'vitalism'. Moreover, our image of Mendel as the source of a strictly positivistic foundation for genetic science is thereby complicated somewhat.

Mendel, Darwinism, and the Sex of Species

Despite the tremendous insight contained in Mendel's paper, the fact remains – and has been the subject of much speculation – that it was all but ignored in his own time. Canguilhem suggests that, even if it had been widely known, 'given the nineteenth century's passionate interest in Darwinism, which is to say, in the theory of evolution, Mendel's theory of heredity would probably have been dismissed as a peculiar and backward form of fixism' (1988:116). The point here is that biology developed side by side with evolutionary theory, and the problems that preoccupied its early practitioners were mainly those to do with change, development, and the uniqueness of the individual organism in relation to its species. Darwin's theories were in keeping with the predominant tendency of the nineteenth century towards a greater awareness of the historicity of things, an attitude that saw change everywhere, and which keenly felt the loss of the past. Mendel, by contrast, was in the business of explaining change away – or, at least, of accounting for its presence by linking it to the re-emergence of traits long preserved in the primordial time of the sexual cells. In this sense, we might say that genetic science is born of an attempt to stand outside of a linear concept of time. Its concern is with subindividual elements that return and pass through different organisms.

Published just three years after Mendel's paper in 1868, Darwin's *The Variation of Animals and Plants under Domestication* addresses itself to many of the same topics concerning change and stability in the reproduction of nature. His starting point, however, is quite different:

The differences between natural varieties are slight; whereas the differences are considerable between the species of the same genus, and great between the species of distinct genera. How do these lesser differences become augmented into the greater difference? How do varieties, or as I have called them incipient species, become converted into true and well-defined species? (1993:264)

From the outset, Darwin assumes that nature generates new species over time. His basic unit of analysis is the individual organism as it changes throughout the generations according to the dictates of chance and environment. Operating under the law of natural selection, the vicissitudes befalling the organism aggregate to produce change at the species level. Subscribing to the then-popular theory of 'blending' inheritance (already rejected by Mendel⁵), which held that offspring were endowed with characteristics that were intermediate between those of its parents through the mixing of their bodily material, Darwin argued that variability was mainly caused by external environmental changes in the conditions of life: 'Variations in the organization will in some cases be aided by habit, or by the use and disuse of parts, and they will be governed by the direct action of the surrounding physical conditions and by correlation of growth' (1993:266). Here, the individual organism, as shaped by the forces of its environment, bears the fate of the species through the specifics of its organization. Darwin's work aims to sort out varieties from species, to map the transitions from one to the other, and thereby to justify the introduction of new classifications for organic life. For Mendel, however, things look quite different.

Although his research is framed by the species question, Mendel effectively dissipates the issue by shifting the unit of analysis to the subindividual level. He is concerned with relations between independent sets of dualistic traits, rather than the integrity of the individual organism:

Therefore there can be no doubt that for all traits included in the experiment this statement is valid: *The progeny of hybrids in which several essentially different traits are united represent the terms of a combination series in which the series for each pair of differing traits are combined.* This also shows at the same time that *the behavior of each pair of differing traits in a hybrid association is independent of all other differences in the two parental plants* (1966:22)

It is the independent action of subindividual traits, rather than any questions posed at the level of individual organism or species that is at stake here. The debate over to what extent Mendel was studying the mechanisms of 'heredity' has not been sufficiently attentive to the fact that the terms in which this topic was discussed in the nineteenth century are implicitly undermined in his work.

This is what explains the difficulty that Mendel has in the 'Concluding Remarks' section of his paper, where he attempts to situate his results in relation to the earlier work of Kölreuter and Gärtner. It is as though Mendel is trying to speak two languages at once, as he consistently appears to confuse the notions of 'species' and 'varieties'. This leads Corcos and Monaghan to comment, 'Hence, what Mendel was discussing as the transformation of one species into another was really the transformation of one variety into another' (1993:169).

This distinction between species and varieties – which turns upon a question of sexual propriety, of who may couple with whom, and of what the result may hold for the natural order – was of significance for nineteenth-century evolutionary debates, and is today central to disputes over the legitimacy of genetic engineering and the integrity of individual bodies and organic life. It is not clear, however, that Mendel's confusion is merely due to a lack of terminological rigor. As already noted, right from the start of his paper, he displayed a lack of interest in defining the concept of 'species'. This concept was irrelevant for Mendel, I suggest, because of its location at the molar level, and due to its reliance on (hetero)sexuality as the organizing force of the organism. In contrast, Mendel's work implicitly opens up the possibility of a molecular sexuality. In previous chapters we have traced out a movement whereby the visible organization of the living organism comes to bear the weight of a normative, quasi-teleological (hetero)sexual order of nature. The notion of a biological 'species' – derived from the Latin *specere* ('to look') – is a part of this same movement. It draws together the prominence of the visual with a classificatory scheme premised upon reproductive sexual relations. Yet, if a lawful order to nature may be said to exist, Mendel does not find it in the visible appearance of the individual organism. Rather, Mendel's technovision bypasses organic sexuality due to its restricted focus on independent traits extracted from the plant body's overall organization. In this way, he implicitly undermines the natural order of things, even as he attempts to shore it up through his halting discussion on the fixity of species. Although he wishes to reassure his readers of the lawfulness of natural

couplings, Mendel employs the term 'species' in such a way that it is effectively dissolved into the micro-relations of independent traits.

We can observe this tension at work throughout Mendel's 'Concluding Remarks'. There, he attempts to reconcile Gärtner's evidence for 'hybrids that remain constant in their progeny and propagate like pure strains', with the fact that he has found no evidence to support this claim in his own research. Drawn to speculate beyond his findings, Mendel invents the idea of a 'mediating cell' that '...becomes the basis of the hybrid organism whose development must necessarily proceed in accord with a law different from that for each of the two parental types' (1966:41-2). It is significant that Mendel speaks here – when he is compelled to move beyond his own data – of the organism as a whole rather than of its elements. It may also be relevant to note that it is at the end of this discussion that we find Mendel's onto-theological invocation of the absent God. His deference to a '*unity* in the plan of development of organic life' is not surprising; for, if our earlier thesis that (hetero)sex comes to take the place of God after his 'death' holds, then it would follow that a threat to the priority of the living organism (as representative of the (hetero)sexual order of nature) might produce a reactive move back towards the Christian God as guarantor of meaning and stability.

Mendel's accommodation to Gärtner's account does not hold for long however. Indeed, he immediately raises the issue again by restating it in terms of the '*transformation of one species into another by artificial fertilization*'. It is not clear that this situation differs in any significant way from the previous

experiments under discussion, yet it allows Mendel the opportunity to explain away Gärtner's results by reducing them to the level of his analysis:

If one may assume that the development of forms proceeded in these experiments in a manner similar to that in *Pisum*, then the entire process of transformation would have a rather simple explanation. The hybrid produces as many kinds of germinal cells as there are constant combinations made possible by the traits associated within the hybrid, and one of these is always just like the fertilizing pollen cells. Thus there is the possibility that in such experiments a constant form identical to the pollen parent will result from the second fertilization (1966:44-5).

In this way, the species question is reduced to differing combinations of a preexisting order immanent in the sexual cells. The development of hybrids can thereby be explained mathematically. 'Mediating cells' have no place in this picture, and the 'new species' thereby produced seem to lose their sense of reality.

At the same time, however, Mendel is keen to affirm, with Gärtner, the stability of the natural order against the claims of evolutionists. At the very end of his paper, he generates a rather curious restatement of the latter's position, to which he gives his assent: 'In the complete transformation of one species into another [Gärtner] finds unequivocal proof that a species has fixed limits beyond which it cannot change' (1966:47). That Mendel feels the need to affirm such an evidently confused and contradictory statement reflects the uncertain status of the concept 'species' in his own discussion. We might say that Mendel is

beginning to test the limits of (hetero)sex as the secret essence of both the individual organism and the species concept. Thus, he equivocates between species – defined in terms of (hetero)sexual relations – and (hetero)sex cells in trying to locate a guarantor for natural order. Ultimately, on his account, sex cells implicitly take the place of species, as it is they that produce the ordered, lawful development of traits through the transmission of biological information. Yet, the information transmitted is no longer necessarily beholden to a natural order of organic bodies; rather, it opens up natural bodies to biotechnology. Mendel's technovision sees through the organism to locate a bioinformatic body that anticipates contemporary genomics in both its conservative and radical potentials. Hence, at the 'origins' of genetic science, we find a desire to maintain the stable, lawful reproduction of nature through the agency of (hetero)sex, and yet, already, Mendel has sown the seeds of dissolution. The confusion evident in his concluding remarks manifests the struggle that is taking place within his text between these two tendencies. While order is affirmed on the one hand, the forces of disorder are surreptitiously set free on the other.

Thus, I suggest that Mendel's difficulty in reconciling his proto-informatic approach to organic bodies with the (hetero)sexualized traditions he inherited from both eighteenth-century natural history and nineteenth-century biology sets in motion a contradiction that has silently informed biological thought throughout the twentieth century, and which has become more acute with the rise of genomics in recent years. While scientific endeavors such as the Human Genome Project reinvigorate Mendel's vision of a stable natural order underlying

the complexity of life, the emergence of biotechnologies associated with information theory and contemporary genomics (such as cloning) increasingly generate 'unnatural' sexual connections that threaten to set natural energies free, and to constitute bodies and forms of life that have no precedent in biological history. While this latter move at first appears to be far from Mendel's concerns, the reading of his work advanced here suggests that informatic concepts are not simply external impositions that have been imported into biological science in recent years. On the contrary, genetic science has always been in some sense informatic.

It follows that the political implications of the bioinformatic body may be more ambiguous than are often realized. We are offered us a different perspective on the question of whether the utilization of informatic discourses in biological thought necessarily produces an inherently masculine or disembodied concept of life. If the gender politics surrounding biological science have always been to some degree dependent upon the (hetero)sexual differences of organic bodies, then the generative qualities of the bioinformatic body would seem to offer a ground for thinking in terms that disrupt this reproductive economy, and for challenging the association of informatics with a disembodied masculinism. The tensions apparent within his work suggest the presence of unresolved questions concerning both the nature of 'sex', and its centrality to the organic body, within biological thought.

This reading of Mendel also implies a new perspective on the untimeliness of his work. Historians of genetics have emphasized the futurity of Mendel's

approach in the *Pisum* experiments, arguing that those around him missed the brilliance of his insight, and that it was to take 35 years or more before biologists were to catch up. Rather than dismiss this position, as many do who seek to discover in Mendel a man of his times, I want to radicalize it – to view Mendel as a man of many times. I argue that Mendel's work expresses the natural history of the eighteenth century, as invigorated by the 'photographic' technology of the early nineteenth century, and which reaches forward towards the genomics of the late twentieth century and beyond. His experiments with pea plants bring together a Newtonian vision of nature, as filtered through the (hetero)sexualized lens of the Linnaean tradition, and a natural ontology that anticipates the biotechnologies of molecular biology. As such, Mendel's enquiry is more than a beginning long since surpassed. Possibilities opened up, yet unthought in his work, return to unsettle the foundations of contemporary genomics, and perhaps to reopen the issue of sexual politics in the age of biotechnology.

In what follows, we will trace this Mendelian tension between, on the one hand, the meaningful order of life, and on the other, the disruptive force of biological information, through the work of several authors influential in the discursive constitution of molecular biology. We begin with the intervention of another physicist into the biological realm.

Molecular Biology and Thermodynamics

The story of how Mendel's work was rediscovered and incorporated into studies of inheritance in the early twentieth century is well known. This event was

to inaugurate a period of research activity generally known as 'classical genetics', and which extends up to the time when Watson and Crick's model of the structure of DNA is unveiled in 1953. Working with a chromosomal theory of inheritance, classical geneticists focused on the study of mutations in their attempts to uncover the nature of genetic material. They sought to follow the path that Mendel had embarked upon – a path which led towards the subindividual, molecular level – but their efforts were frustrated by the limits of their resolving power. As Ernst Mayr has written in reference to the period of classical genetics, 'The period from 1930s to 1950s saw intense activity among the students of the gene, but it was also a period of considerable frustration. ...Not being able to see genes directly, one could learn about them only by inference' (1982:801). Although they struggled mightily, classical geneticists were unable to claim Mendel's incipient technovision as their own. Individual chromosomes appeared unwilling to divulge the genetic secrets they held within, and resisted all attempts at decomposition by the scientific gaze. The sought-after revelation was only to be achieved through the intervention of ideas from the physical and chemical sciences in combination with certain technical and rhetorical innovations.

In the same year that solid evidence was first produced identifying DNA as genetic material, another physicist was to make a decisive entry into the biological field. Erwin Schrödinger's *What is Life? The Physical Aspect of the Living Cell* (1967) (first published in 1944) has long been acknowledged as exerting a formative influence over the constitution and shape of early molecular biology. Following the invention of the electron microscope in 1940, which

allowed scientists to discern cell structure and contents at much higher levels of resolution, the time was ripe for the emergence of molecular biology. In this context, Schrödinger's role was twofold. His book served to draw many physicists and chemists into the biological conversation, and it also provided them with a metaphorical vocabulary and way of thinking about 'life' that was to shape biological discourse at the molecular level.

Like Mendel, Schrödinger brought a physicist's concern for the lawful mechanics of matter to the study of biological phenomena. Unlike Mendel's Newtonian physics, however, the explicit impetus for Schrödinger's intervention lay in questions posed by the science of thermodynamics in relation to quantum theory. The stability and reproduction of organic life appeared to throw down a challenge to the second law of thermodynamics – which outlined the existence of a universal cosmic tendency towards dissipation, disorder, and eventually entropic heat-death – and as such, biological life seemed to elude the reach of the physicist's explanatory powers. Since the mid-nineteenth century, when Mendel was tending to his pea plants in seclusion, up until Schrödinger's reflections on the question of life in the mid-twentieth century, biological science had sustained its independence through resisting the claims of thermodynamics. Mendel and Schrödinger, however, can both be seen as engaged in projects that challenge the boundaries which had been drawn between biology and physics. Insofar as Mendel's concern is with establishing the viability of a lawful natural order that underlies the apparent chaos of life, it presages Schrödinger's notion of a 'code-script' that controls and directs the stable growth and reproduction of a

living organism. Each, in his own way, seeks to give an account of the physics of 'life itself'. Genetic science, from this perspective, is driven towards molecular biology by continually testing its limits against the claims of mechanical physics and thermodynamics.

Like Mendel's proto-informatic science, thermodynamics is a product of the nineteenth century. Its two basic laws state, first, that there is no loss of energy when heat is converted into mechanical power; and, second, that within a closed system energy will progressively become dissipated and unavailable for work until a situation of equilibrium is reached, at which point life cannot exist. In a sense, thermodynamics challenges the centrality of the reproductive imperative in nature by suggesting that the *telos* of life is ultimately death. This tension between the dissipating force of thermodynamic physical law on one side, and the organizing power of organic life on the other, inhabits the natural sciences from the time of Mendel through to the moment of Schrödinger's challenge to the uneasy confidence of a mechanistic biological epistemology that had pushed aside, but not entirely dispelled, the specter of vitalism. As Evelyn Fox Keller writes of the relationship between thermodynamics and biology:

The genesis of the second law was, of course, in the practical problem of increasing the efficiency of steam engines, but just because its thrust was to negate the possibility of perfectly efficient transformation of heat into motive power (in other words, without dissipation of energy), from the very start the question of how a living organism manages such effective conversion of the sun's heat into its own animate power lay close at hand (1995:48).

In *What is Life*, Schrödinger draws upon twentieth-century quantum theory in an effort to explain how the reproductive order of life – as represented by the living organism – defies the second law, and therefore requires the formulation of a new physics. Gesturing towards what would later become the predominant understanding of DNA, Schrödinger argued that the chromosomes within a fertilized egg must ‘...contain in some kind of code-script the entire pattern of the individual’s future development and of its functioning in the mature state’ (1967:22). Governed by this ‘code-script’, the living organism maintains itself ‘by continually drawing from its environment negative entropy’ (1967:76). Organic life, for Schrödinger, is characterized by its ability to continuously renew its own organized nature by feeding off the natural order around it. Thus, he claims that ‘...it needs no poetical imagination but only clear and sober scientific reflection to recognize that we are here obviously faced with events whose regular and lawful unfolding is guided by a “mechanism” entirely different from the “probability mechanism” of physics’ (1967:84-5). Rather than manifesting unpredictability at the micro level, while submitting to the slow decline towards eventual heat-death at the macro level, the organism seemingly resembles the stable, orderly functioning of a pure ‘clockwork’. According to Schrödinger’s quantum mechanics, the ‘dynamical’ functioning of clockworks is due to the fact that they ‘...are built of solids... strong enough to elude the disorderly tendency of heat motion at ordinary temperature’. This provides a model for the ‘new physics’ of life. For Schrödinger, ‘...the point of resemblance between a clockwork and an organism... is simply and solely that the latter also hinges upon a solid – the

aperiodic crystal forming the hereditary substance, largely withdrawn from the disorder of heat motion' (1967:91). He speculates that it is this molecular quantum state that allows the organism to defeat thermodynamic decay. In other words, the time of the organism is its own. The aperiodicity of what will later be called the 'genome' allows nature to reproduce itself in a process that Schrödinger refers to as 'order from order'.

We have noted already that modern technovision can be characterized in terms of a desire to withdraw from temporality and finitude. A similar aspiration has also been uncovered in Mendel's work. Schrödinger's influential contribution to this project is his idea of the 'code-script', which he likens to an 'all-penetrating mind' that always already knows the future development of the organism (1967:22). In this way, human temporal and visual limits are transcended by a technology lying at the fundament of life. The term 'code' implies that a system of laws is involved. At the same time, however, for at least the past two centuries, a code is also something that conjures up the quality of *secrecy*. Presumably, the secret possessed by a genetic code-script would concern the origin of the natural order that sustains the life of the organism as it battles thermodynamic entropy. We have previously suggested that the secret of the organism lies in its (hetero)sex, which is itself a surrogate for God in the modern world. Does this now hold for Schrödinger too?

Today, *What is Life?* is conventionally regarded as the text which first proposed that the essence of life can be accounted for by an underlying genetic code. James Watson, for example, credits Schrödinger's book as his inspiration

in turning to genetic questions because it offered a mechanism for reducing biological life to a molecular code that might be deciphered. He writes, 'I disdained the very idea of vitalism. If such a "vital" force were calling the shots in nature's game, there was little hope life would ever be understood through the methods of science. On the other hand, the notion that life might be perpetuated by means of an instruction book inscribed in a secret code appealed to me' (2003:36). This is a common reading of Schrödinger, yet I think it overly simplifies his position. In Schrödinger's desire for a 'new physics' there is a good deal of ambiguity around the question of whether the 'code-script' of life may be read through the optic of modern science. Watson's move recasts the notion of code in such a way that it evacuates the secrecy of its 'secret', which he presumes to be merely hidden below the surface and awaiting discovery by the technoscientific key that will unlock the chemical-mechanical order. Nature's code is thereby opposed to any suspiciously vitalistic or ultimately secretive concept of 'life itself'. This is precisely the reductive move that propelled molecular biology further towards the conception of biological information implicit in Mendel. Yet, in important respects, Schrödinger's work runs counter to this tendency to simplification. For example, he claims that, 'It seems neither adequate nor possible to dissect into discrete 'properties' the pattern of an organism which is essentially a unity, a 'whole' (1967:30). Indeed, Schrödinger's characterization of life in terms of discrete systems that change via 'quantum jumps' might well be read as anticipating more recent theories of complexity and self-organization in certain respects.

In an alternative reading of Schrödinger's text, the biophysicist Robert Rosen argues that the argument of *What is Life?* is actually 'quite incompatible with the dogmas of today':

[Schrödinger] thought that this 'life' was exemplified by, or manifested in, specific organisms, but that at root, biology was not about *them* – it concerned rather whatever it was about these particular material systems that distinguished them, and their behaviors, from inert matter. The very form of the question [*What is Life?*] connotes that Schrödinger believed that 'life' is in itself a legitimate object of scientific scrutiny (2000:6).

On Rosen's reading, Schrödinger did not believe that life could be reduced to a code-script that may simply be deciphered by modern science. On the contrary, the secrecy of the code was of paramount importance to its functioning. Rosen argues that the question posed in *What is Life?* is still before us today, and that answering it would require coming to terms with life as that which escapes the predictive laws of physics. For him, in claiming that the organism *feeds* upon negative entropy (or information), '[Schrödinger] was saying that, for the entire process of order from order to work at all, the system exhibiting it *has to be open* in some crucial sense' (2000:17). On Rosen's reading of *What is Life?*, although he does not state it as such, the living organism constitutes a complex open system that exchanges energy, matter, *and information* with its environment. Hence, he claims that, 'Such thermodynamically open systems can be considered "phenotypes without genotypes"' (2000:18). There is a certain

recuperation here of the complexity of life as the focus shifts from inertial structures to active forces. For Rosen, the new physics of life envisioned by Schrödinger ‘...can be expressed as a shift from material causations of behavior, manifested in state sets, to formal and efficient causations’ (2000:27). While this is an important move, I suggest that, for Schrödinger, the *secret* of life is not merely in that the organism is a thermodynamically open system. Furthermore, we can question the threefold nature of causality implicit in Rosen’s account by recalling our discussion of Heidegger’s fourfold notion of causality in chapter two, especially his contention that modern science and technology conceals the absent presence of final causes. In this light, it may pay to reexamine Schrödinger’s text for traces of onto-theology. Paradoxically, I suggest that we may find signs of a divine perspective in the place of the thermodynamic ‘demon’.

Maxwell’s Demon is the name given to an imaginary being invented by the physicist James Maxwell in the 1860s in order to explain how it might be possible to thwart the second law of thermodynamics. This demonic entity was charged with combating the increase of entropy within a closed system by controlling the flow of molecules (which were conceived of as stable and eternal in themselves) in such a way that no work is performed, and hence no heat/energy is lost. The potential for such a being to exist has been subject to much ongoing dispute, but the crucial point for us here is found in Keller’s suggestion that a line can be drawn from Maxwell’s Demon right through to Schrödinger’s code-script. Insofar as the code-script directs the biological reproduction of life, it runs counter to the

entropic tendency and serves the same purpose as the demon. 'The most important point', Keller claims, 'is [the demon's] shift in reference from God to humanlike intelligence, a shift extended by Schrödinger ever more inward, until it becomes, in the mid-twentieth century, the ghost inside the molecular machine of life' (1995:55). Yet, in what sense does this 'ghost' really express a human form of intelligence? I suggest that this is something of a misreading of Schrödinger's position. While the metaphors may in general have become more 'technological rather than theological' over the intervening hundred years, *What is Life?* still advocates a thoroughly onto-theological conception of the demon that governs life – and its (sexual) reproduction.

The biological organism (*qua* open system) feeds on negative entropy according to Schrödinger. Life, in defying the second law of thermodynamics, is *informed* by the order of nature. It is able to do this because the secret 'code' of life, identified with the demon or 'all-penetrating mind', enables inner and outer nature to be harmonized according to the laws governing the production of order from order. The effect of this move, however, is to push back the ultimate question of the source of natural order, and to raise the question of whether all life is determined by this secret source. Perhaps it was in response to this question – implicitly formulated by the logic of his scientific enquiry – that Schrödinger composed the epilogue to *What is Life?* Although entitled 'On Determinism and Free Will', the key opposition informing this supplement is clearly that of physics versus biology – a reprise of the animating tension of the entire book. On the one hand, the mechanistic laws of nature that inform the

living organism appear inviolable; yet, on the other hand, *in life*, we experience freedom in our thoughts and actions. Schrödinger's conclusion is as follows:

The only possible inference from these two facts is, I think, that I – I in the widest meaning of the word, that is to say, every conscious mind who has ever said or felt 'I' – am the person, if any, who controls the 'motion of the atoms' according to the Laws of Nature. Within a cultural milieu where certain conceptions... have been limited and specialized, it is daring to give this conclusion the simple wording that it requires. In Christian terminology to say: 'Hence I am God Almighty' sounds both blasphemous and lunatic. But please disregard these connotations for the moment and consider whether the above inference is not the closest a biologist can get to proving God and immortality at one stroke (1967:93).

Most readers of *What is Life?*, particularly those biologists who abhor nothing more than the stain of vitalism or religion upon their science, have always disregarded the epilogue. In the same way that Mendel's religious calling has been effaced from the histories of genetics, Schrödinger's exclamation – 'I have become God' – is generally regarded as an embarrassing lapse of judgment from a somewhat eccentric scientist. His readers would prefer to consider the text to be complete, as an organic whole, closed off in itself, before the page is turned to the epilogue. But what if this confession of the onto-theological basis of Schrödinger's speculations on life represents the return of that which genetic science must always push away in order to maintain its identity?

Schrödinger's onto-theological move opens up the thermodynamic system of the (human) organism to a divine consciousness that informs living matter. The freedom inherent to life is not possessed by the individual, but rather is a secret that inhabits the subindividual level of life as it flows on through and beyond its temporary instantiations in individual organisms. The conscious mind may be that which allows us to recognize our identity with God, but it is not the essence of life itself. Indeed, Schrödinger never explicitly defines 'life' in his text. It appears as a somewhat mysterious, natural force that organizes thermodynamically open systems, and which evades the tendency towards maximum entropy. It might be said that *What is Life?* does not seek to answer its own question, but, rather, calls upon us to recognize the secret which gives the question its ongoing force.

What remains unstated throughout Schrödinger's text is the fact that it is the (hetero)sexual reproduction of the organism that ensures the immortality of living matter. It may be worth noting here that concepts of sexual difference first make an appearance in *What is Life?* at the very moment that Schrödinger sets out his account of the code of life:

For though the single chromosomes are sometimes clearly distinguished and individualized by size and shape, the two sets are almost entirely alike. As we shall see in a moment, one set comes from the mother (egg cell), one from the father (fertilizing spermatozoon). It is these chromosomes... that contain in some kind of code-script the entire pattern of the individual's future development and of its functioning in the mature state (1967:22).

The code that controls the development of life and governs its functioning, and which assures its ultimate victory over time, is a script that presumes and conjures up (hetero)sexual reproduction. Unlike Mendel, Schrödinger directs his attention to the level of the organism — a concept that is essentially defined in terms of its (hetero)sexual organization. At the same time, however, Schrödinger's 'code-script' is generated by a form of technovision that unwittingly translates the reproduction of life into informatic terms. It challenges forth the sexual energies of nature according to an atemporal framework that has already determined their place and functioning in life. The concept of (hetero)sex is implied here both in terms of being and doing; yet, this remains unthought. The secret of life lies just beyond the limits of scientific vision.

Thus, in his own way, Schrödinger introduced into genetic science the metaphor of the code of life as a product of modern technovision, and with implicit and interrelated connections to both onto-theology and (hetero)sexual difference. The way in which this was to be picked up in the emergent discipline of molecular biology depended to a large extent, however, upon the resonance that readers of *What is Life?* found with two other major intellectual tributaries of the mid-twentieth century: information theory and cybernetics.

Life in the Information Age

Discourses revolving around the notion of 'information' have been crucial in shaping the theory and practice of molecular biology since its earliest days over 50 years ago now. Despite the length of this history, however, the concept of

biological information has always suffered from a degree of ill-definition and semantic slipperiness. Its elucidatory value within biology has been the subject of considerable dispute, which continues today among philosophers of science (Maynard Smith, 2000; Sarkar, 2000) as it does among social and cultural critics.

It can be argued that 'information theory', in its relation to molecular biology, has always been more of a metaphorical resource than a literal source of rigorous concepts imported into the life sciences. The language of 'coding' and 'information' has functioned as 'rhetorical software' (to employ Richard Doyle's (1997) term) for a biological discourse that has been enamored with computer science metaphors ever since the 1940s. At this time, Schrödinger was posing the question of life, and of its 'code-script', in a way that found significant resonance with two other influential contemporary approaches to problems concerning the communication of information and the control of bodies (both mechanical and living): Claude Shannon's information theory, and Norbert Wiener's cybernetic theory. This section will discuss the former, while cybernetics will be the topic of the following section.

Claude Shannon and Warren Weaver's *The Mathematical Theory of Communication* (1949) put forward an unconventional concept of information that, like Schrödinger's understanding of life, bore an essential relation to the thermodynamic notion of entropy. Unlike the biological conception of life, however, Shannon and Weaver's concept of information was defined in a positive correlation with entropy, rather than in resistance to it. On first appearances, then, information and life appear to be divergent concepts. At the same time,

however, there are many structural and rhetorical similarities between the two theories that served to draw them together. Not least of these convergences was the association made in each theory between life or information and freedom. It was also to prove crucial that for Shannon and Weaver, as for Schrödinger, a process of coding was the key to how freedom was actualized in life and in information.

Information, in Shannon and Weaver's mathematical theory of communication, is a *quantitative* measure of a particular message that is transmitted relative to the complete set of all possible messages that could have been selected in a specific situation. In simple terms, the more entropy or disorder there is in a situation, the more freedom there is in selecting a message, and consequently the higher the information value will be. As they put it, 'this word information in communication theory relates not so much to what you *do* say, as to what you *could* say. That is, information is a measure of one's freedom of choice when one selects a message' (1949:100). To take an example that is germane to our interests here, from the perspective of Shannon and Weaver's theory, the determination of 'sex' would be a situation in which very little information is present. When a baby is born and the proclamation 'It's a boy!' or 'It's a girl!' is made, we gain little information because the degree of freedom in the situation is very low. Under the ontological limitations of (hetero)sexual difference, the options are restricted to a binary choice: male or female, boy or girl. Irrespective of the meaning attributed to this occurrence, the message we receive is one of only two options allowed within this communication system, hence its information

value is negligible. Indeed, one interesting element involved with the importation of Shannon and Weaver's information theory into biological thought is precisely its relation to the meaning of (hetero)sexual difference. Because the living organism is implicitly defined by its (hetero)sexual organization, the concept of biological information, alongside the notion of arbitrary messages that are freely selected, has the effect of freeing up the sexual forces of life to a certain extent. Even though the implications may not have been explicitly thought through at the time, the equation of the technological transmission of information with life allows the freedom of relatively unstructured nonorganic relations to silently inhabit the body of molecular biology.

When speaking of the informational context of (hetero)sexual difference, we are perhaps reminded of Mendel's experiments with plant hybrids, in which only constantly differing traits that could be clearly classified into one of two categories were admitted as scientific evidence. Although I have claimed above that Mendel's work anticipates the move that we are currently tracing – i.e. the shift to an understanding of life in terms of biological information – we can recognize here that his experiments produce little information in the sense that Shannon and Weaver use the term. It is natural order rather than entropy that Mendel values. On the other hand, however, Mendel's own mathematical approach to biological questions is quite in line with mid-twentieth-century information theory insofar as both reject the *meaning* of a 'message' as a relevant factor in the reproduction of life.

Shannon and Weaver are quite explicit on this point:

The word *information*, in this theory, is used in a special sense that must not be confused with its ordinary usage. In particular, *information* must not be confused with meaning. In fact, two messages, one of which is heavily loaded with meaning and the other of which is pure nonsense, can be exactly equivalent, from the present viewpoint, as regards information (1949:99)

The meaning of a message is bracketed here in order that the statistical aspects of the situation can be calculated. The transmission of a message, on this model, is simply an engineering problem. While the implications of this approach for genetic science and the study of heredity are readily apparent, I maintain that they were already foreshadowed by Mendel in his (incomplete) break with the overtly sexualized character of the plant hybridization tradition. By decomposing the organism into individual traits, Mendel effectively undermined the concept of 'sex' as a *meaningful* category and opened up life to the technological. From this perspective, genetic science, from its very beginnings, has always been figured in informatic terms and Shannon and Weaver's theory should not be considered as an entirely external element imposed upon the biological. Organic life in nineteenth-century biology was centered on the organizing force of (hetero)sexual difference, but Mendel bypassed all of this as he prepared the way for biological thought to descend to the molecular level – a move which anticipates the eventual emergence of reproductive technologies that bypass organic sex. Information theory, as first conceived by Shannon and Weaver, reinvigorates this move whereby statistical analysis becomes the key to understanding how discrete information is produced and transmitted across time without any

essential relationship to a higher level of organization or meaning. Insofar as the transmission of biological information comes to be taken as analogous to the reproduction of life, information theory implies a new role for sex within genetic science — one that has proven difficult to reconcile with the onto-theological commitments of earlier biological thought. Like Mendel, information theory posits the transmission of a stable message based on a statistical measure, yet, within the biological tradition, it is a meaningful notion of (hetero)sexual difference, and its correlate ‘species’, that ensures continuity in the natural order. An unarticulated tension is thereby inherent to the concept of ‘biological information’ — which is both reductive and yet possesses the potential for a renewed understanding of freedom in relation to biological and social life.

The identification of information and life in molecular biology was hastened all the more by the key role that the concept of a code played in the theories of both Schrödinger and Shannon/Weaver. For the latter, the coding of a message is required if it is to be transmitted in the most efficient manner through a communication channel. Code is the means by which the information value of a message is protected against the threat of disrupted transmission due to noise. For Shannon and Weaver, ‘[communication] theory contributes importantly to, and in fact is really the basic theory of cryptography which is, of course, a form of coding’ (1949:115). Information cannot be simply presented as it exists in the state of entropy. It requires a code in order that it may reach its destination unscathed. In this formulation, information begins to appear as structurally similar to Schrödinger’s onto-theological concept of life, which also comes to our

attention through the mediation of a ‘code-script’. This convergence becomes all the more apparent when we consider that, for Shannon and Weaver, the measure of information is defined in relation to entropy, while, for Schrödinger (and for the biological tradition more generally), life is defined through an antagonistic relation to the dissipating forces of death. In a sense, information theory simply makes apparent that which was implicit in biological discourse all along. In both instances, the freedom that belongs to information or to life is a product of the entropic disorder that sustains – through its opposing nature – the organization and order to be maintained. The concept of a (secret) code enables the reproduction and development of life, or the transmission of information, to take place within a context of overall disorganization. In this situation, one may easily be led to evoke a divine force that will account for the free expression of life (as was the case with Schrödinger) and this is never more apparent than in early cybernetic theory.

Information, Entropy, and Cybernetics

Norbert Wiener’s project of constructing a cybernetic science, begun in the context of military research the early 1940s, was undertaken in conversation with Shannon and Weaver’s work. This was particularly the case in regard to the relationship that both posited as existing between information and entropy. Yet, in his two most influential books – *Cybernetics: Or Control and Communication in the Animal and the Machine* (1961) (first published in 1948) and *The Human Use of Human Beings: Cybernetics and Society* (1967) (first published in 1950) –

Wiener went beyond the design of conventional communication systems to construct a research program that crossed the boundaries separating machine from animal from human. As such, his work is important for understanding the way in which life or the body can be regarded as open to technology. He was especially concerned with the role of feedback processes in determining the ability of a system to adapt to new circumstances through time. Feedback is here conceptualized as the key communicative stage in the service of control. Systems, whether technological, social, or biological, which incorporated feedback could thereby adjust themselves to deal with complex, changing situations. Crucially, for Wiener, to be effective as feedback, the information content of a message must be resolutely defended against attacks of 'noise'. Moving beyond nineteenth-century thermodynamics and towards the new information theory, he argued that communication engineering was the science appropriate to its times insofar as '...its main interest is not economy of energy but the accurate reproduction of a signal' (1961:39).

Wiener was to draw together Shannon and Weaver's thinking on the transmission of information with Schrödinger's claim that life feeds upon negative entropy. Like Schrödinger, he was interested in the implications of quantum theory for how we understand 'life', especially for the lack of absolute determinacy that it implied, and for the possibilities it held for explaining the maintenance of homeostasis. Rather than the stability offered by a 'code-script' withdrawn from the thermodynamic flux, however, Wiener believed that the

stability of the organism was dependent upon its acquisition and use of reliable information from the world around it. His 'demon' lay in the power to inform.

Wiener was adamant that, 'Information is information, not matter or energy' (1961:132). As distinct from matter and energy, it is information alone that resists the tendency towards entropy, and is thereby positioned as the essence or secret of life. While citing Shannon and Weaver, however, Wiener characterizes information in a way that appears to be opposed to their position. He writes, 'Just as the amount of information in a system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization; and the one is simply the negative of the other' (1961:11). Where Shannon and Weaver had identified information with entropy, Wiener opposes the two. Yet, this divergence in definition is more apparent than decisive for the import of the two theories. The crucial difference actually lies in Wiener's extension of the concept of information in such a way that reintroduces the *meaningful* content of the message. While Shannon and Weaver measured information quantitatively in terms of the freedom of choice among potential messages within the communicative situation as whole, Wiener was not prepared to accept such a narrow definition of information. Yet, by removing the bracketing of meaning from the message, and by associating information with organization, Wiener opens up the communicative system to a return of the onto-theological.

Just as Schrödinger's code-script was the expression of God at the basis of life, Wiener's concept of information evokes a divine origin for organized life. Once again, it is in the battle of life versus death, of order versus entropy, that we

discover the underlying dynamic that shapes the situation of the organism or communicative system. Wiener is an advocate for a new conception of physics that will address itself to the element of chance and contingency that is built into the fabric of the universe. Speaking of this situation, he writes: 'For this random element, this organic incompleteness, is one which without too violent a figure of speech we may consider evil; the negative evil which St Augustine characterizes as incompleteness, rather than the positive malicious evil of the Manichaeans' (1967:19). Entropy – the tendency towards disorganization and disorder – is the manifestation of evil; it threatens life with a slow descent into total chaos. Information resists this evil, and therefore is on the side of the good, and, as per Wiener's reference to St Augustine, on the side of the god. Cybernetics is the study of messages that organize and are, at bottom, of divine origin.

From this perspective, Wiener's invocation of Shannon and Weaver's concept of information may perhaps also reveal a hidden onto-theological aspect of their theory. For in reciting the central claim of the mathematical theory of communication, i.e. 'the more probable the message, the less information it gives' (1967:31), Wiener implicitly raises the question of the 'first' message and of the origin of organization. Doyle points out the paradox that is involved here by noting that, while a message's information content is tied to its improbability, there is a point of regress at which this logic collapses in upon itself. This is because, 'A truly singular, unprecedented phenomenon would in some sense make no sense – we would lack the tools of signification necessary to read or interpret it' (1997:45). For Doyle, this points to the existence of an 'unthought

thought' that necessarily precedes all communication. Thus, by bringing the meaning of the message back into the equation, Wiener exposes the unthought thought of information theory, and we find that this is none other than the secret thought of a divine origin. The question is, from whence would the message with the highest possible information value arise? What is the name that we may give to the source of order and organization, which first informs matter and energy? Wiener's implicit invocation of God in this place of origin is reflected in the fact that, for him, information and life are identified with meaning: 'In control and communication we are always fighting nature's tendency to degrade the organized and to destroy the meaningful' (1967:26). The fight against evil is one in which the meaning and natural order of life is clearly at stake. Whereas for Shannon and Weaver, the freedom of information is sustained by entropy and disorder, Wiener gives voice to the other side of the tension between meaning and information insofar as he posits that entropy or freedom is a threat to life. Emerging out of this theoretical environment, molecular biology will tend to side with Wiener, and to reaffirm the value of a stable natural order that runs back through Mendel to the eighteenth century. At the same time, however, cyber-discourses associated with the concepts of code and information also brought another, quite different potential to the tradition of biological thought.

Wiener's association of the organizing force of the organism with the presence of an absent God is one we have seen before. Going back to the writings of Kant, and to the beginnings of biological science in the early nineteenth century, I have suggested that a quasi-divine presence inhabits the organized body of life

and is expressed through the concept of (hetero)sex. I have also argued that (hetero)sexual difference is itself one response to a troubling condition of natural freedom that emerges with the 'death of God'. In this regard, it is interesting to note that Wiener's distaste for entropy — for its association with irrationality, incomplete determinism, and randomness — often sounds much like an aversion to a certain conception of freedom, or to the free production of nature. Given that he is interested in applying cybernetics to questions of biology, we might perhaps expect to find a (hetero)sexual component to his account of control and communication in life. Here, we may turn our attention to Wiener's discussion of 'affective tone' within the human or animal nervous system. Described as a feeling of pleasure or pain that accompanies an action, this bodily affect constitutes a feedback mechanism relaying messages throughout the living organism. For Wiener, the functioning of this system of affects is premised upon a quasi-teleological reproductive force. He writes, 'Biologically speaking, of course, a greater affective tone must occur predominantly in situations favorable for the perpetuation of the race, if not the individual, and a smaller affective tone in situations which are unfavorable for this perpetuation, if not disastrous' (1961:128). That we might easily bring to mind many exceptions to this economy of reproductive affect is not my point here; I am more interested in suggesting that Wiener has sex on his mind. In speculating on how these affective messages might be sent most efficiently, he notes that 'The high emotional and consequently affective content of hormonal activity is most suggestive' (1961:129). To speak of hormones in the mid-twentieth century, of course, was

almost inevitably to speak of (hetero)sexual difference, as it was a time of intense scientific interest in the role of hormones in constituting the essence of maleness and femaleness. Wiener does not disappoint us here. Immediately, albeit somewhat hesitantly, he draws a connection between the hormonal transmission of messages and unconscious sexual drives. He brings these elements together by noting ‘...the fact that in the theories of Freud the memory – the storage function of the nervous system – and the activities of sex are both involved. Sex, on the one hand, and all affective content on the other, contain a very strong hormonal element’ (1961:130). What are we to make of this association? Might this unconscious connection between (hetero)sex and the hormonal feedback mechanism coordinating the affective messages circulating through the living body be a sign of some greater force or purpose in life? Is the long-term stability and direction of life a product of this (hetero)sexual information in conjunction with a feedback mechanism that regulates both communication and the control of the organism, and which must be defended against all ‘noise’ if a fall into evil is to be avoided?

To be sure, Wiener says nothing of the sort. Yet, as Katherine Hayles has noted, he returns to the topic of hormonal flows and the circulation of sexual information between bodies in the final chapter of *Cybernetics*. Hayles claims that, ‘The choice of examples foregrounds sexuality, but this is a kind of sex without sexuality’ (1999:109). Her point is that the cybernetic flow of information threatens to dissolve the boundaries of the individual subject, that is, of the autonomous self as possessor of a discrete sexual identity. What we see here, I

suggest, is a return of the same tension that animated the work of both Mendel and Schrödinger. On the one hand, there is the explicit desire to affirm stability, natural order, or homeostasis in the reproduction of life; but, on the other hand, the concepts of code or information implicitly work towards the decomposition of the individual organism. 'Sex' is the terrain upon which this tension is played out. As figured between God and nature, (hetero)sexual difference presents itself as a crucial force of organization that connects the organic being to the natural and social order of which it is a part. Indeed, for Wiener, both the living organism and all forms of animal and human community depend upon an organizing force that resists the encroachment of noise and entropy. Evil is to be combated though that which draws living beings together, not just temporarily, but over time in such a way that allows them to reproduce and avoid death. Through (hetero)sexual difference, Wiener suggests, God and natural order are immanent to life.

Capital and Computer Science

Another issue that Wiener raises near the end of *Cybernetics* is the influence of capitalism on the flow of information in contemporary societies. Specifically, he is concerned that the concentration of the means of communication in the hands of a dominant economic class will have deleterious effects upon the free flow of information that is necessary for the homeostasis of society to be maintained. This question of the influence of capital upon genetic science was a crucial factor in the constitution of molecular biology, and has only continued to become more vital in the intervening years as the potential for profit to be

realized from investments in biotechnology has attracted a growing bioentrepreneurial class.

In her history of the concept of genetic code, Lily Kay provides us with a substantial commentary on the relation of capital to the control of genetic information. She suggests that World War II was a 'watershed' for American science in terms of its relation to capital. She writes, 'hardly any aspect of science, including the cognitive, technological, disciplinary, and organizational, remained unaffected. The war created new institutions and reconfigured older relations, recasting them in new forms' (2000:74). Especially important in effecting these changes was the vastly increased funding that science received under the auspices of the Office of Scientific Research and Development (where Weaver had a leading role). According to Kay, by the end of the war, the United States government was spending ten times the amount of money on research as it had been in 1938. Much of this money went to four elite universities – MIT (where Wiener was based), Caltech, Columbia, and Harvard – and three leading industries – Bell Labs (where Shannon worked), General Motors, and General Electric. Military objectives were the main force driving scientific activity and technological development in the 1940s, and by the end of the decade the Department of Defense's research activities accounted for 65% of all government-sponsored research and development expenditures. Cybernetics, and what was to become known as information theory, both emerged out of this time of war. The need to assemble, analyze, coordinate, and control information was paramount to military research, and thus to the leading sciences of the time.

Crucial to meeting the requirements of this militarized science was the development of machines for processing information more rapidly and accurately. This need created a synergy between a nascent computer science and postwar military objectives. As Kay notes, 'Computers could automate and accelerate military operations, which led to a intensified commitment to faster and more powerful computers' (2000:104). Indeed, this intertwining of military and informatic objectives leads Keller to claim that '...far and away the most consequential impact of WWII on scientific life – even for the life sciences – came about as a result of the development of the computer. This newest of machines – a machine that was to transform the very meaning of mechanism – had itself been developed to cope with the vast increase in complexity of life outside the biological laboratory that had come with the war' (2002a:56-7). Indeed, as we have seen, a concept of the living organism modeled after the computer was central to Wiener's work in particular. Although large-scale applications of computing power in the field of biology were some decades away, postwar computer science provided a key metaphorical resource that, alongside an influx of physicists and their technologies into the life sciences, helped shape the emergence of molecular biology.

The advent of computer science and its influence on all of the natural sciences was but one example of the way in which technological imperatives, especially those embodied in the resolving power of devices that aimed to 'see' right down to the level of nature's 'code-script', came to realize Mendel's mathematical technovision in the molecular biology of the mid- to late-twentieth

century. Kay (1996) argues that the field of molecular biology was delimited from the outset by instruments and technologies that directed all attention to the submicroscopic realm of life, and which catapulted the physical chemist to the center of life science. This meant that the focus of biological enquiry was to effectively shift from the organismic level, where biology had traditionally found its object ever since its emergence in the early nineteenth century, to the level of molecular structure and law. Biology was, in a sense, catching up to Mendel, and realizing his technovision in the informatic, computer-driven economy of postwar American science.

Another key factor in the development of molecular biology was the infusion of huge amounts of capital from private corporations into the field. In particular, Kay has documented in great detail the influence of the Rockefeller Foundation in shaping the research agenda of biological science in the postwar period. Not only did the foundation contribute about \$25 million into U.S. molecular biology during the years 1932-59, but:

The Foundation's power to shape life science transcended the dollar amount of its investment; its effectiveness lay in creating and promoting institutional mechanisms of interdisciplinary cooperation through extensive systems of grants and fellowships, and in systematically fostering a project-orientated, technology-based biology. As the correspondence files, reports, and diaries of the officers reveal, during the 1930-1950s the Rockefeller projects became densely interwoven with the scientific agenda of those universities that were heavily supported through the Foundation's molecular biology program (1993:6).

Given this degree of influence, it is obviously important to ask the question: what motivated the Rockefeller Foundation, and others like it, to become involved in the life sciences? Kay notes that the philanthropic aims of the Foundation were in no way separate from its business interests. Hence, the decision to finance molecular biology should be seen in the context of furthering a particular vision of the type of scientific research that was valuable to the reproduction of the current socio-economic order. More specifically, Kay's claim is that, 'Their projects aimed to restructure human relations and to develop social technologies commensurate with the material and ideological imperatives of industrial capitalism' (1993:10). From this perspective, the objectives that underwrote the infusion of large amounts of capital into molecular biology were nothing less than the reshaping of life – both biological and social – according to the needs of capitalist political economy. A path is thereby opened up for the biotech companies of the later twentieth century, who have increasingly come to set the research agenda for contemporary genomics. Equally important, however, at least from our point of view here, Kay's work suggests that the relation of capital to genetic science exhibits a certain tension between, on the one hand, affirming a meaningful order of life, and, on the other hand, utilizing the discourse of biological information. Thus, while capital seeks to cast the current socio-economic order in naturalistic terms in order to facilitate the reproduction of conditions conducive to the realization of profit, it also wishes to promote the investiture of information technologies in the subindividual level of life, which implicitly opens up the 'natural' order of things. From this perspective, the influx

of capital into genetic science only serves to exacerbate the existing tensions that we have been tracing out in this chapter.

Here, in the mid-twentieth century, as it is with the entire history of genetic science, the issue of eugenics is never far from the surface of enquiry. Kay points out that the Rockefeller Foundation supported a number of eugenic projects in the early decades of the twentieth century. By the time that the molecular biology program was being assembled, however, eugenics had lost much of its scientific credibility, and this led to the more neutral terminology found in the Foundation's new 'Science of Man' agenda. This was an ambitious undertaking orientated around the long-term goal of developing a comprehensive and rational approach to social order and control through the integration of natural, medical, and social sciences. For Kay, this is merely eugenics under a different name: 'A concerted physicochemical attack on the gene was initiated at the moment in history when it became unacceptable to advocate social control based on crude eugenic principles and outmoded racial theories' (1993:9). If eugenics was about selective breeding and the regulation of reproductive sexuality, then the program of molecular biology represented a different strategy for achieving the same goal – the control of 'sex' and of life through the establishment of a new social order, which was, at the same time, to remain a 'natural' order. This was the appeal of molecular biology for the Rockefeller Foundation's political, economic, and social objectives. As Kay puts it, 'A biology governed by faith in technology and in the ultimate power of upward causation is far more amenable to strategies of control than a science of downward causation, where elements cannot be fully

understood apart from the whole' (1993:17). Genetic engineering was always the goal and, in an epistemological climate awash with concepts derived from cybernetics, information theory, and computer science, this may be seen as a further step towards the dissolution of organic sex. Capital's purposes require only the transfer of biological information, and the technological control of bodies through programming of the codes of life.

The desire of capital to invest in technologies aimed at the control of subindividual bodies has only intensified in the age of genomics. Chapter four will take up this issue again in relation the HGP. I will suggest that Wiener is correct to worry that capitalist penetration of life will lead to the breakdown of certain forms of bodily and social organization. I will also argue, however, that the political potential inherent in the capitalization of life is more ambiguous than may first appear.

The Bioinformatic Body

Throughout the 1940s, then, both during the war years and in the aftermath, capital, alongside ideas about information, control, and communication, circulated throughout scientific circles. Nevertheless, it would be a mistake to think that these factors all simply coalesced to determine the direction of biological research. Keller argues that while information theory, cybernetics, and computer science shared common interests, conceptual approaches, and forms of representation — to the extent that we may refer to them all under the general title of 'cyberscience' — this interdisciplinary formation diverged from the program

of molecular biology in an important sense. She points to an apparent divergence of perspective:

Cyberscience... was developed to deal with the messy complexity of the postmodern world, over the very same period of time in which molecular biology was crafting its techniques for analyzing the simplest strata of life. The one repudiated conventional wisdom about the analytic value of simplicity, whereas the other embraced it; the one celebrated complexity, whereas the other disdained it. Small wonder, then, that these two disciplinary structures diverged. We might even say they inhabited different worlds (1995:85).

From Keller's perspective, cyberscience and molecular biology emerged at the same moment in time, but took quite different paths. Yet, such an account makes it difficult to explain the influence that discourses of information, and of cybernetic control and communication, had upon the establishment of molecular biology as a discipline. It may perhaps be more useful to look at cyberscience itself as an uneasy amalgam of two divergent tendencies – an ambiguous embrace of complexity and freedom at the level of the living organism or cybernetic system, counteracted by a desire for order and determinism at the level of the code or message, with its simple and linear transmission of information, and with its exclusion of noise. This divergence might be recognized in Schrödinger's uncertain coupling of the stable order of the 'code-script' and the freedom associated with 'life'; or in Wiener's reluctance to fully embrace the free flow of information beyond the boundaries of the organism. It raises the

question of whether the code or informatic message provides that which is essential to the organism or to the cybernetic system. Molecular biology, for its part, seems to have been born out of a belief that the answer to this question is 'yes'. A further question is thereby raised however: what happens to life, to God, to freedom, when they are banished to the extra-biological, and discredited by association with 'vitalism'? Might they be said to haunt molecular biology, perhaps to return in the most unlikely of places?

While the precise moment at which cyberscience began to exert a formative influence over biological science is a matter of dispute, most commentators consider 1953 – the year of the discovery of the structure of DNA – to have been an important year for the constitution of molecular biology as an informatic discourse. As Keller puts it, 'With Watson and Crick's invocation of "genetic information" residing in the nucleic acid sequences of DNA, some notion of information (however metaphorical) assumed a centrality to molecular biology that almost rivaled that of the more technical definition of information in cybernetics' (1995:94). The concept of genetic information was then formalized, to a large extent, in 1958 when Francis Crick laid out what was to become the key tenet of molecular biology: the Central Dogma. The idea of a unidirectional information flow from DNA to proteins took genetic science down the path of simplification. The Central Dogma rejected the cybernetic notion of feedback in favor of an emphasis on the delivery of a message carefully composed at the origin of a causal chain. In Crick's formulation, which was quickly to become accepted truth, genetic information was self-contained, inviolable, and held the

key to life. The task of gaining access to the secrets of genetic information had already been cast in terms of 'breaking the code' by the physicist George Gamow, and together these two developments firmly established information discourse as the governing mode of representing nature within molecular biology. For many contemporary critics, however, this is precisely where the problems lie.

In *How We Became Posthuman*, Katherine Hayles provides a critique of contemporary information-based cultures and the concept of virtuality. For Hayles, 'The great dream and promise of information is that it can be free from the material constraints that govern the mortal world' (1999:13). She traces this concept of information back to the post-WWII period, and more specifically to the rise of cyberscience. On her account, the problem is not so much in the way that Shannon defined information as a probability function divorced from context, as it is the way in which this heuristic bracketing of meaning tended to be forgotten as the concept was transferred to other domains beyond communication engineering. As Hayles puts it:

Taken out of context, the definition allowed information to be conceptualized as if it were an entity that can flow unchanged between different material substrates.... Thus, a simplification necessitated by engineering considerations becomes an ideology in which a reified concept of information is treated as if it were fully commensurate with the complexities of human thought (1999:54).

Hayles' point is that information must always be materially instantiated in order to exist. Her concern is that information has become disembodied today, and made in to a fetish.

Hayles locates the emergence of this reified notion of information within a general cultural shift away from conceptualizing things in terms of presence or absence, and towards an emphasis on pattern versus randomness. It is Wiener's work that is said to exemplify this shift: 'In the "dematerialized materialism" of the battlefield where life struggles against entropy and noise, the body ceases to be regarded as a material object and instead is seen as an informational pattern' (1999:104). For Hayles, Wiener's position exhibits too much anxiety over maintaining control of bodily boundaries, and thus closes down the possibilities that exist for rethinking what it is to be human today. To her mind, the positive aspect of the posthuman condition is in its embrace of the contingency and unpredictability that goes along with reconceptualizing human being in terms of an open system. In a sense, she advocates that we affirm one of the two tendencies we have identified as coexisting within cyberscience – specifically, the tendency associated with freedom, complexity, and life, as opposed to the tendency towards natural order, the simplicity of coding, and the linear transmission of informatic messages. What is not so clear, however, is whether Hayles' antipathy towards informational discourses is necessarily on the side of freeing up these new possibilities. It is also not certain whether the opposition she draws between information theory and cybernetics on the one hand, and embodied reality on the other, does not itself privilege a basically conservative

concept of human embodiment over against other virtual or nonorganic possibilities opened up on the technoscientific landscape. If, as I have suggested, the concept of biological information possesses the potential to free life from the straitjacket of organic form, then it requires a recognition of the ambiguous nature of the 'disembodiment' effected by informatic discourses.

Hayles' work raises the question of where molecular biology stands with regard to the reification of information. When she notes that, 'Shannon's distinction between signal and noise had a conservative bias that privileges stasis over change' (as did Wiener's antipathy towards entropy) Hayles evokes a charge that has often been leveled against contemporary genomics. She continues, 'Noise interferes with the message's exact replication, which is presumed to be the desired result. The structure of the theory implied that change was deviation and that deviation should be corrected' (1999:62). This is a position that may well be inherent in any notion of a genetic code as the 'secret of life' – at least, as long as that secret is conceived as a message which must be faithfully translated and read in order to assemble a body. Hayles' critique of disembodied information, insofar as it may be read in terms of genetic code, suggests that the aspect of cyberscience pursued by early molecular biology, and which was influential in constituting the HGP, has serious limitations as a means of explaining life and living beings.

Indeed, this is precisely the thesis pursued by Kay (2000) in her study of how 'information' came to signify biological specificity from the 1950s onwards. She documents key changes in the ways that nature tended to be conceptualized

in biological discourse during the mid-twentieth century. Where specific organization had once been the definitive trope of biology's object, life increasingly came to be figured through a discourse of information in the second half of the twentieth century. Kay makes the important point that, amongst the intellectual excitement of cybernetic research, 'The information discourse and its modes of signification bestowed upon the biological sciences – long beleaguered by Comtean inferiority – some of the high status and promise of command and control fields' (2000:114-5). This, in turn, drew more funding to molecular biology and fuelled its growth. The promise of controlling life through the decoding of genetic information has yet to be realized, however, and, from Kay's point of view, is unlikely to happen any time soon. Her study emphasizes the way in which information discourse was an imperfect fit for the object of biology:

Though often interchangeable, the two concepts – *specificity* and *information* – did not directly map onto each other.... The discrepancies resided in the categorical difference between the two: specificity denoting material and structural properties; information denoting nonmaterial attributes, such as soul, potentialities, and form (telos), previously captured by the notion of organization and plan (logos). The genetic code had been widely viewed as the key to life's secret logos (2000:328).

As with Hayles, information discourse is here identified as a dematerializing force that is unable to comprehend the plenitude of nature's materiality. The problem, as Kay describes it, is that, 'Though remarkably compelling and productive as analogies, "information", "language", "code", "message", and "text" have been

taken as ontologies' (2000:2-3). On her reading, trouble arises because the separation of disciplinary domains has not been respected. The qualities of living matter are thereby not recognized for what they are in themselves. For Kay, information discourse constitutes only a partial perspective on life that is in effect a form of biopower that disciplines and controls living forces. Again, information is here regarded as essentially reductionist concept that sucks the life out of bodies. Yet, if biopower is also productive and promiscuous in its connections and effects, then perhaps the concept of biological 'information' cannot be so easily characterized in terms of reductionism and disembodiment. Specifically, it may be that informatic discourses are only repressive in their relation to life insofar as the latter is figured in organic terms that are themselves quite conservative.

Richard Doyle, to take another example, is also concerned with the deleterious effects of information discourse. In his study of the rhetorical transformations that shaped the emergence of molecular biology, he aims his critique at the body that is produced through the discourse of information. Doyle names this construction the 'postvital body', and describes it as '...a body in which the distinct, modern categories of surface and depth, being and living, implode into the new density of coding... the postvital body is a transparent sequence that has nothing behind or beyond it' (1997:13). This is a body modeled upon the computer, with its organic nature conceptualized in terms of a mere bundle of information. Moreover, for Doyle, the computer itself is collapsed into its program within the rhetorics of molecular biology. Eschewing analysis of communication

theory and the cybernetic moment, he places emphasis on Schrödinger's *What is Life?* for the role that it played in establishing the concept of genetic code. The book is credited with effecting a 'fundamental reprogramming of the rhetorical software of genetics' due to the fact that, 'Schrödinger mistakes or displaces the pattern of the organism by its "code-script", injecting the life of the organism into its description' (1997:28). Again, it is a matter of reduction – of reducing the living organism to a set of instructions. Doyle argues that Schrödinger gave voice to a previously unarticulated possibility in biological science by suggesting that, 'no body, indeed, no life, need exist at all outside of the "aperiodic crystal"'. For Doyle, quite simply, this means that, 'the body, and life, have disappeared' (1997:33). Yet, as we have seen above, this is not the only possible reading of Schrödinger's text. On the contrary, *What is Life?*, as I have argued, does not necessarily set out to resolve its own question; rather, Schrödinger's onto-theology locates the secret of life beyond the reach of reductionist physical science. Doyle, along with Hayles and Kay, holds the nascent discourse of coding and informatics responsible for stripping life of its natural body. Viewed as an external imposition – be it from physics, communication theory, cybernetics, or computer science – information theory, for these critics, holds little respect for biological life. Yet what if, as I have argued, a certain informatic discourse has always been inherent to genetic science? Moreover, what if nature or life has always been open to bioinformatic technology? The question not yet broached is whether the subindividual interactions that can be conceived through the

discourse of biological information may in fact lead to the formulation of a different concept of (nonorganic) life.

Doyle does, nevertheless, draw an important connection between information discourse and onto-theology. He points to George Gamow's 1954 conceptualization of the 'coding problem' (i.e. how to explain the synthesis of proteins from the structure of DNA) in terms of 'translation' as a key technology of molecular biology – 'a technology that retools the depths of the body as a secret, even sacred archive' (1997:40). We have already discussed how the concept of a 'code' conjures up a notion of secrecy, and how in the case of genetic science the response has been to try and lay the secret bare. Doyle argues that, 'Crucial to this project was the implicit notion that this "book of life", like its intertextual counterpart, the New Testament, offered one proper reading, one story, one Truth' (1997:40). The project, initiated by Gamow, of 'breaking the code' of DNA and uncovering the mechanism of 'translation' is, for Doyle, a reductionist gesture. He claims, 'More than treating the molecular as the basis for the living, Gamow's move translates the molecular as *no different from* the living' (1997:42). Here we uncover an ideal of translation without loss, which thereby denies to living matter a reality of its own. According to Doyle, Gamow is able to make this move because he operates with a tacit belief that 'everything is readable' – this is the 'unthought thought' that ensures universal translation. 'Thus, in its figuration as a "cryptograph" or a "puzzle", the notion of the genetic code made possible a kind of positivist mysticism' (1997:49). All that is required is the key that unlocks the secrets of life and allows their legibility to be

recognized. Natural order is presumed in an onto-theological move that Doyle, paraphrasing Heidegger, describes as the coming of the 'age of world scripture'⁶.

The biblical associations called up by this notion of reading the 'Book of Life' are also highlighted by Kay's study of the genetic code. As she puts it, 'The metaphor of the "Book of Life" and its subsequent variant, the "Book of Nature", reaches back to antiquity.... But this metaphor of transcendent writing acquired new, seemingly scientific legitimate meanings through the discourse of information' (2000:2). The question is, was this a secular takeover, or a troubling return of that which had been supposedly banished? For Kay, 'Theistic implications, though only implicit, have loomed large over the scriptural representations of the genetic code as the Book of Life' (2000:295). Certainly, the conceptualization of genomics as 'reading' or 'decoding' DNA slipped easily into a tradition of deciphering the word of God as it appeared in nature, and which had been especially marked since the scientific revolution of the seventeenth century. Recall the onto-theological desires of Linnaeus and eighteenth-century natural history, which sought to uncover a divine order underlying the apparent diversity of the world. In effect, what Doyle and Kay are suggesting is that this onto-theological tradition remains in effect today. Under conditions of universal translatability, the ideal message always gets through. Noise is not a problem here.

The space which frames all such translation remains unthought in this picture. Indeed, this was Heidegger's own nascent critique of cyberscience. In a late essay entitled 'The End of Philosophy and the Task of Thinking', written in

the mid-1960s, he claims that, 'Cybernetics transforms language into an exchange of news. The arts become regulated-regulating instruments of information' (1993:434). It is not the reduction of meaning that Heidegger objects to in the seamless transmission of messages, however, it is the absence of the poetic – of the freedom that inheres in *poiēsis*. Cybernetics is modern technology insofar as it commands and controls, insofar as it is based in calculation and representation, and insofar as it is therefore unable to receive the coming-to-presence of things outside of preexisting categories of thought. In the present age, Heidegger claims, '"Theory" means now supposition of the categories, which are allowed only a cybernetic function, but denied any ontological meaning' (1993:435). Yet, as we know from chapter two, Heidegger's thinking on technology does not advocate for a rejection of such ways of revealing. Instead, he suggests that we extend technovision to its limit, perhaps there to catch a glimpse of the process of withdrawal through which life and world are secretly given.

With this in mind, I want to return to Gamow's project of decoding and translation, and to quote Doyle once more:

Even while the explicit aim of [Gamow's] article, indeed of molecular biology generally, is to determine and articulate the fundamental chemical and physical mechanisms that make up the 'secret' or 'book' of life, it is the very allure of the 'essence' of life that helps drive the investigation (1997:56).

It seems to me that Doyle is here giving voice to a key tension of molecular biology as a scientific project. For, if we follow molecular biology through to its avowed goal of controlling life, then does not the glow of victory dissolve along with its opponent? Without a secret to reveal, is molecular biology not confronted with a more terrifying freedom? Is this not the same tension that we have identified as running throughout cyberscience? The uneasy juxtaposition of freedom, life, and the code-script in Schrödinger, Wiener's anxiety over the status of the human organism and community in a cybernetic world, and even the tension between entropy, meaning, and the very possibility of information in Shannon and Weaver's theory of communication, are all indicators of the limits of modern technovision. In this chapter, we have seen that this tension, which revolves around the 'secret' of life – of its authority, its reproduction, and of its revelation and control – is often implicitly played out through ontotheological discourses of (hetero)sexual difference. We might say that Mendel's initial difficulty in reconciling his proto-informatic approach with the tradition of organic (hetero)sexuality that governed his intellectual environment is reiterated throughout the co-development of information theory, cybernetics, and molecular biology.

Ultimately, I suggest that the tension generated between a growing informatic discourse in biology, which aims to control life at the subindividual level, and a concurrent desire to reaffirm the precedence of the organic body, which continually defers to the ultimate authority of a natural order, may also be understood in terms of the modern technologies of gender. The implicit

contradiction within molecular biology in regard to the bioinformatic body is effectively displaced by a quasi-teleological, (hetero)sexual representation of matter and energy. Gender concepts provide a resolution (however unstable) to problem of the paradoxical freedom of nature by distributing the divergent desires for control and subordination into separate ontological dimensions of life coded as masculine and feminine, respectively. Cyberscience, like Mendel's proto-informatics, marshals an informatic discourse that puts the meaning and stability of natural order into question. The resulting anxiety is repeatedly alleviated by the reaffirmation of (hetero)sexual difference or normative gender concepts, which function to ensure both the order and authority of nature.

In chapter four, we turn to the Human Genome Project as we begin to examine how the tension between biological information, natural order, and divine meaning inhabit contemporary genomics.

Notes

¹ For a summary of the controversy over Mendel's position as the first geneticist see Orel & Hartl (1994).

² Farmers in the region in which Mendel lived were particularly active in regard to the breeding of hybrid plants and animals (See Orel, 1996:22-35).

³ See chapter two for a more extended discussion of the emergence of photography in the first half of the nineteenth century.

⁴ For details of Mendel's extensive scientific education, see Corcos and Monaghan (1993:22-26).

⁵ Mendel writes, 'Experiments on ornamental plants undertaken in previous years had proven that, as a rule, hybrids do not represent the form exactly intermediate between the parental strains' (1966:9).

⁶ Heidegger's original formulation is 'the age of the world picture'. It refers to the fact that, with the advent of modern science and technology, the world can be represented as an object.

Chapter 4

Reading and Writing the Human Genome

What is most impressive to me is not so much the ways in which the genome project has fulfilled our expectations but the ways in which it has transformed them.... Contrary to all expectations, instead of lending support to the familiar notions of genetic determinism that have acquired so powerful grip on the popular imagination, these successes pose critical challenges to such notions (Keller, 2000:5).

Throughout the 1990s, in newspaper articles, on magazine covers, and in popular science books, the field of genomics quickly established itself as the new frontier of science. It seemed as though a crucial breakthrough was perpetually imminent, one which would usher in a new understanding of life, and thereby change the way that we think about medicine, health, and the relation of the biological to the social. The source of all this expectation was the Human Genome Project (HGP). In the wake of the project's completion, however, its impact and meaning for the future of biology, and of society, is still a matter of interpretation and contestation.

In many respects, the HGP may be seen as the realization of molecular biology's investment in the concepts and discourses of computer science and information theory during the 1950s. The genomic body is a bioinformatic body – a body composed of encoded biological information. The genome is conceived as both the origin and controller of the messages that circulate throughout the

communication system composing the human organism and giving shape to its life. From the discovery of the proto-digital structure of DNA to the notion of a genetic 'program', molecular biology has always been constituted, in part, by informatic discourses derived from 'cyberscience'.

At the beginning of the twenty-first century, biology may be said to have entered the era of 'Big Science'. Most notably, this is due to its increasing reliance upon immense computing power and technologies that allow the production and processing of large amounts of biological data. The story of the HGP – an international project to determine the sequence of chemical bases comprising a human genome, and which was mainly funded by the U.S. government via the National Institutes of Health, along with the nonprofit Wellcome Trust in Great Britain – is well known and has received much public attention. This interest was in large part generated by the appearance of a private company – Celera Genomics – which, in 1998, set itself up as a competitor to the publicly financed project, thus creating the appearance of a race to be the first to complete the sequence of the human genome. The urgency that this endeavor took on as a consequence of this highly publicized contest was central to the perception that an event of extraordinary importance was occurring.

In this chapter, I examine some of the discourses surrounding the HGP and the new genomic era. Beginning with the field of study known as Science and Technology Studies (STS), I consider the ways in which sociological studies have sought to explain the production of knowledge within contemporary

biological science and its social implications. STS may be characterized as one of three main approaches within recent social criticism of science, alongside feminist science studies, and another more heterogeneous grouping of social critiques that draw attention to questions of political economy, race, and the reduction of life to biological determinism. After reviewing these critical approaches in relation to genetic science, I bring them into juxtaposition with several of the popular accounts of the HGP and its implications that have appeared in recent years. While affirming the insights of contemporary social criticism in my analysis of the key claims and themes found in these popular explications of genomic science, I am more interested in uncovering that which is as yet unthought in this work. More specifically, I attempt to read these popular texts in relation to the discourses of (hetero)sexual difference and onto-theology that I argue are intrinsic to modern biological science. I then turn to the role of visual technologies in genomics as a first step in formulating a different way of theorizing the HGP. Here, I try to locate genomic technovision in relation to the genealogy of scientific vision that we have been tracing out in previous chapters. In short, I propose to consider the HGP as photography. In so doing, I hope to indicate a path that leads beyond both reductionist accounts and competing critiques of genetic science, and towards some new openings for thought that may be offered by contemporary genomics.

The Culture of Biological Science

A culture of bacterial life within a Petri dish is a familiar image of the biological laboratory, but there is also a laboratory culture that shapes the way in which biological knowledge is produced and the form that it takes. The study of scientific or laboratory cultures has been the main interest of STS scholars for the past twenty years. Their investigations tend to focus upon the diversity of scientific ways of knowing, and the complex and contingent methods or strategic negotiations by which scientific facts are produced in laboratories and other micro-level settings. From this perspective, local assumptions and micropolitical strategies are crucial factors in giving shape to scientific practice and its products.

Bruno Latour is the figure most commonly associated with STS today. In *Laboratory Life* (1979) (with Steve Woolgar) and *Science in Action* (1987), Latour lays out an approach to studying science that focuses on the small-scale interactions and politics involved in the construction of facts within the laboratory setting, and which rejects the notion that abstractions such as 'socio-economic classes' or 'gender' can be appealed to in order to explain the actions of scientists. He advocates a form of Actor Network Theory (ANT) that incorporates nonhuman actors as participants in the process of settling a scientific controversy. Implied here is a certain enlargement of what we might normally consider to be the social realm. At the same time, however, Latour argues that social structures do not significantly inform the process of fact construction within the laboratory. His claim that such structures are produced out of the micro-level

political interactions taking place within laboratories therefore effectively diminishes the complexity of social interactions involved in the production of scientific knowledge. Latour's perspective emphasizes the point that science is one of the most powerful forces involved in the shaping of contemporary societies, but his theory also has difficulty acknowledging the influence of pre-existing social factors on the practices and outcomes of science. For this reason, it is difficult to draw his work into a conversation about the politics of gender and science.

Karin Knorr Cetina is another central figure in the development of STS and studies of scientific networks, and her recent ethnographic study, *Epistemic Cultures: How the Sciences Make Knowledge* (1999), is a landmark in sociological studies of molecular biology. She defines an epistemic culture as '...those amalgams of arrangements and mechanisms – bonded through affinity, necessity, and historical coincidence – which, in a given field, make up *how we know what we know* (1999:1). Knorr Cetina's work examines and compares two particular epistemic cultures: molecular biology and high energy physics (HEP). Her intent is to show that each of these scientific endeavors involves more than merely the application of one and the same scientific method to a distinct area of enquiry. Instead, she claims that there are 'machineries of knowledge construction' peculiar to each epistemic culture. Uncovering the way in which each of these machineries is constructed leads her to a view of science that dispels any suggestion of a unified practice or form of knowledge:

Magnifying this aspect of science – not its production of knowledge but its epistemic machinery – reveals the fragmentation of contemporary science; it displays different architectures of empirical approaches, specific constructions of the referent, particular ontologies of instruments, and different social machines. In other words, it brings out the *diversity* of epistemic cultures. This *disunifies* the sciences (1999:3).

For Knorr Cetina, the differences between the epistemic cultures of HEP and molecular biology are many. She draws contrasts between the two fields in terms of how their work is organized in space and time, their different symbolic systems, their relations to the empirical world, and the way in which each employs technology, among other features. Most definitely, these are sciences in the plural.

My main interest here is in focusing on the characterization of molecular biology in *Epistemic Cultures*, but there is one key aspect of the contrast Knorr Cetina draws between the two sciences that should be noted at the outset. Because her fieldwork was begun in the mid-1980s before the HGP was conceived, the rapid developments of genomics in the 1990s are not featured in the study. This raises a difficulty insofar as Knorr Cetina's analysis is based in a comparison of 'the communitarian science of physics with the individual, bodily, lab-bench science of molecular biology' (1999:4). The opposition drawn between the large transnational collaborations typical of HEP, with its search for 'the basic components of the universe', and the independent, competitive, small molecular biology laboratories, which undertake research focused upon particular empirical

bodies, is central to Knorr Cetina's case for the epistemic disunity of the natural sciences today. The HGP, however, was a collaborative, transnational project that aimed to discover the genetic information that many scientists believe to be the basic components of life. It is therefore not unreasonable to suggest that the HGP represents molecular biology's transformation into a 'big science' on the model of physics. This would seem to severely undermine the disunity thesis, and Knorr Cetina is well aware of this. As she puts it:

Has the genome project brought molecular biology closer to the big-science ways of working examined in the last chapter [on physics]? The suggestion here is that it has not, or at least not yet – partly because the genome project is itself far from being a centralized research effort comparable to experimental HEP (1999:81).

By the end of the 1990s, however, the HGP had indeed become a highly centralized and coordinated project undertaken by just three 'labs' in the U.S. and Britain. Of course, this was by no means a smooth transfer to a completely different operating mode. On the contrary, throughout the lifespan of the HGP there existed a marked tension between the newly constituted collaborative mode of operation and the more established competitive relations between individual labs. This tension was exacerbated to a large degree by the emergence of private biotech companies seeking to profit from the wealth of genomic data.

We read nothing of all this in *Epistemic Cultures*, and yet, it may still be the case that Knorr Cetina is correct in maintaining a separation between the

machineries of knowledge in HEP and molecular biology. Contemporary science, after all, does not possess a unified theory of nature. Yet, on the other hand, as we saw in chapter three, molecular biology might in fact be said to find its origins in physics – indeed, to find that it possesses something like a double origin in Newtonian and quantum physics via the interventions of Mendel and of Schrödinger, respectively. The advent of the HGP and other ongoing genomic projects suggests that the apparent differences between the epistemic cultures of molecular biology and physics may hide a deeper coherence at the level of the relation that each desires to establish with nature. This is a thought to which we shall return below.

For now, I am interested in the epistemic subjects that derive from these machines of knowledge construction. For Knorr Cetina, subjects and objects alike are the products of epistemic cultures. The conventions, devices, sites, discourses, and practices that comprise the machineries of knowledge are also constitutive of scientists as agents of knowledge. Again, there is a distinction to be made: ‘This is perhaps molecular biology’s first most important difference from experimental high energy physics: in the molecular biology laboratory, the person remains the epistemic subject’ (1999:217). In contrast to the physics experiments, in which each researcher must be integrated into, and subordinated to the central technology of the project, the molecular biologist stands as an embodied seeker of truth. Not only is the biologist embodied, but also towards the end of her discussion of laboratory cultures, Knorr Cetina notes another aspect of the constitution of these scientific subjects:

In a sense, gender also added to the tensions and asymmetries in molecular biology. This contrasts with experimental high energy physics, where the duality of gender appeared to be widely replaced by what one might call mono-gender. Mono-gender is the stylistic rendering of everyone as a physicist, regardless of their gender in everyday life. The mono-gendered physicist looks more like a male than a female.... In the molecular biology labs observed, the duality of gender... appeared to be maintained and to play a role in everyday life (1999:232).

From one perspective, it is perhaps not surprising that molecular biology should be marked by gender categories given the centrality of reproductive (hetero)sex and (hetero)sexual selection to the main currents of biological thought (i.e. both genetics and evolutionary biology). Perhaps more notable is the fact that this, apparently external, social structure has forced its way into Knorr Cetina's text, thereby upsetting the epistemic culture of the laboratory. For gender is not allocated an acknowledged role in the machineries of knowledge construction. It is, instead, theorized as a social factor that must be dispelled in order to ensure the smooth running of the epistemic machine. This is achieved, according to Knorr Cetina, through '*joking relationships*' that ease the tensions produced by such social 'disjunctions' (1999:233). Indeed, humor is often a means for relieving anxiety. But why should the disjunction of gender produce such tension in the molecular biology laboratory? Why does *this* social factor cause trouble?

The question of the relationship between laboratory and social world is addressed early on in *Epistemic Cultures*. Knorr Cetina argues that laboratories reconfigure both natural objects and social subjects. Rather than a physical

space, the 'laboratory' is itself theorized as being, first and foremost, this process of reconfiguration between the natural order and the social order. Laboratories are thus defined '...as *relational* units that gain power by instituting *differences* with their environment: differences between the reconfigured orders created in the laboratory and the conventions and arrangements found in everyday life...' (1999:44). Social factors are thus transformed as they enter into an epistemic culture. The machineries of knowledge production produce both compliant objects and the neutral (or neutered) epistemic subjects who will manipulate them. The emphasis throughout Knorr Cetina's account is on the laboratory as the *active* coordinator of interactions between the natural and the social. Scientific method, as manifested by the epistemic arrangements of the laboratory process, is presented as always being *in control*. Its authority goes unquestioned. There is no comment, for example, about how the economic system within which the laboratory operates might affect its processes of reconfiguration. This is a striking absence in view of the rise of the biotech economy in the 1980s, and of the increasing commercial pressures and conflicts that become all too apparent with the HGP in the 1990s. Understanding the laboratory as a process of reconfiguration allows us to see how nothing remains the same within its ever-shifting boundaries. What it is not so clear, however, is whether it allows us a perspective on that which persists. The surprising appearance of gender categories at the end of *Epistemic Cultures* suggests that not all social factors reconfigure in the way that the laboratory apparatus demands. An explanation of the effect of gender differences on the epistemic culture of molecular biology,

however, is foreclosed by Knorr Cetina's theoretical framework, which allows no place for social structures within the laboratory.

Biology and Gendered Culture

Published four years before *Epistemic Cultures*, Bonnie Spanier's *Im/partial Science* (1995) is also a study of molecular biology, but one that belongs to a quite different epistemic field: feminist science studies. If Knorr Cetina's work may be said to be a study of the internal workings of specific scientific disciplines, then Spanier's attention to the external, social context in which science is undertaken, and, in particular, to the rhetorical influence of gender ideology on biology, might represent something like its antithesis. This is perhaps an apt characterization given that there has been surprisingly little contact between STS and feminist studies of gender and science over the past twenty years.

Spanier's text can be situated in a tradition of feminist enquiry that we have already encountered in chapter one. There, we discussed how authors such as Schiebinger (1993), Merchant (1980), Jordanova (1989), and Keller (1985) have examined the origins of modern science during the Enlightenment and found it to be implicated in a masculine project of domination over a feminized conception of nature. In these texts, science is characterized as a means by which men sought to uncover and gain control over the secrets of nature in order to perpetuate patriarchal power. Science, from this perspective, represents masculine interests both insofar as its practice is dominated by men, and in fact that its language draws upon numerous gendered metaphors which subtly shape public

conceptions of the natural world to the disadvantage of women. One of the questions implicitly posed by this body of work is that of whether contemporary science exhibits similarly gendered features. *Im/partial Science* is an attempt to show that biological science at the end of the twentieth century is still deeply mired in the distortions of its gendered past.

Spanier's main interest is in analyzing the formal discourse of scientists — as manifested in biological journals and textbooks — to uncover the ways in which it is shaped by gender ideology. Her claim is that molecular biology provides only a partial vision of life because it is contaminated by masculinist bias. Thus, 'In this framework, male and female are inherently different from one another, with maleness assumed to be superior and associated with the natural controller, the action initiator, the "brains", as compared to the female as weaker, more passive, inferior' (1995:3). For Spanier, the presence of gender stereotypes within biological discourse serves to buttress a particular conception of human nature that devalues women and contributes to the maintenance of material privilege for men.

Unlike Knorr Cetina, Spanier affirms a unity of approach that binds molecular biology to physics. Indeed, she claims that molecular biology is the offspring of an encounter between genetic science and certain concepts introduced into the life sciences by the physicists who entered the field following World War II¹. The most notable result of this coupling, according to Spanier, was a strong commitment to reductionism as the method of molecular biology. For her, 'Reductionism in the life sciences is inextricably linked with a mechanistic

approach to nature – “the world as a clock” – built into the seventeenth-century foundations of modern science’ (1995:30). This does not imply that reductionism is inherently masculine. Rather, Spanier points to the role of reductionism in fostering the concomitant ideology of biological determinism, which has, in turn, served to provide justification for many forms of gender inequality over the past two centuries.

There is also a way in which reductionism may be seen to reinforce a peculiarly gendered view of molecular life. In her analysis of molecular biology textbooks, Spanier notes that the central focus is upon the gene as ‘the controlling molecule of life’ (1995:83). DNA is assumed to actively control the development of the body, while proteins and other components are cast into passive, subservient roles. Her claim is that gender stereotypes are being projected onto basic life processes via a reductionist framework ‘that accepts as natural and justified the domination of one superior type over another inferior type’, hence it is ‘necessary to question this representation of “our world” as DNA-dominated’ (1995:95). Here, as elsewhere in *Im/partial Science*, the question raised is that of the implications of a gendered view of nature informed by masculinist ideology. The suggestion is that a hierarchical and oppositional characterization of sex and gender is projected onto the natural world and thus distorts the way in which molecular biology understands life.

Spanier is concerned to show that molecular biologists, like the natural historians of the eighteenth century, see (hetero)sexual difference wherever they look. A good example of this tendency is found in scientific explanations of

particular genetic transactions whereby a single-celled bacterium *E.coli* transfers a portion of DNA called an F plasmid to another *E.coli* cell that lacks it. According to Spanier, because scientists conflate cultural notions of 'sex' with molecular processes, they have, since the 1950s, taken to designating *E.coli* in either male or female terms dependent upon the presence or absence of the F plasmid (1995:56). She notes the way in which this gendering of bacteria rehearses the belief in the male as actor and the female as passive recipient, and thereby also reinscribes all sexual connections within a heterosexist framework. In sum, she claims:

It is no accident that the concept of essential male and female difference, with the male as the natural controller of action and the female defined by absence, gets embedded in the study of bacteria, so deeply held or unquestioned is our culture's belief that male/female difference is fundamental to nature (1995:58).

What Spanier is gesturing towards here is the way that biological science, like natural history before it, has always explained the activity of life by appeal to a quasi-teleological cultural notion of (hetero)sexual difference that serves to establish the appearance of natural order.

The differences between Spanier's account of gendered science and Knorr Cetina's study of the epistemic culture of molecular biology are certainly apparent. At the same time, however, it is worth asking whether either approach ends up casting much light upon the 'essence' – understood in Heidegger's sense of the way in which a thing endures in presence – of 'science'. Knorr

Cetina's ethnography examines molecular biology from the inside, illustrating the contingent details, technologies, and local arrangements that comprise each individual science. Yet, if our contemporary situation is characterized by such 'disunity', then in what sense may we refer to both high energy physics and molecular biology as 'sciences'? Spanier's critique, on the other hand, tackles biological science from the outside, examining the social and cultural factors that distort it. Yet, what are we left with when we strip away the gender ideology? Do we, in either of these accounts, ever actually reach a point at which we may consider science itself as a form of knowledge? Indeed, if such a thing does exist, how would we speak of it? Is there a distinct type of vision or desire that would answer to the name?

Such questions are often broached via the more fundamental question of whether or not science possesses an identity of its own. Here, I want to approach this basic question through two texts that address science from the perspective of gender and identity. Isabelle Stenger's 'The Thousand and One Sexes of Science' (1997) puts forward a position that is very much in line with that of Knorr Cetina, Latour, and other STS scholars. She poses for her readers the very questions that lie unarticulated in the space between the two studies we have been discussing: 'do scientific theories have a sex?' Furthermore, should we follow our intuitive sense that '[science] can be identified with *one* sex, with the one that affirms domination as a value?' (1997:133). For Stengers, a feminist critique that seeks to condemn science as masculine ideology is drawn into a 'black hole', from which it cannot adequately respond to the contemporary

situation of scientific practice. The dangerous attractor is the concept of *identity*, the determination of which allows the critic to judge science and to find it guilty of wielding illegitimate powers over nature. According to Stengers, it is only in refusing to acknowledge the singularity of each science that such a verdict can be reached. Hence, 'In order to escape from the black hole, it is therefore essential to understand the powers at work in the sciences without making oneself the representative of a *superpower* capable of telling the hidden truth' (1997:134). Stengers sides with Latour in claiming that the qualities generally taken to constitute the 'truth' of science – objectivity, truth, neutrality – are in fact retrospective attributions that miss the actual activity of 'science in action'. Moreover, by positing an identity that purports to capture the essence of 'science', feminist critics are said to miss the fundamentally historical character of scientific practices. In this way, these critics are said to play into the hands of those who would advance a reified notion of science as a coherent and all-powerful force for the status quo. The strategy advocated by Stengers, on the other hand, is laughter in the face of such ambitions:

Learning to laugh in the name of the singularity of the sciences, in the name of the thousand and one sexes of their fictions, at those who give an identity to science, who say they know what scientific method is, what the conditions of objectivity are, and what the criteria of scientificity are is a proposition that is in no way neutral (1997:143).

In this way, Stengers hopes to expose the fallacy of a feminist critique of science that assumes itself to be outside of its object. Yet, what of the laughter and humor noted by Knorr Cetina in the molecular biology lab? What of the 'joking relationships' that covers over gender anxiety in science? Such humor raises different questions such as: What if the constitution of 'science' is not assumed to be a matter of a particular identity or method, but, instead, is to be found in the desire for identity and method?² What if science has no identity of its own, but rather is the historical product of a desire to establish identity through a particular methodological relation to the world? Can we imagine an alternative gender critique of science in these terms?

Such questions become apposite if we turn our attention to another text – Luce Irigaray's 'Is the Subject of Science Sexed?' (1985b) – which approaches the relation of gender to science from a quite different direction. While Irigaray writes in a manner very different to that of Spanier, in many respects her work attempts to articulate something of the relation between masculinity and modern science that is left unexamined in *Im/partial Science*. Irigaray's enquiry, moreover, attempts to effect a conceptual movement in precisely the opposite direction to that pursued by Stengers' text:

Every scientific universe seems to have its own worldview, its stakes, its protocols of experimentation, its technology, its syntax: isolated, cut off from the others. From what point of view, then, can one *span* these different horizons, seeking out their meeting grounds, workable intersections, possible crossovers? *By what right can one assume a stance outside?* How does one arrive at it? Historically there

was a God who transcended any *episteme*. But if and when "...science is in power, God is dead" (Nietzsche): from where can one begin to reassemble these worlds? (1985b:73-4).

Taking the disunity of epistemic cultures as her starting point, Irigaray asks us to try and imagine what still remains of 'science'. She challenges us to consider what we are left with after the loss of this God's-eye viewpoint. Is there merely an empty space where God once resided, thus allowing science to dissolve into the many disunified sciences, or has his place secretly been filled? Irigaray's thesis is that deep within the sciences lies a 'locus for common questioning', even if it is very difficult to reach. She writes, 'But, perhaps, one could also ask oneself at this point if there is not, in a subjacent and secret way, a *common force of production*; (man) who does science' (1985b:74). At issue here is not merely the historical dominance of men in the sciences. More importantly, it is a question of the subject position generated by the discourse of science. For Irigaray, this subject position still provides a God-like or onto-theological view of the world by drawing upon the conceptual resources of sexual difference. Thus, she asserts, 'Indeed, that which purports to be universal is equivalent to the ideolect of men and to a male imaginary, a world differentiated by sex' (1985b:77). This masculine imaginary, which is characterized by 'production, property, order, form, unity, visibility, erection', is not merely the product of gender ideology distorting the otherwise neutral workings of science. Rather, it is said to inhere within the reputedly neutral methodology with which the sciences represent the world. Scientific discourse, as characterized by Irigaray, excludes any expression

of the feminine as it strives to dominate, control, and impose a rigid order onto nature.

Again, there seems to be little middle ground to work with here. Where Stengers' essay might be said to neglect the common figuration of scientific desire, Irigaray is perhaps too quick to identify science with a formal, ahistorical discourse characterized in terms of masculine interests and ideology. Somehow, in each account, there remains the sense that we are missing part of the story. Nevertheless, I want to suggest that both Stengers and Irigaray are correct to a certain extent, and that it may be of benefit to see if we cannot combine the insights that each provide. Irigaray, like Spanier and other feminist critics of science, gives voice to the persistent, intuitive sense of the gender of science that we receive through our experience of its power and reach in contemporary societies (and, not least, from the continuing dominance of men in positions of authority and prestige in science). The ways in which the discourses of modern science cohere with those of hegemonic masculinities are apparent in the value that both place upon reason, power, and control. Stengers, on the other hand, as with Knorr Cetina and other science and technology scholars, allows us to grasp something of the complexities involved in current scientific practice, and to gain a feeling for the tremendous amount of work that goes into maintaining the boundaries and authority of scientific knowledge. In bringing these two bodies of work together, we might say that what Irigaray and Spanier recognize in science, is what prevents it from actually becoming what Stengers and Knorr Cetina already perceive it to be. Stengers, in particular, points out the critical potential of

science in relation to that which is – its interrogation of the normal and the conventional. The question is, how do we set this potential free? How, in the context of the persistence of gendered categories within the very constitution of science, do we realize the freedom of (our) nature?

At this juncture, I wish to turn to the Human Genome Project. My thesis is that recent events in the field of genomics and biotechnology may offer the opportunity of a passage beyond the aporia of gender and science in which we find ourselves today. To make such a move, however, will require recognizing what is the same and what is different in the 'new' genomics. It will require analysis of the ways in which the HGP anticipates a different future even as it returns us to the past of biological thought.

Questioning the Human Genome Project

Although the HGP and related developments in biotechnology have enjoyed a high public profile over the past ten years or so, the voices of science and technology scholars have not registered strongly in discussions over the merits and potential implications of what may well become the dominant science of the twenty-first century. Neither have feminist critics been prominent in the debate. Even so, the gendered dimension of genomics has not been entirely ignored. For example, Mary Rosner and T.R. Johnson (1995) reconstruct a familiar patriarchal plot by focusing on the dominant metaphors that scientists use in describing the HGP. The story is that of the (male) hero who is charged with the task of revealing and conquering (feminine) nature. Here, technoscience is figured as a

tool by which the male subject asserts his control over the natural world. Rosner and Johnson draw the conclusion that, 'The values of the Human Genome Project... are hierarchical; the scientist seeks to overpower and demystify nature once-and-for-all. This domination of the Other is entirely complicit in the domination of women and minorities' (1995:126). From this perspective, genomics produces nothing that is new. Instead, it is business as usual as the HGP merely represents a reprise of the sort of masculine science that has existed since the time of Francis Bacon. Surely, there is some truth in this. At the same time, however, we should perhaps not be too quick to assume that the implications of genomics for gender politics are necessarily so evident.

Sarah Franklin (1995), in an essay ostensibly concerned with the 'romance' involved in the pursuit of scientific knowledge, also takes up the question of what it might mean to figure the relation of gender and scientific enquiry in the context of the new genomics. Franklin, however, approaches her subject matter from a quite different starting point. Rather than seeking to locate the HGP securely within the patriarchal tradition, Franklin's interest is in asking '...the question of whether the new genetic sciences can be seen as differently gendered from their antecedents' (1995:63). While she recognizes the force of the feminist critique, noting that the HGP reiterates many familiar themes associated with the mastery of nature as figured in terms of the unknown feminine, Franklin also sees something else happening in the move away from the organism and towards an exclusive focus on the gene. For her, the HGP is the realization of molecular biology's investment in an informational discourse, and this has significant

implications for the gendered relationship that has held between science and its object since the Enlightenment. She claims that, 'The fluidity of the gene is expressed not in the form of a complex organism, but as an information flow. It is described as a code, a cipher. Information is gendered differently from nature. It is more gender neutral' (1995:67). The point here is that the move towards an informational discourse, which, as I argued in the previous chapter, can be traced right back to Mendel's initial work in genetics, allows for connections and couplings that do not necessarily follow the meaningful organic patterns upon which modern biology has generally premised its understanding of nature. The concept of biological information thereby potentially disrupts the seamless reproduction of the organic body and, instead, challenges us to conceptualize a bioinformatic body. As Franklin recognizes, the implications of this transition for the relation between gender and science are profound:

By bypassing heterosexual reproduction, and drawing its analogies instead from the less gender-differentiated idiom of information, genetic science inevitably invites a different set of mergings. Whereas earlier versions of biology drew heavily on the imagery of a masculine science unveiling a feminine nature, and emphasized the fecundity of this coupling, the mergings which inspire the awe of biogeneticists are much more expansive and promiscuous (1995:68).

Here we perhaps glimpse something of the critical potential of contemporary genomics and biotechnology in relation to modern biology, and to the 'nature' of

gender. It is my contention that this critical force remains largely untapped at present.

To date, social critiques of genomics and the HGP have paid little attention to the issue of (hetero)sexual difference as it plays out on the promiscuous terrain of information. Philosophically speaking, the main contention of critics has been that the HGP breathes new life into the worst excesses of reductionist science. This theme is prominent in critical works such as those by Ruth Hubbard and Elijah Wald (1997) and Barbara Katz Rothman (1998). Both texts challenge the primacy of the genetic in explanations for human behavior and illness. Hubbard and Wald argue that the myth of the 'all-powerful gene' is simply bad science because it neglects the environmental context in which both genes and organisms exist. They make the basic, but important point that 'By focusing our attention on microorganisms or genes, scientists succeed in drawing attention away from societal influences [on ill health]' (1997:60). This is a claim that underlies much social criticism of reductionist science. Hubbard and Wald also highlight the ways in which this reductionist agenda converges with the interests of pharmaceutical and biotechnology companies, who stand to make large profits out of the practice of tying new diseases to genes. The fact that most scientists in the field of genetics have ties to such companies only reinforces the dangers inherent in this confluence of private capitalism and public-interest science.

For Hubbard and Wald, 'One of the problems with the Genome Project all along has been that it delivers realms of molecular detail without an inkling of how to interpret it' (1997:172). This claim finds an echo in Rothman's critique of

the limits of genetic science, which charges that the HGP represents a lack of 'imagination'. Again, it is reductionism and the lack of context, especially the lack of attention to the social context in which all meaning is shaped, that is faulted in the project to 'map' the so-called human genome. Rothman's claim is that, 'What genetic thinking – what all reductionist thinking – lacks is an imagination, the leap of the mind that takes us beyond the pieces to see the whole' (1998:222). The 'whole' in question here is 'life', which has always been the ostensible object of biological enquiry, even if its parameters have remained vaguely defined. In many respects, it can be said that life is the problem that biology has always been trying to solve and, for Rothman, 'Trying to reduce life to DNA confronts this problem: DNA is not "alive". It is inert. It just sits there. DNA doesn't create life: life creates DNA' (1998:223). The important point here is that insofar as biological science seeks to reduce human experience to genetics, it provides only a partial vision of life.

In the same vein, the biologist Richard Lewontin (1992), who is one of the most trenchant and influential critics of large-scale genomic projects like the HGP, argues that modern biology operates with an inadequate notion of causality, which fails to appreciate that diseases are not merely the product of genes, but are generally caused by social and economic conditions. Picking up on a well-rehearsed theme, Lewontin (2001) claims that a reductionist framework derived from the physical sciences is simply inappropriate for understanding the living organism. The issue of methodology is an important one for Lewontin as he is at pains to emphasize that 'Science as we practice it solves those problems for

which its methods and concepts are adequate, and successful scientists soon learn to pose only those problems that are likely to be solved' (2001:73). This point is of particular relevance in considering the HGP, with its reliance upon DNA sequencing machines, and for the future of molecular biology. Again, however, we should not be too quick to assume that the critique of reductionism is the last word on genomics and biotechnology. It may be that contemporary technoscience also offers up alternative, and more productive forms of thought and practice.

In assessing the critical potential of the HGP and biotechnology in regard to the reproduction of 'natural order', and in order to approach closer to issues of sex and gender, I suggest that it may be of value to reflect upon another claim made by Lewontin: namely, that science has taken over the role that Christianity once played in the legitimating of knowledge as universal truth. As Dorothy Nelkin and Susan Lindee (1995) point out, scientists' faith in the existence of an underlying natural order often resembles religious conviction, and DNA in particular has come to bear the trace of the holy. Both in biology and in popular culture, DNA has come to serve as an onto-theological principle that underlies all of life; i.e. it figures both the fundamental nature of being and the ultimate source of life. The genome is understood as a sacred text in which natural order is inscribed, and a form of quasi-Christian metaphysics is thereby reinscribed through an avowedly secular science. Nelkin and Lindee discern this tendency at the basis of molecular biology, especially in the well-known works of Richard Dawkins. They claim that although Dawkins appears vehemently antireligious,

his '...extreme reductionism, in which the DNA appears as immortal and the individual body as ultimately irrelevant, is in many ways a theological narrative, resembling the belief that the things of this world (the body) do not matter, while the soul (DNA) lasts forever' (1995:53). As one story (that of science) seeks to replace another (that of theology), the narrative structure remains in place and implicitly or unconsciously evokes the authority of the older tradition. It is worth noting here, however, that the onto-theology evident in the work of writers such as Dawkins draws upon a certain (hetero)sexual narrative. As Nelkin and Lindee remark, 'The immortality of DNA in Dawkins's account is grounded in reproductive processes' (1995:53). Indeed, my interest here is in examining the way in which 'sex' has come to mediate between the theological prehistory of biological thought and the onto-theological condition of contemporary genomics.

In debates around the HGP, this reiteration of religious tropes also takes on a much more explicit form. As a number of commentators have noted, both scientists and popularizers of genomics make frequent use of religious metaphors. On the one hand, this move can be seen in terms of a claim for the importance of genomic research. The politics of securing scientific funding, and of individual prestige, undoubtedly play into the way in which the popular image of the HGP draws upon the rhetoric of religion. Yet, on the other hand, we have seen that the politics of theology and science are more complicated than the mere pursuit of power. Indeed, at the very moment in which those involved with the HGP had their finest hour – at the White House ceremony arranged to mark the 'completion' of the first rough draft of the human genome – the curious

relationship of genomic science and religion was on display. In lauding the scientific achievement of the HGP, President Bill Clinton proclaimed that, 'today, we are learning the language in which God created life'. Briefly reconciled, two of modernity's most notable antagonists, appeared content. Yet, beneath the surface of these remarks, the relationship of science to religion was anything but resolved. Nelkin and Lindee draw our attention to a fundamental contradiction that is created by molecular biologists' appropriation of Christian heritage: if the genome is the 'book of life', or the word of God, then 'Manipulating DNA, from this perspective, becomes a sacrilege, a violation of sacred ground' (1995:41). The HGP, which is intended to allow scientists to intervene and rewrite the text, thereby endangers the sanctity of life. Paradoxically, science threatens to usurp the place of God, even as it draws upon his authority. It is only by emphasizing the potential contribution of genomic science to life – its potential to 'correct' defective genes – that this contradiction is held at bay. The medical discourse used to justify the HGP serves to reconcile its goals with the theological notion of perfection in the human form. The genome is, implicitly at least, God's word made flesh. Yet, this shared normative vision of human life masks an underlying conflict over competing claims to the truth of life. Ultimately, this desire for exclusive possession of the 'truth' expressed through nature may be what separates modern science and Christianity, while simultaneously binding them together. Both lay claim to the same language, the same narratives, because both wish to lay claim to metaphysical truth.

What is also increasingly apparent is that a certain discourse of (hetero)-sexual difference is central to this politics of life. The presumption of heteronormative sexuality in the history of biological thought is matched by the vigor with which fundamentalist Christianity seeks to enforce the specifically modern gender and sexual categories that have dominated European culture since the eighteenth century. The normative force of (hetero)sex appears to be crucial for the coherence of both these worldviews. In this context, we can pose the question of whether the HGP and contemporary genomics merely reiterate and reinforce this onto-theological, (hetero)sexual order, or can we identify a shift in perspective? Recent conflicts between Christianity and advocates for reproductive biotechnologies (such as cloning) suggest that bioinformatic bodies cause trouble for the notion of a divine or stable natural order of things. With this in mind, I turn now to popular accounts of the HGP. For it is here that we may discover how genomics has been conceptualized, shaped, and defined in the public sphere, thus staking out broad limits as to what may be thought in its name.

Popular Science

The HGP has been the recipient of much 'popularizing' over the past fifteen years. To a certain extent, this process may be regarded as serving the need to legitimate and justify the vast public expenditure in the project. At the same time, however, other social and cultural factors also play a part in explaining the surfeit of popular genomic press and its appeal. José Van Dijck's

study of popular images of genetics since the 1950s provides us with a useful starting point here. She argues that the popularization of science should not be conceived simply as a means of diffusing knowledge and overcoming ignorance. Rather, 'Popularization... is a process of *translation* and *negotiation*... in which special interest groups and professional groups are involved in defining the hegemonic meaning of genetics' (1998:10). As such, popularizations are political sites in which the truth or meaning of scientific events and facts are both produced and contested. Moreover, the process through which popularization takes place is not solely one of rational explication and argumentation. As Van Dijck points out, 'Popular appeal often takes shape through the evocative use of mental pictures or compelling stories – or through *images* and *imaginations*' (1998:11). 'Images' may be produced in many ways, often through the use of metaphor or narrative structure, and, in this sense, they exist somewhere in between the literal and the unconscious. Such images unleash an affective force that is not necessarily registered at a conscious cognitive level. Thus, they are an important means by which our genetic imaginations are stimulated and shaped.

For Van Dijck, the production of such images in popular accounts is 'always strategic' insofar as they work either to reproduce or to reframe dominant understandings of genetic science (1998:15). In particular, she notes the importance of plot and narrative structure in popularizations. Such rhetorical forms tend to endow scientific practice with a greater coherency and purpose in retrospect than may have been apparent to participants at the time. As narrated, the events appear to the reader as necessary stages leading up to the desirable

goal presented as the conclusion of the story. As Van Dijck points out, 'The power of narrative is that it serves as a mode of cognition without it being itself recognizable as an interpretive framework' (1998:15). Popular stories thus provide a framework within which new scientific projects can be assimilated to comfortable images of progress towards a better world. If there is an affective force inherent to narrative structure, then we might say that it is a conservative one insofar as it acts to close down the potential for the new to emerge. Popular narratives tend to confine genomic images, and to restrict their ability to produce unforeseen connections and ideas in relation to natural and social orders.

I think it would be a mistake, however, to see the images produced in popular texts as necessarily always consciously deployed or under the control of their authors. Aside from the overt politics involved, it may be of interest to consider how the social and historical situation of genomic popularizers, including the language they inherit, effects the images generated by their texts. The role of metaphor in scientific discourses and practices, for example, is a topic that has been much discussed in recent years, and is also one which opens up questions of the historical and social structures at work in the present constitution of scientific knowledge. As noted above, biblical or religious metaphors, in particular, are often employed in popular texts on genomics. Invocations of the 'book of nature' or the 'holy grail' serve to assert the importance of genetic science, and to affirm its rightful claim over the 'secret of life'. It is also important to note that while metaphors (like the narrative structures in which they are embedded) allow for the understanding of scientific concepts that may be difficult

to conceptualize, they do so in ways that almost inevitably refer back to conventional modes of discourse. To read the 'book of nature', or to decipher the 'code' of life, is implicitly to attempt the recovery of something. While the past may also be a resource for the future, we can again recognize a certain bias against the emergence of the new in the language of popularizations.

This raises an apparent paradox when it comes to the conceptualization and public profile of the HGP. Although it is regularly purported to be a revolutionary breakthrough in science, the way in which the metaphors of 'code', 'map', and 'language' tend to be employed in genomic popularizations implicitly draws us back toward a time that is figured as more certain, more stable, and more orderly. They reinvigorate older concepts, rather than anticipating the future. Even as genomics draws its conceptual resources from an informatic discourse that increasingly emphasizes feedback loops, self-reflexivity, and complexity, popularizations of the HGP have dulled the critical edge of such developments by reinvigorating older concepts that do not open up the prospect of the future. As Van Dijck comments, 'From the new digital context of the genome as a 'computer program' you would expect a digital upgrading of metaphors relating to 'information' and 'networks'. Instead, information pops up consistently in relation to conventional notions of language and reading' (1998:128). In this popular image of the HGP, biological information lies inert within the body, ready and willing to offer itself up to the gaze of the scientist.

A metaphorical impulse towards the domestication of genomic science can also be observed in the way that popular authors tend to figure the driving force

behind the genome project. Popularizations of the HGP frame it almost entirely in medical terms, placing most emphasis on the project's potential for combating disease (Van Dijck, 1998:120). The popular discourse associated with the HGP, and with contemporary genomics more generally, characterizes biotechnology as a tool that will enable scientists to cure disease by making 'corrections' to the genetic code. Genomic science is primarily figured as a restorative endeavor, which will lead to the recovery of health or to the full realization of human potential via the uncovering of a hidden ground plan underlying life. At the same time, this notion of reading the human genome as a prelude to restoring natural order also carries onto-theological overtones, and may be placed within the long tradition of natural theology that runs back to Linnaeus' sexual system of plant classification. Genomics, from this perspective, is resolutely onto-theological. Its religious metaphors draw us back to the type of Christian, (hetero)sexual metaphysics associated with eighteenth-century natural history, and in this sense it tends to close down the space in which a new understanding of nature and its relation to the social might emerge.

In what follows, I consider several recent popularizing books that purport to explain the genome project and its implications to the general public. While an emphasis on the restorative potential of gene therapy – its promise of salvation from the limitations of our bodies – has always been the chief means of establishing public support for the HGP, my interest is not so much in the way that these popularizations construct the HGP in medical terms that emphasize genetic determinism; rather, I try to bring out certain conservative themes that

run throughout each of these texts, and to show how they construct a very 'chaste' image of genomic science that serves to reproduce existing social structures. While none of these popularizations thematize issues connected to 'sex', my argument is that we need to recognize the way in which the exaggerated claims of these popular texts actually serve to obscure their reiteration of the conventional, which, in turn, serves to reproduce an unexamined account of the 'nature' of gender and (hetero)sexual difference.

Narratives of a Genomic Revolution

As the HGP was nearing its end, a number of authors – both scientists and science journalists – sought, once again, to convey its significance and meaning to the public. The early days of the project had been marked by a number of popular books that attempted to generate public interest in the HGP, and to justify its vast expense with speculations about the knowledge that would be gained, and the medical advances that would surely follow from the complete sequencing of the human genome. Now, as the final strands of DNA were being put in order, the need for justification and the potential for profit again called forth a new wave of popularizations. A number of questions immediately arose: What had been found? What did it all mean? Was the original promise of the HGP fulfilled?

These popular authors now had a new, yet very familiar, concept upon which to structure their narratives: a race. The HGP, which had begun with a spirit of international collaboration unusual in the world of biology, had turned into

a competitive struggle between the publicly financed project and a private company called Celera Genomics led by the biologist Craig Venter. Formed in 1998 with the expressed purpose of being the first to sequence a human genome, Celera also intended to patent certain gene sequences that potentially could lead to the development of new pharmaceutical products. The acrimonious competition that developed between these two organizations provided an ideal plot device for popular accounts to work with. The impression of a race, and the high public profile it had already gained through the news media, created a pervasive common sense that something of momentous importance was at stake.

The first, and probably most widely read book to hit the market was Kevin Davies' *Cracking the Genome* (2001), which styled itself as the inside story of 'the race to unlock human DNA'. Davies, a former molecular biologist turned science journalist and editor of *Nature Genetics* (a popular spin-off magazine from the leading science journal *Nature*), has an obvious interest in the promotion of genomics. His book exhibits the sort of uncritical endorsement of geneticists' claims that Van Dijck identifies in her study. Eschewing consideration of nongenetic factors, Davies confidently predicts that, 'The sequencing of the human genome will finally furnish researchers with the tools to find definitive answers to the perennial question: Are complex human traits governed primarily by nature or by nurture?' (2001:235). On offer is certainty and security, as knowledge of the genome will apparently simplify the human condition and allow us to take control of our lives.

Davies' narrative frames the genome sequencing projects as technological achievements that bring molecular biology into the world of large-scale, computer-based, quantitative science. At the same time, however, his story hangs upon the individual agency of the geneticist rather than on the way in which technology shapes biological enquiry. Specifically, Davies casts Venter as the hero in a drama that pits a pioneering scientist, who recognizes the great potential of new technologies, against a conservative scientific establishment. Hence, we read that, unlike traditional biologists, 'Venter had always placed a premium on computational analysis' (2001:143). Yet, when he tried to pursue an innovative computer-based approach to genome sequencing '...the NIH reject[ed] his funding request; the reviewers had considered the task of identifying almost 2 million letters of DNA impossible' (2001:106). The narrative structure of the text follows Venter as he overcomes obstacles in pursuit of his vision. The complicating factor, however — one which always threatens to undermine this image of Venter as a heroic figure striving to discover new genes that will lead to medical breakthroughs — is his association with private capital and for-profit companies that seek to patent genetic sequences. To dispel the negative connotations associated with this competing image, Davies emphasizes both the passion for medicine that Venter acquired while serving in the Vietnam war as a young man, and the way that he was continually turned down for funding by government agencies that did not appreciate the brilliance of his ideas. In this picture, it is the shortsightedness of the state-run HGP that drives Venter into the arms of venture capitalists. Venter, we are told, wanted to move

faster than the official HGP schedule and requested funding to do this, '...only to be repeatedly frustrated by government bureaucracy and skepticism toward automated DNA sequencing' (2001:55). That faster is always better is an unchallenged presumption, for Davies implicitly equates faster sequencing with curing disease sooner.

The overall effect of Davies' narrative is to isolate the essential nature of scientific enquiry from all social factors. This essence is channeled through the person of Craig Venter, who 'almost single-handedly transformed the odyssey to obtain the sequence of the human genome' (2001:52). From this perspective, scientific institutions and other forms of social organization serve only as barriers to the innovative work of unique individuals who are called to create history by something deep inside of them. Davies pays no attention to the work of science studies scholars such as Knorr Cetina or Latour, who have revealed how much the production of scientific knowledge depends upon social networks, machineries of knowledge production, and the social construction of natural 'facts'. Nor does he acknowledge the critiques that feminists have mounted against the gendered dimensions of science. Aside from disgruntled biologists who are represented as standing in the way of progress, Davies' only acknowledgment that the HGP has its critics comes in the form of a brief mention of Lewontin's criticism of 'DNA fetishism'. This is quickly dismissed, however, as merely a critique of the language used by HGP promoters, rather than something that implicates the science itself. This again reflects the separation of science from society that is a consistent feature of the popular literature on the HGP.

We find an almost identical narrating of the story of a geneticist-hero, who struggles against bureaucratic obstacles in order to reach an important scientific goal, in Ingrid Wickelgren's popular account of the HGP entitled *The Gene Masters* (2002). She, too, emphasizes the role of pioneering anti-establishment figures who are willing to take up new technologies and drive science forward into the future. Venter is again the hero of the story. Wickelgren, a science journalist, speculates that, 'Perhaps he was born with an unusual temperament that can usher revolutions' (2002:18). Venter is described in terms that emphasize his status as an outsider: 'Prickly, rebellious, and impatient, Venter never fit comfortably into the scientific establishment' (2002:259). As in Davies' account, this characterization of Venter feeds upon an idealized and romantic image of the lone scientific 'genius' detached from society and the ways of ordinary people. It builds upon, and builds up, an image of (true) science as a mysterious practice possessing privileged vision into the truth of nature.

In contrast to this individual genius at the heart of scientific progress, institutional science is characterized as rife with timidity, rigidity, and petty politics. In Wickelgren's story, it is Francis Collins, the head of the HGP, who stands in for the conservatism of the scientific establishment. He is introduced to readers as a man who '...had found it far easier than Venter to work within the confines of the system' (2002:28). Moreover, '[Collins] was popular among his NIH-funded colleagues in the genome project because he was friendly, unpretentious, and unlikely to challenge the status quo' (2002:99). In contrast to Venter's grand vision of the future, 'Collins also represented the pinnacle of success of small-

scale biology' (2002:99). Wickelgren's narrative reinforces the myth that real science lies in the extraordinary rather than the mundane. Like Davies, she places much emphasis on the technology involved with bringing the HGP to fruition, but, again, the machineries of knowledge production are cast here in merely instrumental terms. The focus is upon the scientists whose vision allows them to recognize the potential uses to which new technologies may be put. Hence, although her narrative appears to evoke the future, it is really to a past image of science that she draws us.

Wickelgren also has to rescue her hero from his potentially damaging association with the unseemly and apparently unscientific world of venture capital and profit. Venter's efforts to distinguish his nonprofit research center, The Institute for Genomic Research (TIGR) from its for-profit financial partner, Human Genome Sciences (HGS), are accordingly reinforced in *The Gene Masters*. Hence, while 'Venter's academic colleagues accused Venter and TIGR of playing a nasty game in which they hid their data for commercial gain', in reality 'Venter begged for better terms at almost every HGS board meeting. But the board, composed mostly of businessmen, was unsympathetic' (2002:77). By presenting Venter as a man who had to suffer rejection by the shortsighted bureaucrats that administer the mundane activities of science, and who was thereby driven to private capital by his scientific vision and desire to cure disease, Wickelgren implicitly constructs an image of a pure science that stands apart from economy and society. Yet, the unstated implication that it is unusual

for a leading molecular biologist to be associated with a private, for-profit company is quite erroneous.

Indeed, the fact that research in molecular biology has become closely intertwined with the pharmaceutical industry over the past twenty years is the starting point for our third popular account of the HGP. Written by one of the British scientists involved in the genome project, John Sulston's *The Common Thread* (2002) (coauthored with the popular science writer Georgina Ferry) reads like a lament for the lost soul of biology. He looks back to the days of a (supposedly) pure science untainted by commercial considerations. The narrative here is one of good versus evil, framed in terms of the collective public interest versus private profit in a race to secure control of the human genome. In this version of the story, Venter is the villain, while Sulston himself emerges as the hero who defends the true scientific tradition that places knowledge above all else.

For Sulston, the complicity of biology and capital in the pursuit of private profit represents the beginning of a new era: 'But more importantly, and partly driven by genomics, biology had undergone an economic sea change – it now held the promise not only of tremendous knowledge and great benefits to humankind but also of fabulous wealth. As biologists we had lost our innocence' (2002:184). The complicated relations of molecular biology, economy, and society are acknowledged here, but only to the extent that they represent a debased version of science. As with Davies and Wickelgren, Sulston's account of the HGP effectively constructs science in itself as a pure endeavor, separate

from social, commercial, and political factors, and which has only now become corrupted through human weakness and greed. He argues, furthermore, that the intrusion of economics into science has led to the ill-considered equation of the latter with technology. Displaying a traditionalist sensibility, Sulston downplays the technological side of the HGP and argues that new technologies were not really required to get the job done (2002:265-6). Here, real science is definitely not techno-science.

In each of these popular accounts of the HGP, older images of a pure and noble science are conjured up and given new life as a means of producing an image of genomics that emphasizes its humanistic, medical promise. These popularizations exhibit much of the reductionist hubris that critics of the HGP have pointed to as evidence that the importance of sequencing a human genome has been overstated. Sulston, for example, claims that, '...the generation that really understands the human genome... will understand life' (2002:5). For Davies, the HGP represents '...perhaps the defining moment in the evolution of mankind' (2001:9). Moreover, 'The complete human genetic sequence will reveal the fundamental properties of all human genes, allowing their functions and interactions to be integrated into a miraculously complete picture of human biology and evolution' (2001:14). Similarly, Wickelgren describes the HGP as '...the culmination of a century of research into the human genetic code, a lengthy molecular treatise at the center of every cell in the human body that describes in detail how to construct a human being' (2002:5). These popular accounts of the HGP each create an image of genomics as the science of the

(very near) future, and as a tool that will allow human beings to take control of life itself. Very few doubts are raised in regard to the claims of geneticists, nor are we given any indication that the value of the HGP might be subject to any dispute. In this light, then, it would seem that the popularizers of genomics may indeed be found guilty of overstating its power, and of creating an overblown image of its potential impact.

From another perspective, however, we might say that such popular accounts are marked by nothing less than the very prosaic and conservative nature of their claims. In each of these texts, despite the hyperbolic language, there is nothing to suggest that discovering 'the secret of life' will really change the way in which we think about our lives. Fundamentally, these stories promise us more of the same – only that it will be better. Scientists will cure more disease, or, at least, (much more quietly) fewer babies with disease-causing genes will be born. While the HGP is characterized as the most important event in the history of biology, its impact is portrayed in ways that are designed to reassure rather than to challenge public perceptions of biology and life. If there is really a genomic revolution in the making, it is difficult to discern from its popular representations. Davies provides us with a good example of how the HGP is at once figured as completely new and yet reassuringly familiar:

For all the debates about whether the sequence of the human genome is more important than the splitting of the atom or landing on the moon, no previous technological accomplishment will have as profound an effect on human life. The explosion in genomic information fueled by the sequence will revolutionize the

diagnosis and treatment of countless diseases. We are on the brink of a new era in which individuals will be diagnosed and treated based on their genome, not their symptoms (2001:216-7).

No doubt, if we are indeed to scramble over the brink and into this new world, the effects will be considerable. Yet, is more effective medicine really all that is at stake in this 'revolution'? Or does contemporary genomics and biotechnology also open a path that leads toward different ways of thinking about bodies, about life, and about the relation of nature to society?

It may be that the narrative mode of presentation favored in popularizations is at least partly responsible for diminishing the intellectual and philosophic impact of the HGP. By representing the HGP as the culmination of a century of genetic research, these popular texts construct a narrative in which contemporary genomics is seen to follow logically from Watson and Crick's initial discovery of the structure of DNA, if not as a project already implicit in Mendel's original plant hybridization experiments. The linear structure imposed upon the events in these stories constrains their possible meanings and directs the reader's attention towards a predefined conclusion in which the object of knowledge is fully realized. Moreover, the completion of the HGP is itself implicitly figured as a step in a larger biological project of complete knowledge and control over life. Through all of this, the drama being played out is that of the realization of the scientific subject. The narrative mode slows down the flows of matter, energy, and information, and reduces the complexity of their interactions with different biotechnologies, thereby allowing for the construction of a knowing subject who

stands over against nature as object. The true subject of science, who possesses full knowledge of life, is present throughout the narrative as the predesignated end to which all events lead.

While issues of gender or sexual difference receive very little attention in popularizations of the HGP, there is little doubt that the scientific subject, or 'hero', who uncovers the 'secret' of life is figured in masculine terms. The masculine subject is one who reveals nature's secrets in order that he may take control of life and its evolution, and therefore ease his anxiety over disease, disorder, and death. This is implicitly acknowledged in Winkelgren's title – *The Gene Masters*. At once connoting masculinity and conferring control, the term 'master' keys into a discourse of (hetero)sexual difference that has structured the popular image of scientific enquiry running back at least as far as the eighteenth century. This is another way in which popularizations bear the weight of the past even as they seemingly evoke the future. Van Dijck points out that gendered subject positions have always played a significant role in constructing popular images of genetics. She notes that, 'By virtue of their ascribed feminine characteristics, women hardly fit the category of "scientist" at all' (1998:24). It is not so much that men dominate these stories, however, as it is that the scientific subject position is defined in terms that evoke a complex of characteristics associated with masculinity, e.g. the imputation of rationality and the desire for control. The gendered subject in these genomic stories is not produced through the construction of a common identity between men or masculinity and science, but rather through a common form of desire to which each responds. Both

modern gender concepts and biological science rely upon an implicit understanding of nature that is structured by a discourse of natural (hetero)sexual difference. This concept of natural order is what allows each to establish a basis for control over the diverse expressions of life that confront it. Our question here is this, how is the conceptual status of 'sex' and (hetero)sexual difference affected by the HGP and its associated biotechnologies? What might contemporary genomics and biotechnology allow us to think in regard to nature, and to the categories of sex and gender, that has previously been unthought? Is there a nascent alternative politics of sex waiting to be invented in the biotech age?

(Hetero)sex, Onto-theology, and the Politics of Nature

Although one or two commentators such as Franklin have suggested that contemporary genetic science allows for 'promiscuous' couplings that challenge the normative force of gender and sexual categories, popular literature on the HGP and genomics has remained conspicuously silent on this issue. This silence may be a reflection of the fact that biological thought has always had a fundamental investment in a quasi-teleological narrative of (hetero)sexual difference as the basis for organic life. Indeed, the lack of both popular and critical discussion about 'sex' in relation to the bioinformatic body can perhaps be attributed to this unquestioned sexual presumption underlying the reproduction of DNA and genetic 'code'. We can, however, catch a more explicit glimpse of how the discourse of (hetero)sexual difference is employed to reinforce a conserva-

tive politics of nature if we turn to another popular text, Matt Ridley's *Genome* (2000), which is perhaps the most widely read and referenced work on the implications of the HGP. Ridley, a very successful popular science writer and former editor of *The Economist*, takes the HGP as a fulcrum for propagating a narrative of evolutionary biology and psychology that features many of the same characteristics that we have identified in other genomic popularizations. His introduction leaves readers in no doubt about the great importance that should be attached to the HGP:

Being able to read the genome will tell us more about our origins, our evolution, our nature and our minds than all the efforts of science to date. ...I genuinely believe that we are living through the greatest intellectual moment in history. ...until now human genes were an almost complete mystery. We will be the first generation to penetrate that mystery (2000:6).

As with the popularizations examined already, it is apparent that the grandiose claims of geneticists will not be held up to critical scrutiny here. Ridley's language is reminiscent of eighteenth-century natural history, both in terms of reading the 'book of nature', which is presumed to divulge its secrets willingly to the scientist whose technology enables him to see what had formerly lain hidden, and in terms of the gender of that scientist who 'penetrates' the depths of nature. Yet, for all the extravagant claims made in the name of contemporary genomics, once again we will find that there is actually very little on offer here that might give credence to these bold assertions.

First of all, Ridley has his own brand of scientific purity to defend. Throughout his text, he argues that science is corrupted whenever it comes into contact with either the State or any ideology that seeks to promote collective interests over those of the individual. Yet, while the liberty of the individual is paramount for Ridley, it turns out that the 'individual' is not as *indivisible* as it first appears. Somewhat paradoxically, throughout *Genome* Ridley attempts to buttress individual liberty by locating its basis at the sub-individual level. His strategy is to try and demonstrate that the genome is something like a 'free' market, where there is competition among genetic factors and only the fittest survive, and then to argue by analogy to human social life, relying upon the implicit presumption that what is natural is good. Ridley draws upon Richard Dawkins' concept of the 'selfish gene', but goes further to argue that what most geneticists refer to as 'junk' DNA can be thought of as 'selfish DNA'. Junk DNA, which refers to the roughly 97% of the genome that is thought not to contain any genes, is not known to have any purpose, but this lack of knowledge does not prevent Ridley from attributing a selfish desire to it. Combining selfish genes and selfish DNA, he conjures up an image of individual self-interest, or 'selfish exploitation', which attributes a basic state of competition to the chemical fundamentals of all life (2000:127). Taking off from this molecular base, Ridley performs numerous leaps of logic in translating the genome into exemplary forms of social organization. Throughout his text, genetic differences are effortlessly transposed into parables of idealized social order. To take one example:

But who or what controls these genetic differences? The truth is that nobody is in charge. It is the hardest thing for human beings to get used to, but the world is full of intricate, cleverly designed and interconnected systems that do not have control centers. The economy is such a system. The illusion that economies run better if someone is put in charge of them – and decides what gets manufactured where and by whom – has done devastating harm to the wealth and health of peoples all over the world... (2000:151).

Given the subtext of evolutionary biology that underlies Ridley's text, with its predilection for attributing any and all behaviors to a certain reproductive imperative, we might find this assertion that there is no overarching center of control to be somewhat ironic.

Nevertheless, if all is indeed a matter of decentralized competition, then we might begin to wonder about what it is that holds an organism together. How does the organizational level at which 'individual' choice may be exercised arise? As it turns out, it is that mysterious biological entity called 'life' which is largely responsible for the individual's coherence. Life, according to Ridley, is characterized by 'the ability to replicate and the ability to create order' (2000:12). Quoting Schrödinger, Ridley claims that, 'living creatures "drink orderliness" from the environment'. The key to organic life is the biological 'information' that allows living beings to create and reproduce order out of 'the random chaos of the world' (2000:12). At the intersection of these two abilities (or desires) for order and reproduction, however, we find a dual discourse (ontology and action) of (hetero)sexual difference that effectively holds everything together. The

information that really matters is located in a pre-existent sexual order that is somehow embodied in the genome, which, for Ridley, is the bearer of digital information. Echoing the metaphors of computer science that helped fashion molecular biology out of information theory in the 1950s, Ridley describes the genome as, 'a record of our history written in the code for a working machine' (2000:22). Just as a computer runs on digital information in the form of either a '0' or a '1', the genome is structured by opposing chemical bases represented by 'A' and 'T' or 'C' and 'G'. The notion that the biological information crucial for life exists in a dual, oppositional form that both attracts and repels its other lends itself easily to a reading that assimilates male and female, or masculine and feminine bodies to this digital informatic economy. A certain thought of (hetero)sexual difference is implicitly equated with the fundamental code of life that organizes bioinformatic bodies.

We can see this presumption of digital (hetero)sex as the representative of a natural informatic order at work in Ridley's chapter entitled 'Sex', where he discusses genetic 'imprinting'. This little-understood concept refers to differences in the functioning of certain genes depending on whether they have been inherited from the mother or father. As Ridley puts it, 'The gene "remembers" which parent it came from because it is endowed at conception with a paternal or a maternal imprint' (2000:208). Despite a prevailing climate of uncertainty, Ridley speculates that imprinting is 'another illustration of the selfish gene and of sexual antagonism in particular' (2000:210). Interestingly, this theory of sexual imprinting implies that cloning a mammal should be impossible as the resulting embryo

would lack either the maternally or paternally imprinted genes needed to 'compete' with their other and thus to ensure normal development. The birth of 'Dolly' the cloned sheep in 1997 is therefore characterized as another 'mystery'. This situation might have given pause to rethink the presumption of an unchanging (hetero)sexual order³, but for Ridley, it is simply an anomaly to be disregarded in moving ahead to his conclusion that 'The brain is an organ with innate gender' (2000:218). The jump from sexual imprinting to social gender is made via Ridley's anecdotal observation that his daughter likes to play with toy prams, while his son prefers tractors. Dismissing all social science research with the claim that it is only interested in denying any role for nature, he points out what is apparently obvious for all to see: 'Boys are more competitive, more interested in machines, weapons and deeds. Girls are more interested in people, clothes and words. To put it more boldly, it is no thanks only to upbringing that men like maps and women like novels' (2000:217-18). Here, Ridley implicitly draws upon one of modernity's most persistently gendered oppositions — that between science and art. The implication is that genomic maps promise knowledge that will deliver control and order to the masculine subject, while the novel places its feminine reader under another's authority. Yet, the plausibility of the very opposition between art and science is itself dependent on a historically specific division of knowledge production that arises concurrently with modern gender categories in the West.

The truth of genetic imprinting, whatever it may be, is not what is at issue here. What I am interested in examining is the way in which the allegedly

revolutionary science of genomics produces such conservative, prosaic thinking, which returns us to the past rather than imagining new possibilities for the future. Ridley's 'Conflict' chapter on 'sexual antagonism' between the X and Y chromosomes provides another good example. The topic here is the evolution of sex-determining genes. According to Ridley, when the sex-determining gene first evolved in males, 'The gene soon attracted to its side other genes that benefited males: genes for big muscles, say, or aggressive tendencies. But because these were not wanted in females – wasting energy they would prefer to spend on offspring – these secondary genes found themselves at an advantage in one sex and at a disadvantage in the other' (2000:109). That genes for certain characteristics are to the advantage or disadvantage of a 'sex' depends, of course, upon their place within a particular narrative that moves toward a certain goal – in this case, it is a quasi-teleological narrative of (hetero)sexual reproduction that encompasses both genetic information and organic bodies. Ridley, however, extrapolates further from this account of sexual antagonism at the molecular level in presenting his readers with the following analysis of gender relations:

Suddenly it begins to make sense why relations between the human sexes are such a minefield, and why men have such vastly different interpretations of what constitutes sexual harassment from women. Sexual relations are driven not by what is good, in evolutionary terms, for men or for women, but for their chromosomes. The ability to seduce a woman was good for Y chromosomes in the past;

the ability to resist seduction by a man was good for X chromosomes in the past (2000:115).

This, apparently, is the bold new future that the human genome opens up to us. My point here is not that nature has nothing to do with sex and gender, but rather that the prejudices of evolutionary biology are being passed off as the horizon of a new genomic future.

It is at moments like this, and at many other times throughout *Genome*, that Ridley sounds very much like the genetic determinist he vehemently denies to be. His repeated denials of this label lead him, in the end, to the same question with which Schrödinger concluded his *What is Life?* – the question of human freedom. Ridley's problem is that he needs to reconcile his belief in individual freedom, and thus responsibility, with his subindividual account of genetic forces that construct bodies as they see fit. To achieve this goal, he needs to find a non-genetic origin for free will that will not invalidate the metaphysics of nature underlying his account. Remarkably, his solution again echoes Schrödinger as he turns to physics in order to explain the existence of biological freedom. Rather than quantum theory, however, it is chaos theory that provides Ridley with a crutch. As he explains it, 'the theory holds that even if you know all the determining factors in a system, you may not be able to predict the course it will take, because of the way different causes can interact with each other' (2000:311-12). Freedom is apparently generated in the unpredictable space where genetic and external influences interact. How the individual may be said to have control over such free events is not entirely clear however. Ridley's best

effort at an explanation – ‘Freedom lies in expressing your own determinism, not somebody else’s’ (2000:313) – seems to obfuscate rather than clear up the question. In the end, Ridley again enlists genetic factors to reconcile his concept of freedom with his political and economic philosophy: ‘The single-minded obsession of the genes to do the determining in their own body is our strongest bulwark against loss of freedom to external causes’ (2000:313). Finally, the belief that freedom is to be found within ourselves, rather than in our interactions with others, seems to be little more than an article of faith.

Indeed, ultimately, it is the Judeo-Christian heritage of the question of free will that interests me more here than the specifics of Ridley’s answer. We recall from chapter three that Schrödinger’s answer to the question of free will was the remarkable pronouncement that he identified himself and every other free being with God. Ridley, on the other hand, seeks to undermine any such thoughts of a divine secret behind life. Subtly, throughout *Genome*, Ridley’s language suggests that genomics and evolutionary biology has come to take the place of religion in explaining our world to us. The genome is compared with the Bible, or referred to as ‘scripture’. Yet, he is also quick to assert that it should not remain ‘sacrosanct’ now that we have the technological ability to alter it. Where the onto-theology of Ridley’s text really lies, however, is in the way in which it takes over the discourse of (hetero)sexual difference as a stable and secure ground underlying the organization of bioinformatic bodies and, indeed, of all life. At the same time, this reading offers a way to account for the persistence of the ‘pure’ science ideal in popularizations of the HGP, despite all evidence to the contrary. Like

transcendent experience in religion, faith in the existence of a pure, undefiled science allows us to imagine leaving behind the limitations and anxieties of our social existence. While attributions of purity to biological science allow for faith in a transcendent realm of certainty and truth, the discourse of (hetero)sexual difference similarly assuages anxieties over the authority of nature in the context of contemporary genomics and biotechnology. In many respects, popular accounts of the HGP have to balance the promise of genomics with the insecurity that it generates, and this is where onto-theology comes in. Many of the overblown claims found in popularizations evoke a transcendent authority even as they are undermining the natural order of things. This paradox is often sustained by conjuring up familiar religious images. For example, Davies (2001) evokes the theological with chapter titles – ‘Reading the Book of Life’, ‘The Eighth Day’, and ‘The Language of God’ – that actually bear little relation to the discussion therein. These headings implicitly situate the future within the reassuring tradition of the past and serve to confer authority upon the pronouncements on nature and life that are put forward. Davies flips back and forth between religious metaphors and confident assertions of how the genome shows us the evolutionary record of humanity, without ever feeling the need to address this implicit conflict, much less to try and reconcile the two sides. He is able to do this, I suggest, because the difference between the two approaches is more apparent than substantial.

Indeed, many theological scholars have seen the HGP as an opportunity to call modern science back to its Christian roots, and to bring science and religion

closer together again. Susan Thistlethwaite, for example, claims that ‘the HGP offers a way to overcome long centuries of opposition between religion and science. For the genome may be... “the Book of Life”’ (2003:1). Both the Christian concept of ‘the Word of God made Flesh’, and the belief that the HGP has shown that all life can be traced back to an original text, provide the basis for a certain reconciliation between biology and theology. Yet, the onto-theology of HGP popularizations does not come from an embrace of religion. On the contrary, it is often through the appearance of opposition and difference that sameness is established. Near the beginning of Sulston’s book, for example, he notes that his father was a minister in the Church of England in order to set the scene for an explanation of how he embarked on his scientific path by rejecting his Christian upbringing: ‘I think many scientists have felt that: a sudden overwhelming sense of the power of the human mind. It forces you to look at beliefs based on articles of faith and say, “These don’t really measure up; sorry”’ (2002:15). By setting up an opposition between science and religion, Sulston positions his biology as an onto-theology that usurps the place and role that Christianity formerly had in explaining the origin and fundamental nature of reality.

Another good example of the way in which biological thought relies upon religion even while appearing to disparage it can be seen in James Watson’s popular book, *DNA: The Secret of Life* (2003). Watson, co-discoverer of the molecular structure of DNA with Francis Crick, also establishes his rejection of religion in the introduction to his text. Somewhat optimistically, he states that,

`Our discovery put an end to a debate as old as the human species: Does life have some magical, mystical essence, or is it, like any chemical reaction carried out in a science class, the product of normal physical and chemical processes? Is there something divine at the heart of the cell that brings it to life? The double helix answered that question with a definitive No' (2003:xii). It is not so much that Watson is incorrect in his assessment of whether such debates have ended, what is of greater interest is that the debate continues within his own text. Not only does he begin by, once again, banishing the `various forms of vitalism', he also returns to the issue in the final pages of his text. There, he worries that because our understanding of how DNA works is as yet incomplete, some elements of vitalism persist. In the end, Watson expresses the hope that, `Our DNA, the instruction book of human creation, may well come to rival religious scripture as the keeper of the truth' (2003:404). This continually perceived need to distance vitalistic and religious concepts is characteristic of the history of biology, to the extent that we may be entitled to ask: What would biological thought be without this gesture of refusal? Vitalism and the `mystery' of life appear as the unconscious thought of biology, forever returning to threaten disruption. Especially troubling for biological thought is the vitality of life expressed through `unnatural' sexual couplings. Indeed, it may be that the explicit rejection of theology serves as a cover for the unacknowledged incorporation of an onto-theological, quasi-teleological (hetero)sexual narrative of life.

While the ideal of a pure science plays into the reproduction of the existing social order, the analysis of genomics and biotechnology in terms of ontology and (hetero)sexual difference points to tensions around the concept of natural order. The important point is that the characterization of a chaste, unmixed or undefiled science as presented in popular accounts of the HGP is precisely what must be undermined if we are to realize the potential of the bioinformatic body. Questions of sex and gender may be passed over in discussions of genomics only because they presume the existence of a natural reproductive order grounded in (hetero)sexual difference as the very basis of biological science. From a different perspective, however, the HGP might be said to open up new 'sexual' possibilities for the reconfiguration and transmission of biological information across the boundaries of individual organisms. The nature of the bioinformatic body is not at one with either itself, or with sociological categories of gender. My suggestion, therefore, that we read hegemonic images of contemporary genomics with an eye for the possibilities of an alternative sexual politics of nature. Finally, in this chapter, I pursue one possible approach to this project by returning to the issue of technovision in relation to the HGP.

Visions of Technoscience

One of the challenges in thinking through the impact of the HGP involves the necessity of drawing together and articulating the many discourses informing technoscience. The attempt to engage with genetics and biotechnology from a number of different perspectives might also be said to characterize the work of

Donna Haraway, which perhaps provides us with a good reference point in attempting to collect our thoughts on the ground covered so far in this chapter. Haraway's *Modest_Witness@Second_Millennium.FemaleMan@_Meets_Oncomouse*TM (1997) brings insights from the fields of science and technology studies, feminist science studies, and social criticism of science to bear upon both popular and scientific representations of biological technoscience. Along with Latour and Knorr Cetina, Haraway insists that nonhumans be included in any analysis of the social relations of technoscience. She argues that facts are not simply uncovered via a neutral or scientific method, but come into being via complex material-semiotic networks. As with other feminists, she is interested in interrogating the co-production of gender categories and modern science. And along with Lewontin and other social critics, she draws attention to how the reductionism of contemporary genomics and the circulation of biotech commodities feed into capitalist accumulation strategies. In addition to these perspectives, however, Haraway also draws our attention to the important role that visual technologies play in the constitution and reproduction of knowledge in the life sciences. This is the point that I wish to emphasize here. I want to consider why it is that Haraway is drawn to the visual when it comes to articulating the intersection of gender, technology, political economy, and the production of scientific knowledge.

We may begin by noting that it is an optical figure — the 'modest witness' — that brings together the different strands of Haraway's analysis of technoscience. Where the concept of a 'witness' invokes the values of presence and

visualizability, the modesty of modern scientific culture is found in the peculiar way in which it discounts itself in the process of observation. For Haraway:

This is the culture within which contingent facts – the real case about the world – can be established with all the authority, but none of the considerable problems, of transcendental truth. This self-invisibility is the specifically modern, European, masculine, scientific form of the virtue of modesty. This is the form of modesty that pays off its practitioners in the coin of epistemological and social power. This kind of modesty is one of the founding virtues of what we call modernity. This is the virtue that guarantees that the modest witness is the legitimate and authorized ventriloquist for the object world, adding nothing from his mere opinions, from his biasing embodiment (1997:23-4).

Through its modest culture of self-invisibility, Haraway argues, modern science has claimed for its own a view of the world previously reserved for God. Her figure of the modest witness – the self-effacing masculine subject who testifies to the purity of scientific knowledge – articulates (hetero)sexual difference, onto-theology, and technovision in a way that allows us to experience their co-implication in the production of scientific knowledge.

What I would like to point out here is that the figure of the modest witness could well be understood in terms of the nineteenth-century proto-photographer. Both are men who desire to take control of their world by calling on nature (in the place of God) to step forth and report upon its own condition via a 'modest' visual technology that withdraws itself from the image thus revealed. The question

before us is that of the relation of this modest culture of 'photographic' science to present-day genomics and to our biotechnological future. For Haraway, contemporary genomics is a site where contemporary struggles over scientific vision are contested. Like many other critics of the HGP, she provides us with a critique of gene fetishism grounded in Marx's classic theory of commodity fetishism. At the same time, however, she reads the artifacts of biotech culture within a particular historical context – that of 'the love/hate relation with apocalyptic disaster-and-salvation stories maintained by people who have inherited the practices of Christian realism...' (1997:43). Haraway argues that 'the "human genome" in current biotechnical narratives regularly functions as a figure in a salvation drama that promises the fulfillment and restoration of human nature' (1997:44). It is the authority generated by this narrative structure that allows the gene to appear as a fetishized figure promising us salvation. Looking to the ends, rather than the origins of human being, this is another take on the onto-theology of genetic discourses. Here, the gene appears as a 'thing-in-itself', a form of 'pure being', or a fetish. The modest witness mistakes genome mapping for a simple unveiling of what is – he desires a 'photograph' that will reveal the truth of nature. In this way, gene fetishism answers to both masculine and scientific desires by making life seem 'clear and under control', and by generating a knowing subject that is in control even as it ostensibly defers to its object.

This is not merely a matter of biological reductionism, however, for a fetish represents a displacement of desire. Faith in DNA as the essence of 'life itself',

as an omnipotent and omniscient entity, may serve to fulfill a myriad of desires, both conscious and unconscious. Pointing to the many investments – libidinal, economic, epistemological, and political – that may be at stake in the production of biological knowledge, Haraway claims that gene fetishism represents an ‘odd balancing act of belief and knowledge’ (1997:146). We might say that this is a matter of *technological affect* – an articulation of technovision and unconscious desire. Perhaps this is no better illustrated than when it comes to affirming (hetero)sexual difference. Here, *appearances* are perhaps able to substitute for the more complex interactions that produce them because they satisfy the gendered desires for a secure and stable natural order that is both under control and yet still an ultimate source of authority.

As an alternative to the concept of the modest witness, to the self-certain mode of seeing that withdraws itself in order to affirm the independent presence and autonomy of its objects, Haraway employs the optical concept of ‘diffraction’. Her strategy is to turn to ‘marked’ groups – those who stand outside of the white, middle-class, masculine standard – in order to uncover alternative perspectives that can generate forms of ‘situated knowledge’. For Haraway, it is through the eyes of such gendered or racialized others that we might diffract scientific vision and thereby produce patterns of difference that have positive consequences in the world. Curiously, she pays less attention to the ways in which technologies themselves might be sources of diffraction. In seeking to mutate the character of the modest witness, she focuses her attention on the location of the witnessing subject. While important, such an approach limits our attention to social and

cultural differences as they inform technoscience. Rather than focusing on the human observer, I wish to interrogate the role of contemporary visual technologies themselves in the production of both knowledge and non-knowledge in technoscience. The HGP has made it all the more apparent how reliant molecular biology has become upon technology in the production of knowledge. The automation of DNA sequencing technologies, especially techniques such as polymerase chain reaction (PCR) (for the amplification of regions of the genome) and electrophoresis (to identify the DNA thereby produced), were crucial to the success of the genome project, as was computer processing of vast amounts of data. Each of these technologies renders biological information into visual terms for the sake of ordering and comparing. The technovision of the HGP is ultimately based in the presumption that DNA 'codes' may be simply translated into standardized representations that may be read by a 'modest witness'.

We can note here that the status of visual representations in science has attracted a certain amount of critical attention from both feminist science studies and STS. Scholars of laboratory studies have uncovered the practical work that goes into producing the different types of scientific images that stand in for natural objects on the basis that they are agreed to be 'true' (Lynch & Woolgar, 1990). These studies contest the immediacy and transparency that is often attributed to visual technologies in scientific results. Indeed, Latour (1990) argues that modern scientific culture can be distinguished by a rationalization of vision and the creation of a space of 'optical consistency'. The main benefit gained via

this visual regime, according to Latour, is the greater mobility of images. Through visual translation across different sites, objects can be drawn into polemical situations and thereby used to settle disputes. For Latour, the history of science may be understood largely in terms of the invention of new technologies of visualization that enable the resolution of disagreements. Thus, the means of producing visual representations are inherently political.

Feminist critics are also concerned with the politics of visual representation, but more in terms of the ways in which technologies associated with scientific vision are dependent upon, and tend to reproduce cultural context. Notably, Lisa Cartwright's *Screening the Body* (1995) attempts to assimilate the dominant mode of representation in modern science to the history of cinema, and to analyze this scientific gaze in terms of its role in imposing gender categories and stabilizing sexual difference. Taking up a Foucaultian perspective, she claims that medical science has used cinematic technology to discipline, regulate, and reconfigure the human body. Whether it is the 'masculine fascination' with objectifying minute bodily organisms through microscopic cinematography, or the emergence of x-ray technology and its role in the fetishization of the female body, medical technovision is cast as a means of surveillance and control of feminine bodies. While this is a valuable perspective, we can also question Cartwright's identification of the biological gaze with a specifically cinematic technology. She locates the emergence of both forms of vision in the shift from natural history to biology in the early nineteenth century. For Cartwright, the interplay between the new field of physiology and the older practice of anatomy 'informed the filmic

elaboration of life as an entity that was both temporally and spatially constituted in modernist science' (1995:11). In her focus upon cinematic technology, however, Cartwright repeats a move common to many cultural critics – the characterization of photography as little more than a precursor to the moving image. Yet, it remains that photography, not cinema, provides the technological context for the emergence of biology and many other sciences in the early nineteenth century. Moreover, recent developments in biotechnology give credence to the suggestion that photographic vision remains of significant import today in the constitution of scientific vision.

One such development, which shares much in common with the HGP, is the Visible Human Project (VHP). This project, which was begun in 1990 under the auspices of the U.S. National Library of Medicine, sought to construct a digital image database representing typical male and female adult bodies. Like the HGP, the VHP was funded by the National Institutes of Health, and aimed to provide a complete and universal picture of the interior of two generic human bodies. Rather than a genetic map, however, the VHP sought to construct a visual anatomy of the body through photographic and other visualizing technologies (specifically, computed tomography, still photography, and magnetic resonance imaging). The results of the project – the Visible Man and the Visible Woman – were made available via the National Library of Medicine's website in 1994 and 1995, respectively.

In her study of the VHP, Catherine Waldby (2000) draws on Heidegger's theory of modern technology in order to explain the way in which the project 'en-

frames' human bodies. From this perspective, the technovision of the VHP reveals the human body as a bioinformatic 'standing reserve' that is always available for technical manipulation. Waldby also points to the way in which technoscience is linked to both visibility and masculinity:

This bringing-to-stand of the natural world as object takes place through the primacy of the visual which characterizes scientific knowledge, the dependence on visual ordering and remote sensing which distinguishes scientific knowledge from, say, philosophical knowledge. ...This visibility is set up by the organization of modern technology which addresses the world *as picture*, and addresses the subject of technology, that is 'Man' as observer, one whose understanding is played out in and as vision (2000:30).

The VHP, with its goal of creating a visual archive of *the* male and female human bodies, takes its place within a tradition of anatomical representation which, like eighteenth-century natural history, privileges the visual as a sign and guarantee of an underlying order and authority. Like the HGP, the VHP alludes to a narrative based in the recovery of a lost of origin, and its two representative bodies have often been referred to as the new Adam and Eve. As Waldby points out, 'One of the historical functions of the deployment of Adam and Eve as anatomical figures is to place them as temporal norms, original, perfect bodies from which all other bodies depart as variation and degradation' (2000:116). Again, there is the conjunction of (hetero)sexual difference and Christian

tradition, and the suggestion of an onto-theological desire guiding contemporary biotechnologies.

Waldby characterizes this biomedical imaginary as being governed by a form of iatrogenic desire that continually disrupts the stability of life even as it idealizes stable, self-identical entities. While iatrogenesis usually refers to the pathological side effects of a medical intervention, Waldby employs the term 'IatroGenic desire' to characterize '...the desire to create, not disease, but rather kinds of bodies which are stable, self-identical entities rather than fields of perverse contingency' (2000:118). Waldby figures this desire as a 'reaction formation' that seeks to negate the contingent and unpredictable results of biotechnical interventions into the complex networks of bodily life. If early photography is a reaction to the newly recognized historical contingency and complexity of nature at the end of the eighteenth century, then the VHP perhaps stands as a 'photographic' response to the condition of nature under the sway of bioinformatics. The implication, to which I shall return, is that the computer is today a biotechnological 'camera'.

In Waldby's formulation of IatroGenic desire, we can also hear an echo of a common criticism that many feminists have leveled against technoscience – that it employs a peculiarly masculine form of vision. The gender attributed to IatroGenic desire is apparent in Waldby's comment that, 'The VHP is pornographic in the sense that it gives an exhaustively visualized form to IatroGenic desire.... it is a picturing of this desire which claims to leave no recess beyond the reach of the medical gaze, to show "everything" in an excess of

spectacle' (2000:114-15). As noted in chapter two, pornography can be seen as answering the need to affirm (hetero)sexual difference through visual representation, and this pattern is repeated by the VHP's own 'pornographic' staging of (hetero)sexual difference. As is often the case, however, Waldby's account leaves the connections between 'photographic' vision, masculinity, and technoscientific desires as merely implicit, assumed but undertheorized.

This issue is taken up, in a more explicitly feminist mode, in Sarah Kember's *Virtual Anxiety: Photography, New Technologies and Subjectivity* (1998). Kember has no qualms about identifying the normative subject of both photography and science in masculine terms, nor of characterizing their common object as nature exemplified by the female body. For her, the basic function of photography is to alleviate the anxiety of a masculine subject when faced with an object that is perceived as difficult to control. Kember argues that the photograph may be considered as a fetish object insofar as it is 'used as a way of defending the subject against a perceived threat, or of compensating the subject for a felt or imagined loss' (1998:27). Indeed, ever since its emergence in the early nineteenth century, photography has frequently been figured as a response to loss and the passing of time. As in Haraway's account of gene fetishism, the photographic object is here presumed to restore a sense of wholeness and presence that allows the subject to feel as though he is in control.

For Kember, both the VHP, with its digital image archive, and the HGP, with its technologies for imaging the molecular elements of human life, embody the continued presence of 'patriarchal fantasy' and its concurrent anxieties in

contemporary science. More specifically, she argues that these new technological projects perpetuate a masculine science that is voyeuristic and seeks to know and control the fecundity of nature for the purposes of maintaining power and reproducing male privilege (1998:87-95). The difficulty with Kember's position, however, is that it appears to rely upon an ahistorical concept of (hetero)sexual difference that stands outside of science and technology. Hence, there can be no consideration of the ways in which contemporary imaging technologies, in concert with new biotechnologies, might produce different possibilities for the relationship between gender and scientific knowledge. The digital image is here merely another means of control, another visual ploy to allow men to claim the power of autonomous creation for themselves.

Waldby, by contrast, is alert to the potential that both the VHP and the HGP may hold for undoing the old presumptions that underlie conventional gender politics. Notably, she points to the way in which each project implicitly raises questions over the very status of human being: 'The *project* of these Projects ... is to address the category of the human, not in the first instance as a social *subject*, but as driven organic matter, as organ-ism' (2000:38). From this perspective, human life is continuous with other forms of organic life. As a challenge to the limits of a species, which are conventionally defined in terms of 'sex', this move is also likely to unsettle normative (hetero)sexual relations. As the focus grows sharper, it seems as though the ontological distinctions presumed by both the VHP and the HGP become less certain. This is not only the case in regard to the human-animal divide, as the human-nonhuman

distinction is also put under pressure. As Waldby notes, 'Biotechnologies address and incite organisms as themselves technics' (2000:39). Hence, we might go further to say that the techno-genesis of the organic body — its inherent openness to biological information — decomposes that very body and throws the privilege of the organism into question.

If early photographers could not be sure whether it was nature itself or their cameras that were responsible for the appearance of the images before them, we might now identify a similar ambiguity that inheres within these new visualizing technologies of life. Although the intention of both the VHP and the HGP is to usher the human to full presence, the effect may in fact be quite to the contrary. For Waldby, each of these projects creates a spectacle that may be understood as 'posthuman' insofar as they allow us to catch a glimpse of the ways in which technoscientific forces can both produce and undermine the stability of the categories 'human' and 'nonhuman'. Paradoxically, the very successes of projects that aim to technologically reveal and order the human threatens to unleash the nonhuman, and to free the nonorganic from the body of the organism. As Waldby puts it, 'The possibility of the posthuman is not to do with the transcendence of the human, its replacement, but rather with the recognition and exposure of the networks of production which constitute human techno-genesis' (2000:49). Hence, our critical response to technoscientific projects such as the HGP cannot simply be a matter of rejecting their reductionism and grandiose ambitions for the control of life. Instead, it is a matter of trying to be attentive to the unarticulated possibilities that currently exist within

hegemonic theories and practices. In this regard, Waldby notes that, 'the HGP constitutes a tacit acknowledgment that all organisms are open systems which engage in transversal and intraspecies genetic exchanges as well as filial, species-specific genetic lineages' (2000:44). This is another way of saying that posthuman 'sex' might be more than what biology has generally thought it to be.

'...That Nature May Be Able to Represent Itself'

We began this chapter with Keller's suggestion that the HGP has challenged the doctrine of genetic determinism as much as it has reinforced it, and Waldby's work throws some light upon this contention. Now, finally, I want to try and locate the technovision of the HGP more explicitly within the history of visual technologies in biology. Again, Keller's work can be of assistance to us in surveying the terrain. In an essay entitled 'The Biological Gaze' (1996), she suggests that 'looking' into 'the secrets of life' always involves some sense of 'touching' that which is observed. Keller points out that technovision in biology has generally required the death of its object. Indeed, nineteenth-century visual technologies, such as the microscope, could not penetrate the cellular level of life without destroying the very object they sought to observe. Prior to the advent of photography, literal death was the only available means of extracting an object from the flow of time.

This situation began to change notably with the emergence of molecular biology in the second half of the twentieth century. With the development of plasmid 'vectors' or probes in the 1970s, the biological gaze seemed to become

at once more intimate, yet less intrusive. These genetic probes physically touched their objects as they were inserted into, and visually reported from within living cell nuclei by lighting up when activated. Looking was touching; touching was looking. Yet, although this form of touching did not require death, the resulting images were not simple impressions of life itself. As Keller remarks, 'What we see in these slides are the fingerprints left by the genes or gene fragments which, with the aid of viral vectors acting as prosthetic fingers, we have manually inserted into the cell's nucleus. Thus, what we see as we gaze at the secret of life is life already, and necessarily, transformed by the very technology of our gaze' (1996:120). Despite advances in visual technologies, representation could not stand as a pure expression of living nature.

In a more recent text on 'The Visual Culture of Molecular Embryology' (2002b), however, Keller is considerably more sanguine about the possibilities that contemporary biotechnologies allow for the 'direct observation' of molecular life. The cause of her optimism is to be found in the convergence of recombinant DNA technology and computer science, and the promise that the resulting visualizations allow biologists to 'see' molecular dynamics such as gene expression and protein folding. Computer-processed images, generated via technologies such as confocal laser scanning microscopy, have in recent years given new meaning to the tradition of visual observation in biology. As Keller notes:

Without question, [these new technologies] have brought about a renaissance of microscopy in the biological sciences. And with that renaissance has come a

renewed emphasis on the epistemological importance of what is still referred to as 'direct observation', even with the increasing reliance on computer reconstruction for making optical data visible. Indeed, even images that are not viewed through a microscope (and in some cases could not in fact be seen through a microscope) are taken to provide visual evidence. Seeing is believing, or so alleges the title of an increasing number of articles (2002b:229).

Just as nineteenth-century scientists wished to believe that photography would allow nature to appear before them in an unmediated form, contemporary technoscience appears to revive the desire for an 'unmediated' presentation of nature itself. In this light, perhaps the computer — insofar as it is a visualizing technology that strives to be adequate to the historical self-presentation of nature — may be regarded as the camera of the twenty first century. Indeed, photography is today becoming increasingly digital-based, so it is perhaps not surprising that the computer is asserting its claim to be the pre-eminent technology of image production. This move in itself might well be seen as the logical conclusion of the mathematical enframing of nature in modernity.

Reflecting on these digital images, Keller notes that, 'Such a conflation between the real and the virtual inevitably generates serious questions for philosophers, but such questions are surprisingly absent from the biological literature' (2002b:233). Perhaps even more surprisingly, questions of this nature are also absent from Keller's text. They are replaced by a cautious enthusiasm for this new form of technovision, which she describes thus, 'So lifelike can the animated spectacle be made to appear that it induces a powerful sense of

firsthand witnessing, the conviction that one is watching “life itself” (2002b:233). Are we, then, to be witness to the reinvigoration of the ‘modest witness’? Are the desires of the proto-photographers of the early nineteenth century, who wished that nature may be able to represent itself, alive and well at the intersection of molecular biology and computer science today? Keller is speaking here of the technovision of contemporary developmental biology, but what might be gained by critically examining the HGP in terms of ‘photographic’ vision?

As discussed in chapter two, photography is a technology of time. It offers us a visual field seemingly withdrawn from the temporal flow of life. Rather than the presentation of a simple past, however, the affective force and ‘traumatic’ repetition of a photographic image suggest a different, nonlinear ontology of time. We can compare this photographic ontology with the time of the genome, which also appears to contain the past and its repetition within a single image. Of course, the notion that DNA sequencing may be regarded as a photographic technology is not exactly novel. Van Dijck draws our attention to advertising slogans like ‘One-Hour DNA’, which aim to promote the sale of gene-sequencing machines (1998:139). It is now possible to take a digital photograph, or a ‘snapshot’, of one’s genome. Here, a trace of the object is withdrawn from the time of the body and presented photographically. Wickelgren is also drawn towards photographic metaphors in her popularization of the HGP: ‘Like footprints in the sand, mRNA disappears quickly unless scientists chemically preserve it in another form, like a photograph. In this case, the “film” is so-called cDNA, or “copy” DNA, a stable laboratory copy of our genetic shadows’

(2002:73). Such a description may seem apropos in view of the digital convergence of photography, biotechnology, and computer science. Perhaps of even greater import, however, is the common structure of desire that can be identified in the relation of both photography and the HGP to the self-presentation of nature.

Photography, to recall, first emerged in the early nineteenth century out of a scientific milieu that was marked by a crisis over the limits of representation. The discipline of biology also began to take shape at this time out of the ruins of natural history, which had collapsed as nature came to be increasingly viewed in terms of a new dynamism and temporality that disrupted the certainty and order of scientific knowledge. The transparency of the natural world to human vision had been thrown into doubt by the end of the eighteenth century, and the new object of biology – ‘life’ – was a furtive and invisible prey. Part of the reason that the life of nature became inaccessible to the scientist was the increasing scrutiny under which the physiology of human vision came to be placed. The subjective observer was cut off from objective knowledge by the materiality of embodied sight. Photography, on the other hand, as a technology that promised to augment the eye and to clarify vision, held the potential of restoring order by allowing nature to truthfully represent itself.

Born in this photographic era, biology has traditionally addressed itself to the visibly organized organism as the representative object of life. With the HGP, however, we are perhaps in a position to gauge the implications of the change of focus that has been growing steadily sharper since the time of Mendel. Although

we may consider the HGP to be the fulfillment of the project of molecular genetics, and, indeed, to be the realization of Mendel's ambition to uncover the universal at the subindividual level, it is not at one with modern organic biology. We can better understand the potential of genomic vision, I suggest, if we conceive of it as drawing its force from both the past and the future. On the one hand, like the desire animating early photography, the HGP expresses a wish to return to the certainties of representation that characterized eighteenth-century science. If the advent of photography expressed a widely felt desire to transcend the uncertainties of time and subjectivity, then the HGP reprises this move which sought to recover the divine vision associated with natural history. Like the project of natural history, the genome project seeks to nominate the visible, assuming that it presents itself to the technological gaze as a system of atemporal natural order. On the other hand, however, where natural history relied upon (hetero)sexual difference to guarantee the order it presumed to uncover, contemporary genomics does not have the same recourse. This is because it is concerned with life at the level of molecular information. Descending below the level of the organism, the HGP opens up the human being to the nonlinear genetic flows and biotechnological connections that owe no debt to the strictures of normative (hetero)sex.

In a situation marked by the pull of these two antagonistic forces representing the past and the future of biological thought, the HGP repeats the dynamic of nineteenth-century photography in terms of the successes and the frustrations of its scientific ambitions. As the speed of its resolving power increased, it found

that life was not quite as simple as had been presumed. As suggested in chapter two, this dynamic may in fact be seen as exemplary of modern technology as such. According to Heidegger, modern technology, as a mode of revealing both matter and energy, challenges forth nature as 'standing reserve' so that things may be ordered according to relations of identity and difference. At the same time, however, modern technology also *responds* to the coming to presence of nature in its originary openness to *technē*. Enframing – the 'essence' of modern technology – expresses the desire for a certain type of technovision that is as much given by nature as imposed upon it. Enframing figures human desire for a withdrawal from temporality and finitude, and for the fixing of objects within a well-defined and secure network of representations, but it also provides a concealed opening to freedom at the limits of its vision.

To conceive of the genome project in terms of photography or 'modern technology' is clearly not a great stretch. Like the early photographers of the nineteenth century, the molecular biologists behind the HGP sought a technology that would allow nature to be represented automatically. They wished to uncover, secure, and regulate the universal code of life by way of a visualizing technology that would reveal the molecular order of the human body. Yet, while this desire to classify is reminiscent of the eighteenth century, and retains its onto-theological qualities, contemporary biotechnologies do not merely aim to catalogue nature; instead, they are animated by a desire to take control of life and to reorder it. Thus, the images of the HGP point to the future as much as the past. The question is, just how different will this future be?

The desire for control of life introduces a certain tension into genomic science. Just as early photography deferred to the authority of nature even as it sought to capture its image, just as it gave itself over to the time of nature even as it sought to suspend it, so the HGP posits the genome as the ultimate authority over life even as biologists seek to usurp that power. Scientific photography in the nineteenth century sought certainty, knowledge, and truth through the technological revelation of nature. As we saw, however, this project led only to the appearance of a multiplicity of differences and details, which thus disrupted the en-framing of the picture; and this is arguably precisely where the HGP has left biological thought. According to Heidegger, this failure is the source of a 'saving power' that holds the potential for freeing our vision from enframing. Rather than rejecting modern technology, he suggests following it to the limits of its vision, to the place from whence it becomes possible to glimpse its own process of seeing, and thus to be able to recognize the biological object as an event taking place in its own time.

Lastly, we might note that the desire for control manifested by the HGP also reiterates the relation of masculinity to nature, self, and world. Yet, the frustrations of that desire never allow this parallel structure to coalesce into an identity. If the HGP figures the limits of modern technovision in relation to the natural world, especially with regard to the reproduction of gendered ways of knowing and being, then it may be that we are called upon to rethink the relations of biotechnology, (hetero)sexual difference, and nature. It may be that another

mode of vision is coming into sight. Such is the thesis that I will pursue in the final chapter of this dissertation.

Notes

¹ See chapter three for more on this period and the entry of physicists into biology.

² In making a case against the imitation of the natural sciences by the social sciences, Stanley Aronowitz and Robert Auch argue that, '...the legacy of scientism is not a particular set of methods but the very idea that the study of the world *requires* a method' (2000:712). Here, I am interested in raising the question of how this scientific desire for method, and the relationship to the natural world that it implies, relates to the desire for gendered identities.

³ This is a topic to which we shall return in the final chapter of this dissertation.

Chapter 5

Posthuman Sex: Cloning and Technonature

In crucial cases... repugnance is the emotional expression of deep wisdom, beyond reason's power fully to articulate it. ...The repugnance at human cloning belongs in this category (Kass, 2004:147).

But after having thus considered the *manifest* motivation of the figure of a 'double', we have to admit that none of this helps us to understand the extraordinarily strong feeling of something uncanny that pervades the conception (Freud, 1985:358).

If there is one issue that has taken center stage in public concern over biotechnology during the past ten years, then it is surely the prospect of cloning human beings. Popular plays, films, and novels have all been devoted to working through the anxieties generated by the idea that someone may become two (or more). Indeed, when it comes to the issue of cloning, we may perhaps say that it is as much a matter of aesthetics as it is of science. Both Leon Kass, former chairman of The President's Council on Bioethics, and Sigmund Freud suggest that the clone, or the double, invokes an affective response that goes beyond conscious thought and (scientific) reasoning. Cloning draws our thinking on technoscience towards a possible future that is fundamentally troubling in a way that is difficult to explicate in logical terms. As an exemplary representative of contemporary biotechnology, cloning finds itself always already given over to the nonscientific. Its meanings proliferate well beyond the laboratory.

It was 1997 when Dolly, the Scottish sheep, first propelled the science of cloning into our global consciousness. What was special about Dolly was that she had allegedly been cloned from a post-embryonic, differentiated cell, thus demonstrating for the first time that adult cells could be made to return to an undifferentiated state and to stimulate new life. This news appeared to tap into a deep pool of barely articulated anxiety. Alan Petersen notes that 'Dolly quickly became a symbol of the transgressive potential of the new genetics in general' (2002:73). In his study of how the news media portrayed cloning in the two years after Dolly's birth, Peterson found that 'News reports on Dolly and on human cloning thereafter deployed fictional descriptions of cloning as duplication or imitation, as mass production, and the like, rarely including commentary that questioned this depiction or raised questions about the validity of the Dolly experiment' (2002:85). He suggests that the lack of critical reflection, and the reliance on popular culture evident in the news media shapes the issue of cloning in such a way as to preclude any serious discussion of what is at stake. Undoubtedly there is some truth in this. Yet, the reliance on fiction perhaps also suggests that there is an element of the public anxiety over cloning which cannot be processed simply at the level of rational debate over the implications of technoscience.

Immediately following Dolly's birth, prominent biologists around the world were quick to distance themselves from the possibility of human cloning. For it was not the cloning of a sheep per se that raised such a stir, but rather the possibility that this was a technology that could be transferred to human

reproduction. Despite the denials, the possibility of human cloning appeared all the more real in February 2004 when two South Korean researchers – Woo Suk Hwang and Shin Yong Moon – reported that they had successfully produced human embryos through a cloning procedure, which they referred to as ‘somatic cell nuclear transfer’ precisely to try to deflect the negative connotations associated with the concept of cloning¹. It is not clear that cloned embryos could indeed develop into human beings even if given the chance², but this is not really what I am interested in exploring here. The question of cloning, I want to suggest, is one that taps into deep cultural anxieties over the role of sex in the natural order of things, irrespective of whether or not ‘clones’ will one day walk among us.

This final chapter first considers the response to human cloning from the field of bioethics. I draw on Freud’s essay on ‘the uncanny’ to provide an alternative account of what is at stake in the various responses that we find to this issue. Drawing again upon the work of Judith Butler³, I argue that the pervasive anxiety exhibited over human cloning is connected to the maintenance of a (hetero)sexual order of nature. I then turn to examine the work of a number of writers who have interrogated and tried to reimagine the relationship between biology and sex. The question of whether biotechnologies such as cloning are leading our thought in the direction of a notion of ‘posthuman sex’ is thereby raised. Finally, our genealogy of genomic vision is brought to the point where we may begin to see a new set of relations between nature, technoscience, and

sexual difference, and to envisage a critical perspective that is open to what 'sex' may become in the future.

Cloning, Bioethics, and the Uncanny

Karin Knorr Cetina suggests that 'cloning is the *steam engine* of molecular biology' (1999:148). This may be read in two ways. On the one hand, it points to the fact that DNA cloning is the everyday work of molecular biologists. It is a technology that enables bodies to be transformed into 'unnatural' production sites populated by 'molecular machines' (1999:149). On the other hand, it perhaps also suggests that the technology behind cloning may play a similar role in relation to the conceptual lexicon of the twenty-first century as the steam engine did in the nineteenth century (perhaps most notably in association with thermodynamic thinking). Despite the everydayness of this practice, conservative critics, such as Kass, intuitively recognize the threat that cloning presents to the natural order as it has been predominantly conceived since the eighteenth century. In what is perhaps the single most reiterated statement of opposition, Kass' argument against cloning is based not only in an intuitive sense of 'repugnance', but also in what he refers to as 'the profundity of sex':

To see cloning in its proper context, we must begin... with the anthropology – natural and social – of sexual reproduction. Sexual reproduction – by which I mean the generation of new life from (exactly) two complementary elements, one female, one male, (usually) through coitus – is established (if that is the right term) not by human decision, culture or tradition, but by nature (2004:151).

We can note immediately that what is at issue here is really the naturalness of (hetero)sex, or, the extent to which a particular organization of sexual energies is legislated by nature. For Kass, cloning represents a threat to the natural teleology that is expressed through heteronormative, reproductive human sexuality. Like many other critics of human cloning, he is concerned that we do not become seduced by the promises of technoscience. From this perspective, the possibility that human beings might be produced, not according to the dictates of 'nature', but through the designs of biotechnology, poses a challenge to the meaning and value of human life. Hence, Kass claims that 'Whether or not we know it, the severing of procreation from sex, love and intimacy is inherently dehumanizing...' (2004:155). Cloning threatens the hegemony of (hetero)sexual reproduction, and is thus seen to lead us beyond what is human. Indeed, this would be the logical conclusion if (hetero)sex defines the essence of the human. This is a point to which we shall return. For the moment, I want to explore the idea that cloning reveals to us the need to rethink 'sex' in relation to bioethics.

Where Kass foregrounds the ontology of sex in his discussion of the ethics of human cloning, other commentators tend to subsume such considerations under the more amorphous categories of 'human nature' or 'human dignity'. Those who support therapeutic cloning tend to focus on the potential health benefits that may accrue through further research with embryonic stem cells, with many also affirming the increased possibilities for parenthood that childless couples may gain through reproductive cloning. For this group of commentators,

fears that human cloning will transgress human dignity or our fundamental nature are misplaced and shortsighted. Bioethicists such as Arthur Caplan point out that human life has always been defined in relation to different technologies. For Caplan, 'Social and political choices, not scientific advances, will determine how our dignity and autonomy are to be squared with the prospect of birthing from artificial wombs or enhancing our mental capacities through genetic or neuronal engineering' (2004:175). This expresses a common viewpoint among supporters of unfettered development in biotechnology. These commentators believe that technoscience is neutral in and of itself with respect to attributions of value, which are presumed to arise externally. From this perspective, the human and the technological are inextricably interrelated but ontologically separate.

Opponents of human cloning share this presumption of an ontological divide, and the bioethical literature is replete with attempts to define the essential characteristics of human nature, which are to be defended against the intrusions of biotechnology. Often, in these arguments against cloning, the connection to (hetero)sexual order is implicit, if not quite expressly thematized. George Annas, for example, states his opposition to human cloning in this way: 'Cloning is replication, not reproduction, and represents a difference in kind not in degree in the manner in which human beings reproduce' (1998:80). The difficulty with such arguments is in finding a basis on which to establish that such a move away from heteronormative reproduction does indeed violate some essential tenet of human being or dignity. Almost inevitably, it seems, this is where the ontotheological extends into the explicit domain of the theological.

Ronald Cole-Turner (2001) provides us with a thoughtful explication of the often-vague notion of 'human dignity' that generally underlies both Christian and avowedly secular objections to human cloning. He notes that there are three meanings frequently associated with the concept: dignity in terms of freedom or autonomy; dignity as uniqueness; and dignity in the sense of human beings as ends in themselves rather than objects for the use of others. As other commentators have noted, the attempt to argue that cloning denies uniqueness to the cloned person appears to founder both upon a mistake of genetic determinism, and on evidence to the contrary in the form of identical twins (nature's clones). The objection that cloning does not treat children as ends in themselves is also problematic insofar as it is not clear that cloned children would necessarily be treated more like objects than other children who are already shaped according to their parents' desires in any number of ways.

It is the issue of freedom, or autonomy, that seems of most interest in the context of human cloning. Cole-Turner notes that, from a theological perspective, the concept of dignity is grounded in 'the fundamental belief that humans are created in the image of God' (2001:259). It is not so much that humans are created *like* God, however, but the fact that they are created *by* God which seems important here. Translated into more secular terms, it is the idea of a *free* process of creation that human cloning seems to violate. The question posed is this, if human being is not the result of God or nature giving freely of itself, is 'human dignity' thus compromised? The answer, I suggest, would be in the affirmative only if we accept the implicit claim that (hetero)sex provides a channel

for the unchanging essence of humanity, and if (hetero)sexual difference represents a necessary mechanism for ensuring a freely given natural order. The prospect of human cloning is unsettling because it threatens to violate a process of natural production that appears to be both free and yet, at the same time, generative of a stable order that may be known. From this perspective, the freedom associated with 'human dignity' is an ambiguous one. In a certain sense, we may say that much of the opposition to human cloning manifests not so much a fear of losing individual freedom, but a (perhaps unconscious) fear of freedom – i.e. of the freedom that may accrue to human beings in the absence of a natural order of things.

This is not to say that there are not other reasons to be wary of human cloning. From a practical point of view, there are legitimate concerns about the effect large-scale cloning (of plants, animals, or humans) might have on the biodiversity that evolutionary processes thrive on (Gould, 2001). There are also serious dangers involved with abrogating the regulation of biotechnologies such as cloning to the for-profit market economy (Tracey, 1998). Of course, the clearest objection to human cloning – at least for the moment – may be that it is simply not a safe or reliable means of producing human beings. This is the opinion set forth by Richard Lewontin (1998), who argues that most of the questions put forth by philosophers and theologians are simply irrelevant to the issue of human cloning. For Lewontin, most concerns over cloning are irrational expressions of a 'deep cultural prejudice' against the possibility of 'playing God' (1998:131). He points out that:

After all, it is not as if human genetic clones don't appear every day of the week, about thirty a day in the United States alone, given that there are about four million births a year with a frequency of identical twins of roughly 1 in 400. So it cannot be the mere existence of doppelgänger that creates urgent problems (1998:130).

This is both true and yet somewhat misleading I think. Lewontin is too quick to equate the clone with the identical twin. Unlike the latter, the clone disrupts the temporal order of natural reproduction, and in doing so it conjures up an affective response that cannot simply be dismissed through the cognitive knowledge that there are identical twins in the world. As Sarah Franklin points out, cloning has become 'a condensed signifier for the potential of genetic science to produce unnatural kinds' (2004:250). The clone signifies the disruption of natural processes, and implies the emergence of beings who cannot easily be classified according to established categories of identity and difference. The existence of identical twins may give us good *reason* to dismiss concerns over cloning, but I don't think that it can explain why the idea of a clone seems to affect people in such an unsettling way.

With this in mind, I want to suggest that the way in which cloning unsettles us can be characterized as an experience of 'the uncanny'⁴. In explicating this idea, Freud's discussion of the *Unheimlich* (the German translation of the uncanny) may be of some use to us. Like the public discourse on cloning, Freud is drawn to literary sources and aesthetics in trying to make some sense of the affective quality of the uncanny experience. In seeking to define the uncanny, Freud has recourse to Friedrich Schelling's definition: "'*Unheimlich*" is the name

for everything that ought to have remained... secret and hidden but has come to light' (cited in Freud, 1985:345). To appreciate the appropriateness of this definition, we must follow Freud upon an etymological quest that seeks to uncover the relationship between the words *heimlich* and *unheimlich*. *Heimlich* most commonly refers to something familiar, to that which belongs to the house, or which is comfortable and home-like. But it also possesses another meaning – one that refers to something concealed, secret, and kept from sight. This poses an apparent paradox, as *heimlich* here appears to take on something of the meaning of its opposite: *unheimlich*, i.e. the un-familiar. As Freud notes, 'Thus *heimlich* is a word the meaning of which develops in the direction of ambivalence, until it finally coincides with its opposite, *unheimlich*' (1985:347). The question is: how can that which is familiar and homely also be concealed and hidden from sight? Freud goes on to insist, however, that there is in fact no contradiction to be found here because the concept 'home-like' does indeed imply that something is withheld from view and concealed from the eyes of strangers. *Heimlich* implies that something is withdrawn from knowledge; it implies that there may be something unconscious here. Just as Freud will later insist that life and death drives are never found in their pure forms, here he asserts that the unfamiliar is always to be found at the heart of the familiar. Indeed, this is crucial to the experience of the uncanny. The uncanny, says Freud, is something *secretly* familiar, something that has undergone repression and returned from it.

Freud may not have had clones on his mind, but it is interesting to note that the phenomenon of the 'double' is central to his account of the uncanny. The unexpected appearance of a double is an exemplary instance of the unfamiliar inhabiting the reproduction of someone who seems familiar. In this regard, Wendy Doniger (1998) suggests that much of our discomfort with the prospect of human cloning may be unconsciously connected to the long-standing European mythology surrounding the belief that 'doubles' can magically appear in our world. Most notably, she documents the various ways in which the figure of the double has been associated with anxieties over sexual identity issues. Doniger highlights recurring themes of sexual betrayal in stories involving 'clones' from premodern times through to twentieth-century fiction and cinema – whether it is identical twins in Shakespearean plays, magical doubles in ancient Greek plays, or technoscientific robot clones in films such as *Bladerunner*. Uncertainties regarding sexual connections and their consequences pervade such texts. Doniger sums up the situation in this way: 'Many of these stories of clones are about things other than sex.... But time and again one clone somehow or other stumbles in the other's bed, and this feel of advertent or inadvertent sexual betrayal is, I think, an inescapable part of the terror of cloning' (1998:135). It is as if the figure of the clone brings to light a fundamental anxiety associated with sexual identity, and with the idea of a natural sexual order underlying our relationships of self to other.

If the figure of the clone does indeed invoke an *unheimlich* feeling, Doniger's account suggests that this may perhaps be understood as the *secret* of sex

coming to light. This secret might perhaps be characterized as the *freedom* of nature to produce in a nonlinear and nonheteronormative fashion. The idea of cloning might be uncanny because it brings us face to face with the unknown within ourselves, insofar as our selves are known through (hetero)sexual difference. It would bring us to the limits of our knowledge at precisely the place where our most intimate secrets dwell. This is perhaps captured better in the English term 'uncanny' than in the German *Unheimlich*, for 'canny' is derived from the old English 'cunan' meaning 'to know'. To be canny is to possess an intimate form of knowledge regarding something, thus the un-canny is where one runs up against the limits of that knowledge. It is where our vision is given over to an affect that cannot be cognitively contained. In cloning, we come up against the limits of our self-knowledge insofar as our identities are grounded in a certain (hetero)sexual order.

In modern biological thought, it seems that sex is always paired with death — insofar as life is able to resist death only through its sexual organization. In this context, the general concern over cloning may also be seen as a reprise of a certain uneasiness concerning death that emerged alongside photography in the nineteenth century. In each case, the (re)appearance of an image of oneself provokes a peculiar anxiety over the passing of one's time⁵. Indeed, cloning might well be regarded as a form of reproduction that taps into our insecurities about death. The clone, at least as popularly conceived, reanimates a life that has already passed away. Indeed, a scenario often conjured up in the bioethical literature is that of a dying child being cloned by his or her parents in order that

he or she might live on beyond death. Here, it is perhaps illuminating to find Freud claiming that ‘Many people experience the [uncanny] feeling in the highest degree in relation to death and dead bodies, to the return of the dead, and to spirits and ghosts’ (1985:364). In other words, the uncanny is a manifestation of death – the ultimate limit to knowledge – within life. In this sense, *unheimlich* names a secret that must remain hidden both for the sake of the integrity of individual identity, and for the maintenance of natural order.

It is instructive to note here the parallels that exist between Freud’s account of the uncanny and Butler’s theory of gender melancholia (as discussed in chapter one). Freud characterizes the most prominent examples of the uncanny as being concerned with the phenomenon of the ‘double’, which is said to originate in primary narcissism, and to play a protective role in the securing of the ego’s coherence. For Freud:

When all is said and done, the quality of uncanniness can only come from the fact of the “double” being a creation dating back to a very early mental stage, long since surmounted – a stage, incidentally, at which it wore a more friendly aspect (1985:358).

Similarly, Butler’s theory of the acquisition and reiteration of gender identity through melancholic incorporation is premised upon a certain *miming*, or doubling – in this case, of the disavowed other who cannot be the object of desire. This process involves a splitting of the self whereby a superego is set up as the conscience of the ego. While Butler follows Freud’s theory of melancholia in viewing the superego as threatening the self with the dissolution of its identity,

it may be that Freud's characterization of the uncanny is actually closer to Butler's theory of gender melancholia than his account of melancholia is. The repetition of the same that Freud associates with the uncanny bears much resemblance to the miming of the lost other in Butler. Gender melancholia is the condition of the one who not only does not know what or who has been lost, but cannot in fact know that there has been loss, for this loss is constitutive of the very one who knows not. It is a *secret* loss that lies at the heart of that which is most familiar (i.e. gender or sexed identity). One becomes the double of the other that cannot be known or loved.

For Freud, although the uncanny involves something that is unknown because it has been 'lost' in the constitution of the mature self, that which is unknown reveals itself as such, i.e., as the unknown – or as Schelling puts it, the secret comes to light. Thought in terms of gender melancholia, how might the secret of gender appear and yet still remain a secret? In *Gender Trouble* (1990), Butler suggests that the heterosexual matrix underlying normative gender categories may be disrupted through subversive reiterations of gender, such as those found in 'drag' performances. Drag is said to reveal something like the secret of sex in the performative structure of all gender identities. Returning to this theme in *The Psychic Life of Power* (1997), Butler suggests that drag is the 'acting out' of an unacknowledged and ungrieved loss on behalf of the straight man. Drag allegorizes the melancholic process whereby the disavowed feminine position – that is, the culturally prescribed position from which one can love a man – is taken on in the form of an identification. Drag, we might say, is uncanny

insofar as it involves something that is familiar (i.e. the performance of femininity) becoming strange and unsettling — at least, to many who witness it — through the return of secret, disruptive desire that is found at the limits of identity. This desire remains secret even in its return, however, because it cannot be known within the logic of (hetero)sexual difference that allows it to appear⁶.

If we were to try and update this example for the biotech age, we might perhaps suggest that the idea of human cloning is the technoscientific equivalent of drag — with the crucial difference that it extends our vision beyond the cultural dimension of life and into the material world of sex. Like drag, the prospect of human cloning disrupts the natural order of (hetero)sexual reproduction, and thus uncovers a secret freedom that inhabits the foundation of gendered identities. It exposes the reiteration of (hetero)sex to be a contingency of natural history. In this sense, it would be the uncanniness of cloning that provokes anxieties over individual uniqueness — as (hetero)sexed and gendered beings, are we not all in some sense ‘clones’? The idea of human cloning reveals a deep ambivalence about human freedom in relation to nature that is inherent to modern biology. If contemporary biotechnologies open up the possibility that alternative bio-logics may be drawn from nature, then the ontology of (hetero)sexual difference that has stood as the quasi-teleological ground of the biological organism may not be secure. Technoscience, in this scenario, far from reducing us to biology, may in fact reveal a different sense of natural freedom.

Gender and Bioethics

How might we think about the uncanniness of gender and cloning within a bioethical framework? What sort of bioethics would be adequate to both the potential freedoms and inequalities of our current biotechnological moment? Mainstream bioethics has come under increasing criticism in recent years. As a discipline it is relatively young, having emerged out of concerns raised during the early days of genetic engineering in the 1970s. Bioethics represents the professionalization of ethical reflection, a practice that had previously drawn from diverse sources such as the arts, religious traditions, and oral histories. The perception of a need for 'bioethics' can be seen as emerging out of the decline of both religion and the authority of community in people's lives (DeVries and Conrad, 1998). Taking a historical perspective raises the question of how to ground bioethical decisions today, and whether there alternative models that have been excluded from the discussion?

John Evans has claimed that the emergence of professional bioethics has led to a 'thinning' of public debate as bioethicists have narrowed the focus from 'substantive' to merely 'formal' modes of rationality (2002:7). His argument is that this move is not simply the result of bioethicists' recognition that we live in a pluralistic society where various 'thick' ethical claims need to be translated into a 'thin' common discourse, but rather that it represents a takeover of bioethics by scientists who wish to legitimate their own particular form of rationality through the establishment of bureaucratic commissions (2002:175-80). From this perspective, the discipline of bioethics is from the very start co-opted by the very

scientific mode of rationality that it purports to be offering independent ethical reflection on. Similarly, Donald Light and Glenn McGee argue that the field of bioethics is dominated by the narrow interests of Anglo-American analytic philosophy, which tends to 'reify its own logic', and to practice a form of 'methodological imperialism' that ignores problems which cannot be thought about within that framework (1998:1-4).

In this regard, critiques of mainstream bioethics often converge with the concerns of feminist writers in this field. Indeed, it can be difficult at times to see what is distinctly 'feminist' about many feminist critiques. To take one recent example, let us turn to Margrit Shildrick's argument that feminist bioethics needs to embrace postmodern theory in order to adequately address contemporary genetics. She argues that the grandiose claims associated with the HGP and other bioscientific ventures need to be combated by a move in the opposite direction. Thus, her ethical position advocates a move '...toward greater ambiguity, or rather — to pin down the postmodernist point — to disclosing the ambiguity that already exists' (2004:158). Shildrick finds ambiguity in the very places where certainty is supposed to lie. The impetus for her postmodern ethics lies in the fact that 'Research in genetics, and the genome project itself, continuously both promise order and provoke unease' (2004:162). What remains unclear in Shildrick's position, however, is precisely how this ethics of ambiguity relates to more traditional feminist concerns. For example, she states:

The problem is that both technoscience and the mainstream bioethics concerned with bioscientific endeavour seem unable to break free of their modernist and

humanist roots. Both make assumptions about the 'proper' parameters of the body, about what constitutes identity, about the category of the normal and about perfectibility, and above all about the distinction of self and other. *As a feminist bioethicist...* I see the problematic very differently. In place of certainty, determinacy and resolution, a more reflective awareness would accept that outcomes are intrinsically uncertain (2004:162) [emphasis added].

If feminism involves the recognition and appreciation of ambiguity and uncertainty, of the excess that escapes from analytic and scientific categories in the attempt to order and control, then what is implied about the gender of 'technoscience' and 'mainstream bioethics'? There is evidently some sort of gendered opposition at work here, although its precise form is left unstated.

The identity of technoscience with masculinity is presumed throughout Shildrick's text even though it is never examined as such. A good example of this presumption can be seen in her discussion of the HGP. On the one hand, she references the findings of the genome project in support of her claims for the fluidity of nature. Yet, if the task of postmodern feminist ethics is 'to abandon the desire for the solid ground where certain analytic categories and concepts are fixed in advance' (2004:163), then the goals of the HGP represent the very antithesis of this approach insofar as '.... the genome map is intended to answer on several levels to the desires embedded in the western, cultural, and indeed bioscientific, imaginary' (2004:159). Shildrick's characterization of the HGP draws upon a strong tradition in feminist theory that associates Western technoscience with some sense of masculine domination, yet the way in which this desire for

dominance is undone by the ambiguity of nature in contemporary genomics is not explicitly addressed in gendered terms. I would suggest that the reason the connection between masculinity and science is not foregrounded in her text is the attendant difficulty of articulating precisely what form this relationship takes today. Despite her reticence in this regard, for Shildrick, technoscience is clearly coded as 'masculine', while natural reality expresses a 'feminine' plenitude that escapes from the clutches of the former; hence, feminist bioethics should be on the side of the latter. The question, however, is whether this opposition of masculine science to feminine nature does not rely for its coherence on a peculiarly modern understanding of gender, which is thereby reiterated and reinforced.

In this regard, one benefit to be derived from Isabelle Stengers' work is that she brings this presumption of the gender of technoscience to our attention. As discussed in chapter four, Stengers argues that the feminist critique of scientific rationality reifies science and fails to appreciate the historical character of scientific practice. In *The Invention of Modern Science* she further claims that 'the price paid by the radical character of the critique, whether technoscientific or feminist, is the respect that it accords to the scientist as a privileged interpreter of what science is able to do' (2000:11). In other words, feminists who identify technoscience with masculine ideology are guilty of not interrogating the actual practices, strategies, and achievements of scientists closely enough. Stengers wishes instead for a political and historical understanding of the sciences that is irreducible to any other category of thought or practice. For her, 'science' is only

able to establish a provisional identity on the historical basis of its power to exclude other claimants to know the truth of nature.

Stengers' goal is to establish the singularity of the sciences. What is curious, however, is that while she acknowledges that 'The definition of "science" is never neutral' (2000:25), she appears unwilling to countenance the possibility that there may be a gendered element to the definition of modern technoscience. Although her method calls for the rejection of understandings cast in oppositional terms, it seems that the only possible relation that she is able to envisage between science and masculinity is one that attributes to science a gendered *identity* for the purposes of denouncing it. Her position implicitly situates 'the singularity of the sciences' outside of any gendered social structures. Yet, even if each singular and historical science is indeed constituted (and reconstituted) by political processes that seek to establish authority for a different experimental relation to nature, which is achieved through the dismissal of all other claims as mere 'fictions', we are still left with a peculiar form of *desire* underlying this general scientific project – the desire to deny the truth claims of others in order to establish an exclusive truth of, and control over, nature. Stengers suggests that the singularity of modern science is constantly being reinventing through putting its claims to the test (2000:134), yet this is always framed within an overarching project that responds to the problem of human freedom in the modern world. This is what I believe Shildrick gestures towards in her text, but without ever clarifying the historical specificity of the situation.

Ultimately, both Stengers and Shildrick wish for us to recognize that the power of science to establish the truth of nature is much less potent than its public advocates would have us believe. Stengers claims that the power of scientific truth to exclude fiction is a "'habit of thought" that we need to learn to put at risk' (2000:167). The question is, however, if we are not willing to allow that this 'habit of thought' may extend across different dimensions of social life, if we do not concede that it reiterates the structure of masculine desire as it has taken shape over the same period of time in which modern science has developed along its own path, then will we not miss an important dimension of the power of technoscience today?

Throughout this dissertation I have argued that if social criticism of science is to be adequate to contemporary genomics, and to biotechnologies such as cloning, it needs to pay attention to the concepts of 'sex' and (hetero)sexual difference. Similarly, critical reflection on genomics that wishes to address the relations of gender and technoscience must incorporate both cultural and social factors that influence technoscience and a consideration of the ways in which 'nature' itself is refigured within genomic discourses and biotech practices. The remainder of this chapter takes up the topic of sex in biological and genomic thought as a preface to a different formulation of a critical bioethics.

Questioning 'Sex'

Today, public discourses on the topic of sexual differences remain transfixed on dualistic understandings – male vs. female, heterosexual vs. homosexual. Newspaper stories routinely trumpet the latest findings regarding

the seemingly elusive, definitive source of 'the difference between the sexes', or the most recent speculations in the quest for the even greater prize of the 'gay gene'. The rise of genomics has given fresh impetus to these efforts, but it has also, more subtly, begun to undermine them. The failure of the HGP to provide the ultimate answers about human (sexual) life has forced biologists and others to recognize that nature may be more complicated and diverse in its expressions than previously assumed.

Critiques of popular biological understandings of 'sex' have not arisen solely from feminist and gender theorists external to the sciences. The 1990s also saw a number of critical examinations of the way in which biologists have understood sex emerge from within the discipline itself. Together, these accounts can be divided into two broad categories. Firstly, there are social constructionist studies that seek to uncover masculinist bias in the way that the biological sciences have produced knowledge about sex. Exemplary here are studies by Nelly Oudshoorn (1994), Marianne van den Wijngaard (1997), and Anne Fausto-Sterling (2000). Secondly, there are other studies which switch the focus away from scientists and towards the sexual diversity of natural world itself. The work of Lyn Margulis and Dorian Sagan (1997) has been particularly important here, as has the influence of Bruce Bagemihl's *Biological Exuberance* (1999). More recently, Joan Roughgarden (2004) has also pursued this line of investigation, while Luciana Parisi's (2004) work takes us more explicitly in the direction of biotechnology and sex. In what follows, I will begin with a brief overview of the

social constructionist texts, before turning to the second group of studies, which offer alternative ways of reconceptualizing 'sex'.

In chapter one, we discussed Thomas Laqueur's (1990) account of the gradual emergence of the 'two-sex' model of bodies over the course of the eighteenth- and nineteenth centuries. Oudshoorn's (1994) work continues this story into the twentieth century. Her focus is on the rise of sex endocrinology in 1920s and 1930s, especially with regard to the invention of 'sex' hormones, which were claimed to be the chemical messengers of masculinity and femininity. Sex endocrinologists at this time claimed to have found the missing link between genetic and physiological models of sex determination: hormones. The essence of sex thereby shifted from the anatomical to the chemical. Oudshoorn traces this move through into the 1950s when, under the influence of information theory and cybernetics, sex in the hormonal body became figured in terms of a complex feedback system transferring information between the gonads and the brain. She argues that, while this informatic model recast sexual difference as an issue of the relative quantity of hormones, endocrinology reinscribed a dualistic model of sex in terms of the cyclicity (female) or stability (male) of hormone production (1994:146).

Inspired by the work of Latour and others in science studies, Oudshoorn employs a network analysis that focuses on the interactions between laboratory scientists, gynecological clinicians, and pharmaceutical companies in the construction of scientific knowledge. She is guided by the premise 'that a scientific fact exists only by virtue of its social embeddedness' (1994:10).

Accordingly, her study seeks to uncover how cultural beliefs inform research, and how scientists transform such prescientific ideas according to their disciplinary backgrounds. Oudshoorn also shows how the development of endocrinology was shaped by the availability of research materials, and how this led scientists to become dependent on clinicians and pharmaceutical companies. She argues that sex hormones are not natural entities discovered by scientists; rather, as with all scientific facts, they are produced only through certain contexts, which scientists then conceal (1994:138-9).

Wijngaard's *Reinventing the Sexes* (1997) in many respects picks up the story where Oudshoorn's text leaves off. Focusing on the science of sex hormones from 1959 to 1985, she argues that modern scientific and medical practices create categories of sex and gender that are not naturally occurring. Her main interest is in analyzing the ways in which biomedical researchers developed and utilized a theory of prenatal, hormonal organization of the brain to posit the existence of distinctly masculine and feminine behaviors. Wijngaard argues that cultural beliefs regarding dualistic gender categories are evident in this theory's account of the male brain as developing according to the presence of androgens and the female brain according to a lack of the same hormones. She suggests that hormonal organization theory was readily accepted because it cohered with the accepted, yet erroneous, notion that hormones were sex-specific, despite evidence to the contrary having existed since the 1930s (1997:35-6).

Like Oudshoorn, Wijngaard approaches her object of study from the perspective of actor network theory. As she describes it, 'In this analysis from a social network perspective, the images of masculinity and femininity in accepted knowledge represent the historical and social processes involved in the interactions between biomedical scientists, physicians, psychologists, psychiatrists, feminists, and sociologists' (1997:11). Unlike Latour's actor network theory, however, neither Oudshoorn nor Wijngaard include natural entities as actors within their network analyses. This highlights one of the key limitations of social constructionist approaches, which is implicit in Wijngaard's conclusion that, 'This study has demonstrated the role of cultural context in neuroendocrinological investigations. Sex proves not to be an unquestionable and objective physical characteristic' (1997:116). While there is a valuable claim being advanced here, the focus is restricted to the cultural dimension of life and the materiality of 'sex' is left unexamined. As we noted in chapter one with regard to Butler's work, the dynamism in this account lies solely with the cultural and environmental dimensions of life. Nature appears as something that merely exists 'in itself', and in contradistinction to any social factors, which thus effectively places biology outside of history even though a certain openness of nature to culture and technology is presumed.

Fausto-Sterling, in *Sexing the Body* (2000) makes a similar argument to the effect that the attribution of sex to the body is, ultimately, a social decision based on gender beliefs. She takes this approach one step further, however, in emphasizing that '...components of our political, social, and moral struggles

become, quite literally, embodied, incorporated into our very physiological being' (2000:5). For Fausto-Sterling, 'we literally, not just "discursively" (that is, through language and cultural practices) construct our bodies, incorporating experience into our very flesh' (2000:20). With this recognition, she hopes to overcome the split between nature and culture that plagues social theory. Yet, in her fundamental claim that 'sexuality *is* a somatic fact *created by* a cultural effect' (2000:21), the boundary appears to be breached from only one direction. The material body is in play, but only insofar as it receives its form and function from culture.

Sexing the Body covers much of the same ground as Oudshoorn and Wijngaard's texts in making the argument that 'sex hormones' is a misnomer because androgen and estrogen exist in both men and women. Fausto-Sterling also tackles the politics of sex reassignment surgery for intersexuals, arguing that it represents the imposition of dualistic, social categories of gender onto a natural diversity of sexual expression, which is thereby suppressed. Ultimately, her call to reform the life sciences argues both that the individual differences of natural bodies should be respected, and that we need to find a place for an expanded concept of 'environment' within the study of biology. Thus, her claim that 'The changes that occur throughout the life cycle all happen as part of a biocultural system in which cells and culture mutually construct each other' (2000:242), is a plea for recognition of both cultural/environmental and material/natural agencies in the production of bodies. The more difficult issue, however, is how to

conceptualize the material status and agency of `sex'. It is to this question that I now turn.

Rethinking Sex

Perhaps the most influential voices of recent times in calling for a new understanding of sex are those of Lyn Margulis and Dorion Sagan. In a series of books over the past twenty years, Margulis and Sagan have challenged conventional thinking on sex, life, and evolution, and their work has had considerable influence both within and outside of the biological sciences. For our purposes, the most relevant text in their oeuvre is *What is Sex?* (1997), which argues that sex is a crucial part of the process of energy transformation that constitutes all life. Margulis and Sagan claim that life is driven by a thermodynamic flow of energy and by the symbiotic exchange of matter. Put simply, sex is central to life because it enables these processes to occur. Invoking the second law of thermodynamics, they claim that `sex is... part of a natural tendency to mix things up, to randomize, to lose discrete identity due to the tendency of material systems to reach more probable states' (1997:19). Margulis and Sagan draw upon non-equilibrium thermodynamics to characterize organisms as open systems with energy, matter, and information flowing through them. They argue that `in our sexual activity, we are not only thermodynamically, but informationally, open' (1997:33). Notwithstanding this condition of openness, Margulis and Sagan are adamant that all organisms display a common `purpose': `Today, all growth and reproduction on the surface of this planet — the fantastic pattern we

call life — is underlain by the Second Law and its tendency to reduce physical differences by any and all means available to it' (1997:45). Thus, the purpose of life, and the purpose of sex, is to degrade energy received from the sun via the transformation of matter from one form to another.

In Margulis and Sagan's view of the world, sex is defined not by reproduction, but by genetic recombination. They write, 'The broad, biological meaning of sex simply refers to the recombination of genes from separate sources to produce a new individual' (1997:17). 'Sex', from this perspective, is a verb; it is the act of transferring genetic material. Reproduction does not require sex, as the numerous instances of bacterial and plant cloning that exist in the natural world amply demonstrate. Nor does sex necessarily lead to reproduction. As Margulis and Sagan note, 'any organism can receive new genes — can indulge in sex — without reproducing itself' (1997:17). Among other things, it follows that contemporary genetic engineering is parasitic upon natural sex, rather than being a travesty of the natural order of things. The implications of this position are profound. It suggests that the transmission of biological information at the subindividual level is fundamentally what sex is all about. Put another way, it implies that the meaning of sex is not to be found at the level of the organism.

What does this mean for human sexuality? Margulis and Sagan attempt the (always dangerous) move of translating from the animal — and, indeed, in this case from the bacterial — world to human society. They argue that in many respects we are slaves to our ancient history. Their basic claim is as follows: 'In experiencing sexual temptation or pleasure, we enact a cosmic breakdown more

primordial than life itself, one mandated in the very meaning of the Second Law of Thermodynamics' (1997:46). Human sexuality is therefore basically the same as the sexual desire underlying all of life. We are thereby offered a metaphysical alternative to the quasi-teleology of the reproductive imperative, but one that is equal in scope, for it purportedly underlies *all* contemporary forms of human sexual expression.

In *What is Sex?* Margulis and Sagan run through a diverse range of examples that detail how this thermodynamic metaphysic expresses itself in bacteria, plants, animals, and humans. Given the promiscuous beginnings of bacterial, symbiotic sex, it is somewhat surprising to find that a rather conservative picture of reproductive heteronormativity emerges throughout the text. For Margulis and Sagan, sex is driven by complementarity: 'Although sexual passion does not arise, as Plato mused, from the endless search for our primordially amputated halves, it is due to a primordial doubleness' (1997:91). Their explanation of the emergence of meiotic sex (whereby the haploid (i.e.. single chromosome) sex cells that inhabit the bodies of all human and non-human animals are restored to diploidy (i.e. doubleness) through fertilization) leads Margulis and Sagan to this conclusion:

'Our explanation of why sexual individuals trouble themselves to seek out mates of complementary gender only to dilute their genes is simple. They have no choice.... If they are to participate in the solar gradient-breaking process, they must indulge in sexual fusion' (1997: 122).

It is the sense of exclusivity that is most puzzling here. Notably, it is remarkable is that nowhere in their text on sex do Margulis and Sagan make any explicit reference to homosexual activity in either the animal world or in human society.

Only in the final chapter of *What is Sex?* do we get a glimpse of the fact that other possibilities exist for sexual expression. Here, in speculating on 'the future of sex', Margulis and Sagan note that 'Our society has begun to decouple sex from reproduction' (1997:207). While we might want to note that this 'beginning' could actually be located rather a long time ago, Margulis and Sagan go on to assert that, 'We foresee, in fact, humans evolving into a species composed of populations in which most members do not reproduce' (1997:206). Rather than this presaging a new era marked by freer sexual expression, however, what we find is that the evolutionary narrative underlying Margulis and Sagan's work resembles a version of Hegelian metaphysics. History appears as a dialectical movement through which the sexual process guides life towards self-awareness of its intrinsic global unity. Margulis and Sagan confirm this Hegelian impression elsewhere, stating that 'Life, moreover, appears to be on the verge of perceiving for the first time its strange but true place in an inexorably evolving cosmos' (2000:31). Thus, when we read in *What is Sex?* that 'Each of us is not necessarily aware of the social function of our sexual impulse as it works to incorporate us into the hyperbrain' (1997:207), the effect is to conjure up the rather curious image of material desires leading inexorably towards some sort of Hegelian *Geist*. Rather than continuing to serve as a means of individual reproduction, Margulis and Sagan suggest that sex is increasingly being

deployed as a communicative force that provides cohesion to larger social entities. Thus, 'As we lose our personal reproductive prerogatives to group integration, individual sexual pleasures are expected to be redirected toward the maintenance and expansion of new social organizations' (1997:216).

Sex makes connections; it establishes and maintains networks. For Margulis and Sagan, this is crucial in a global society dominated by the flow of information. 'Cybersex' is to be the next step in our evolutionary history — a move which takes advantage of nature's own inherent technicity. They caution that 'it would be a mistake to consider our libidinous attachments to machines, our fascination with technology, as unnatural: rather, such attachments, incorporated into the great sexual cycles of life, increase the flow of information, the access to and recycling and degrading of energy' (1997:222). Although they do not spell it out, Margulis and Sagan envision a future in which 'sex' does not necessarily connote heterosexual activity and heteronormative gender categories. This is to be achieved, however, only by leaving the physical body behind as we enter the new world of cybersex opened up by communications technology. According to Margulis and Sagan's Hegelian metaphysics, nature is both transcended and yet preserved as the lower level of life. In this ontology, physical difference is negated and change emerges only through the mysterious workings of 'spirit'. Thus:

From an evolutionary standpoint the increasingly filigreed global speed-of-light communications system — motivated by the human desire, often sexual, to be

connected — is better described as a new neural and perceptual infrastructure, the distributed intelligence of a multispecies developing global being (1997:226).

Although Margulis and Sagan begin with the profusion of possibilities offered by the microbial world of symbiotic sex, their story of sex ends with the transcending of a material world governed by heterosexual reproduction by way of the unconscious thought of a global mind realizing itself. Ultimately, the natural world is not a source of difference or creativity on this account, but merely a limitation to be overcome as its inherent telos is progressively unfolded.

The underlying heteronormativity of Margulis and Sagan's narrative can be illustrated by considering their relation to Darwin's work. Although they criticize Darwin's focus on the individual in natural selection, his theory of sexual selection is enthusiastically affirmed. Margulis and Sagan posit the existence of a genetic (hetero)sexual telos in claiming that 'Inferring the genetic desirability of a potential mate is of the utmost importance in all sexually reproducing beings' (1997:159). Ultimately, their work can be included in the mainstream of evolutionary biology insofar as it maintains an almost exclusive focus on reproductive sexuality. Joan Roughgarden, another evolutionary biologist, has recently criticized this approach for its role in 'suppressing and denying diversity' (2004:3). In *Evolution's Rainbow*, Roughgarden argues that Darwin's theory of sexual selection is falsified by the accumulation of evidence to the contrary from nature. For her, 'In ecology and evolution, diversity in gender and sexuality is denigrated by sexual selection theory' (2004:3). Like Margulis and Sagan, Roughgarden intends to provide an alternative to a strictly Darwinian evolutionary

biology, and it is instructive to examine how the two accounts differ in pursuing their common objective.

The most obvious difference between the two theories is Roughgarden's insistence upon recognizing the existence and evolutionary significance of homosexual activity between animals. Her claim is that 'The final nail in the coffin of Darwin's sexual selection theory is the discovery of extensive same-sex sexuality in nature' (2004:127). It is not merely the discovery of such behavior that is at issue here however, as Roughgarden goes on to argue that 'the scientific silence on homosexuality in animals amounts to a cover-up, deliberate or not' (2004:128). She believes that biologists have been reluctant or unable to acknowledge the diversity of sexual expression that exists in nature because this would challenge the guiding presumptions of evolutionary biology — a critique that could also be applied to the theory underlying *What is Sex?*

Intriguingly, Roughgarden's theory of 'social selection', which is offered as an alternative to Darwin's theory of sexual selection, bears much resemblance to Margulis and Sagan's vision for the future of human sexuality. Where the latter see sex becoming uncoupled from individual reproduction so as to serve as a means of establishing connections and networks between people, for Roughgarden, this is already how animal societies operate throughout nature. As she puts it, 'My underlying assumption is that animal species with distinct males and females interact socially to acquire opportunities for reproduction' (2004:175). The idea is that homosexual behavior is a part of the process of social interaction by which animals establish trust and manage relationships.

Hence, 'Mating is then more about maintaining the between-sex and same-sex relationships needed to provide food and safety for the young than about sperm transfer as such' (2004:176). Note, however, that the reproductive imperative remains in place here as the guiding force. Roughgarden acknowledges diverse sexual expressions in nature only insofar as they are adaptive in evolutionary terms. Her theory of social selection is based in the belief — shared by Margulis and Sagan — that *everything* in nature is working towards a pregiven end. She incorporates homosexual behavior into evolutionary biology by arguing that it is a 'social-inclusionary trait' (2004:156). Natural selection for social-inclusionary traits favors those individuals who are able to establish relationships of trust with other animals that then lead to opportunities for (hetero)sexual reproduction. That is to say, same-sex activity ultimately defers to reproductive sexuality on Roughgarden's account.

We can see how this shapes Roughgarden's view of nature by examining her claim that homosexuality can also be a social-inclusionary trait for humans in the right context. She suggests that in certain circumstances the alliance-building function of same-sex activity confers social advantage to those who engage in it. On other occasions, however, gay relations may challenge the dominant homosocial power structure of society and therefore lead to conflict and 'homophobia'. In this latter case, Roughgarden claims that 'Transactions based on the exchange of pleasure may be seen as subverting the power hierarchy, and be crushed by those in control' (2004:261). Yet, while this may be a useful perspective in certain instances, it locates anxiety over homosexual activity solely

at the level of material interests, and ignores other dimensions of social life. In this respect, Roughgarden's theory provides us with a theory that moves us in the opposite direction from that of Margulis and Sagan. Where they see non-reproductive sexuality emerging only beyond the stage when material interests dominate, and when humanity is in the process of realizing its global mind, Roughgarden, by contrast, subordinates all same-sex activity to a future material and heterosexual end. Each theory offers us a one-sided metaphysic that, while insightful on its own terms, seems to miss important aspects of sexual expression. Moreover, I would argue that both theories neglect to consider the connection between (hetero)sex and onto-theology, and the role that this plays in grounding their quasi-teleological, evolutionary narratives.

Another trait that *Evolution's Rainbow* shares with *What is Sex?* is the desire to characterize 'sex' solely in biological terms isolated from cultural and social categories such as 'gender'. The way in which each theory tries to achieve this goal however, offers us another instructive difference. Where Margulis and Sagan define sex simply as the event of genetic transmission, Roughgarden defines 'sex' as 'two parents mixing genes to produce offspring' (2004:16). Curiously, given her explicit goal of affirming sexual diversity, Roughgarden implies that real sex is heterosexual reproduction. Things soon get more complicated, however, as the discussion turns to the question of the relation of 'sex' to 'gender'. While Margulis and Sagan do not employ the term 'gender' in the sociological sense, Roughgarden wishes to distinguish sex from gender on the basis of gamete size and social criteria, respectively. Her claim is that 'The

key point here is that “male” and “female” are biological categories, whereas “man” and “woman” are social categories’ (2004:24). Implied is an additive theory of gender where the social builds upon the biological base, although the precise relationship between these categories is never specified.

Left unexamined here, however, is the implicit shift from sex as a verb to sex as a noun. The question of how the ‘two sexes’ (male and female) relate to ‘sex’ (the social act performed by men and women) is not one that is explicitly addressed by either Roughgarden or Margulis and Sagan. Both appear to presume that there is an essential connection between ontology and action, even as they seek to affirm nature’s openness to sexual change and diversity. I suggest that it is this unexamined presumption that leads both *Evolution’s Rainbow* and *What is Sex?* to propose theories in which the noun ‘sex’ bears the unthought presence of (hetero)sexual difference and the verb ‘sex’ bears the unthought presence of (hetero)sexual reproduction.

Another recent attempt to rethink ‘sex’ may suggest a way out of this quandary however. Bruce Bagemihl’s *Biological Exuberance* (1999) provides us with an account of ‘sex’ that combines elements of a thermodynamic explanation of life (as found in Margulis and Sagan) with an affirmation of sexual diversity in nature (as in Roughgarden). His text has become best known for the exhaustive catalogue of homosexual and transgendered behavior in nature that comprises around two thirds of its 700 pages, but it also contains a significant theoretical perspective on ‘sex’. His initial claim is as follows:

Ultimately, we will see that the plurality of homosexualities in both animals and people suggests a blurring of the seemingly opposite categories of nature and culture, or biology and society. On the one hand, it is no longer possible to attribute the diversity of human (homo)sexual expression solely to the influence of culture or history, since such diversity may in fact be part of our biological endowment, an inherent capacity of 'sexual plasticity' that is shared with many other species. On the other hand, it is equally meaningful to speak of the 'culture' of homosexuality in animals, since the extent and range of variation that is found (between individuals or populations or species) exceeds that provided by genetic programming and begins to enter the realm of individual habits, learned behaviors, and even community-wide 'traditions' (1999:45).

For Bagemihl, the meaning of 'sex' is neither naturally nor culturally determined; rather, it is plastic and open to diverse expressions. With Roughgarden, he affirms the sociability of animals and the possibility that there are 'natural' cultures of sexual expression which depart from the heteronormative paradigm. Also, like Roughgarden, Bagemihl charges that 'the history of the scientific study of animal homosexuality has been — and continues to be — a nearly unending stream of preconceived ideas, negative "interpretations" or rationalizations, inadequate representations and omissions and even overt distaste or revulsion towards homosexuality — in short, homophobia' (1999:88). Against Roughgarden, however, he argues that there is no reason to assume that homosexual behavior in animals is an adaptive trait that contributes to the reproduction of a species.

The central question here is this: why begin with the presumption that sexual activity always has the same purpose? Bagemihl points out that, 'Just as there is a multiplicity of kinds of homosexuality in the animal world, so, too, there are innumerable ways that males and females interact (sexually and otherwise) with each other, only some of which involve reproduction' (1999:195). His claim is that biologists try to subsume all sexual activity under the heteronormative paradigm because they are predisposed to explain everything they see in terms of its 'value' or 'usefulness' for facilitating reproduction (1999:195). What this amounts to is an onto-theological position based in the same impetus at work in the construction of the Linnaean sexual system of classification. From the eighteenth century to the close of the twentieth century, biological thought has been reluctant to consider the possibility that 'sex' is not a unified concept where the mode of doing follows automatically from the state of being. Against this perspective, Bagemihl argues that '[homosexuality] is simply one of many animal behaviors that lack the supposed "purpose" of contributing directly to the perpetuation of the species' (1999:211). By expanding our horizons, we come up with a picture of nature as an open system capable of diverse sexual expression.

Bagemihl's alternative theory of 'biological exuberance' shares with Margulis and Sagan the belief that sex should not be equated with reproduction. He argues that 'reproduction is not the ultimate "purpose" or inevitable outcome of biology. It is simply one consequence of a much larger pattern of energy "expenditure", in which the overriding force is the need to use up excess' (1999:255). Rather than simply referencing the laws of thermodynamics,

however, it is to the work of Georges Bataille (1989) that Bagemihl turns. Evoking 'post-Darwinian' theories of evolution, which emphasize pluralism and self-organization in life, Gaia theory, which suggests that biodiversity has inherent value, and chaos theory, which draws attention to nonlinear processes and unpredictability, he foresees the emergence of a new biological paradigm that will be very much in line with Bataille's theory of general economy. As Bagemihl characterizes it:

Life on this planet is above all characterized by what Bataille calls 'the superabundance of biochemical energy' freely given to it by the sun. The challenge confronting life, then, is not scarcity, but excess — what to do with all this extra energy. Virtually all outpouring of activity, both (pro)creative *and* destructive... all of these can be seen, ultimately, as mechanisms that 'use up' or express this excess energy. According to this view, life should in fact be full of 'wasteful', 'extravagant', and 'excessive' activities (1999:253).

If, as Bataille and Bagemihl would have it, sexual behaviors are merely one aspect of the exuberant and excessive movement that constitutes life, then it follows that homosexual behavior and all other forms of non-reproductive sexuality are natural expressions of this vitality. It follows, moreover, that 'sex' is not equivalent to (hetero)sex in either its ontology or its action. Bataille's work provides Bagemihl with a thermodynamic account of life that does not privilege heterosexual reproduction, nor does it invoke a quasi-Hegelian metaphysics or telos. Indeed, he emphasizes the fact that biological exuberance is not meant as

a causal explanation of sex or life. It is not intended to be an alternative metaphysic or onto-theology. Bagemihl has a strong sense of the limits of Western science, and regards it as merely one available perspective on the natural world among others. In much the same way as we suggested in chapter two that Heidegger's attempt to overcome 'enframing' gestured towards a different type of vision that is able to apprehend the limits of its own sight in the moment of seeing, biological exuberance seeks to view the natural world in terms of an overabundant presence by giving up the desire to reduce this multiplicity and complexity to the strictures of an onto-theology. At the same time, however, we need to keep in mind the point that an exuberant sexual ontology cannot simply rely upon an oppositional style of thinking that pits the free expressions of 'nature' against the prejudices of cultural forms and scientific methods. On the contrary, it must be recognized that technoscience is as natural as nature is technological. 'Sex' is a technology *of* nature, and social criticism of science needs to recognize the ambivalence and ambiguity of genomics and biotechnology is its assessment of their impact on the concept of (hetero)sexual difference. Indeed, for Heidegger, the path to overcoming scientific technovision is opened up to us by modern technology itself. So what, then, of the relation of contemporary biotechnology to the emerging paradigm of biological exuberance?

In many respects, this is a similar question to that taken up by Parisi in *Abstract Sex* (2004). By invoking Baruch Spinoza's concept of 'conatus' — 'the capacity of a body to be affected and to organize encounters among extended modes that increase its capacity to affect' (2004:31) — Parisi gestures towards

something like a notion of biological exuberance. Her touchstone for the new biology, however, is the work of Margulis and Sagan. Parisi's text picks up from where the latter left off in *What is Sex?* She attempts to extend their speculative thoughts on the implications of 'cybersex' by drawing upon the thought of Gilles Deleuze and Felix Guattari. This project involves something of an unresolved tension, however, insofar as Margulis and Sagan's Hegelian metanarrative is somewhat at odds with Deleuze and Guattari's anti-Hegelian, 'machinic' understanding of a nonlinear, immanent plane of nature. Parisi's intention is to reconcile the two theories, even though she is rarely explicit about the difficulties that such a project would need to overcome.

Parisi's starting point is the assertion that 'At the turn of the twenty-first century, developments in information technologies have profoundly accelerated the separation of sex from natural reproduction' (2004:1). She cites the emergence of Internet-based communications, and of new sexual identities and practices in cyberspace, as important factors in this move. Although the incorporeal qualities of cybersex have often been equated with a masculine model of pleasure that seeks transcendence from the limitations of the physical body, Parisi's claim is that they in fact point towards a new concept of 'sex'. Rather than domination and control over nature, the increasing convergence of sexual pleasure and information technology is said to allow for the possibility of a new feminist politics. For Parisi, the advent of cloning and other forms of 'biodigital' sex effectively liberates the female body from its biological destiny, while the free flow of biological information runs beyond the enclosures instituted

by the dominant masculine model of sexual relations. In this context, Parisi argues that we need to construct an alternative understanding of sex that goes beyond the opposition of 'artificial' to 'natural' sex:

This new way points to the dissipation of the male model of pleasure by exploring the implications of a biodigital intensification of bacterial sex: the nonlinear merging and copying of distinct information sources accelerating the emergence of unprecedented entities (2004:4).

In essence, Parisi's argument is that contemporary biotechnologies have moved us into an age of information-based 'biodigital' sex, which, in turn, draws upon an understanding of nature as alive with the nonlinear relations and possibilities of symbiotic and microbial sex that are somehow 'feminine'. Again, the attributions of gender to different forms and strategies of pleasure and desire are presumed without explicit explanation.

Drawing on Deleuze and Guattari's (1987) notion of an 'abstract machine' that governs relations between the virtual and actual dimensions of life, Parisi introduces the idea of 'abstract sex' as a conceptual tool that is intended to move beyond debates of biological determinism (or embodiment) vs. social constructionism (or disembodiment). As she characterizes it, abstract sex underlies and articulates connections between the coexistent, but historically unfolding dimensions of biophysical, biocultural, and biodigital sex. Rather than being bound by the linear character of this historical scheme, abstract sex is said to '...question the pre-established biological possibilities of a body by highlighting

the non-linear dynamics and the unpredictable potential of transformation of matter' (2004:10). One of the strengths of the concept of abstract sex is that it is able to encompass both the ontological and the active aspects of 'sex'. It implies that the bio-logic of a body is not stable and determinate in regard to sexual expression. From this perspective, 'sex is an event: the actualization of modes of communication and reproduction of information that unleashes an indeterminate capacity to affect all levels of organization of a body' (2004:11). Like Margulis and Sagan, Parisi understands sex as a process whereby energy, matter, and especially information flow through bodies constituted as open systems.

The concept of endosymbiosis, which refers to the merging of two formerly distinct organic beings, is important here. For Parisi, it is Margulis' theory of endosymbiosis that explains the machinic, nonorganic quality of abstract sex and its lack of respect for individual or species boundaries. As Margulis and Sagan define it, 'Endosymbiosis is like a long-lasting sexual encounter except that the participants are members of different species' (2000:120). For Parisi, the endosymbiotic quality of abstract sex is found on '...heterogeneous assemblages where the parasiting web between hosts and guests produces new bodies-sexes' (2004:16). Like Margulis and Sagan, her claim is that symbiotic assemblages should not be regarded merely as the province of ancient bacterial sex, but that they underlie and inform contemporary sexual relations. Nor is abstract sex simply a matter of the interactions of biological bodies; rather, it includes 'biophysical elements, socio-cultural energies, economic trades, technical inventions, political forces and particles of desire' (2004:16). The process of

endosymbiosis provides an explanation for how new modes of sex arise throughout history as different heterogeneous assemblages are constituted through the incorporation of new elements.

Parisi characterizes our contemporary situation in terms of the emergence of 'biodigital sex' sometime in the mid-twentieth century. From her perspective, sex becomes biodigital at the moment that life is recast in informatic terms and is thereby opened up to digital biotechnologies. For Parisi, the implications of this move are profound: 'The emergence of biodigital machines of information (genetic engineering and cybernetics) leads to the constitution of "control societies" no longer imbued with the logic of organic sex or entropic reproduction' (2004:129). Employing Deleuze's speculations on the character of post-disciplinary societies, she suggests that 'Control societies are defined by the capacities of biodigital machines to capture all variables of reproduction through an immanent modulation (selection) of information potential' (2004:129). Although I think Parisi tends to overplay the extent to which our contemporary social organization of sexual exchanges has broken with the past, her account does have the advantage of bringing to the fore the ambiguous conceptual nature of 'information' in relation to sex that we have been tracing throughout the history of biological thought. The machinic possibilities of recombinant biodigital sex produce both strategies of control at the molecular level (which increasingly allow for capitalist penetration into the life of the body), and also new possibilities for making 'unnatural' informatic connections that undo the logic of organic

sexual reproduction, and which thereby express a certain freedom inherent in techno-nature.

As is the case with many commentators, Parisi is drawn to cloning as a potent affective signifier of technoscientific power in relation to sex today. She argues that mammalian cloning is the biotechnology most characteristic of the modulation of life that defines control societies. Cloning evokes the specter of technoscience taking control of the natural processes that reproduce life, but it also disrupts disciplinary forms of power that operate along the lines of organic (hetero)sex. Cloning reveals nature as free to combine, to repeat with difference, and to reproduce beyond the normative functions of sexed chromosomes. Parisi's main interest, however, is in recasting our understanding of cloning in 'feminine' terms. She suggests, 'In particular, mammal cloning exposes the emergence of a new kind of sex and reproduction defined by the intensification of mitochondrial recombination' (2004:159). By invoking a maternal lineage, which passes through cytoplasmic mitochondrial DNA, she locates cloning on the terrain of sexual (micro)politics. The unstated presumption is that the natural order of heteronormative reproduction privileges the masculine in its emphasis on nucleic DNA; hence, the parthenogenic sex involved in cloning is a resource for a certain conception of feminist politics. As Parisi puts it, 'The recombination of cytoplasmic material maps a mutation of sex and reproduction, the proliferation of microfeminine particles as inheritable yet autonomous from the nucleic order of filiation (chromosomal exchange)' (2004:156). In this way,

biotechnology offers itself as a conceptual resource for rethinking the politics of gender, science, and nature.

This is a feminist politics that is to emerge neither from cultural formations of identity, nor from an autonomous biologic of nature, but rather, from out of the immanent and unpredictable activity of techno-nature (or 'machinic hypernature') as it constantly works to forge new connections of energy, matter, and information. Rather than a macropolitics organized around the representation of organic identities, Parisi proposes a feminist micropolitics of desire that draws upon Spinoza's ethics of affective relations. As she characterizes it, 'Micropolitics requires the *engineering* of abstract sex (symbiotic desire) where bodies of connection are not determined by the identity of sex but by incorporeal mutations of desire or the machinic compositions of essence (difference)' (2004:41). This is to be a politics that will take its cue from the current convergence of the biological and the technological in formulating strategies to subvert conventional understandings and hierarchies of sex and gender.

Parisi concludes her study by setting out the form that she envisions this new feminist politics taking: 'microfeminine warfare'. This is notion derived from Deleuze and Guattari's concept of 'becoming-woman', which Parisi describes as 'the first step towards a destratification (declination) of the body from the sexed and gendered organism, subject and signifier'. The politics of 'becoming-woman' appears paradoxical in its recitation of that which is apparently to be resisted. The point, however, is that 'Microfeminine warfare emerges and proliferates through a hypernature of intensive recombination between bodies-sexes,

escaping (preceding and exceeding) rather than resisting stratification' (2004:197). It is a matter of freeing up the immanent (feminine) creativity and desire of life, so that new connections and relations may be established in the world of biodigital sex.

For Parisi, conventional Darwinian evolutionary science represents a masculine mode of desire that microfeminine warfare seeks to overthrow. Thus, 'Becoming-woman is a tactic to unblock desire from the economy of pleasure (the patriarchal model of sex) based on lack, scarcity, individual competition, species survival and filiative reproduction' (2004:198). Curiously, however, given her critique of Darwin, Parisi does not subject the metaphysics underlying Margulis and Sagan's symbiotic alternative to a similar critical examination. Their science is presented as providing us with the truth of natural evolution, *and of sex*, while the relation that such an account seeks to establish with the natural world appears as immune from scrutiny. By subscribing wholesale to Margulis and Sagan's metaphysics of nature, with its heteronormative reproductive focus, it may be that the masculine desire for control that Parisi wishes to subvert is in fact reinscribed within her text. As in Shildrick's feminist bioethics, Parisi's microfeminine warfare relies upon a certain concept of nature in its struggle against 'patriarchal' science and the 'masculine' mode of pleasure without ever really explaining the specifics of such characterizations. Ultimately, while it is enormously thought-provoking, there is little in Parisi's text to suggest how the virtual machinations of abstract sex and microfeminine warfare might be productively actualized in contemporary societies where biotechnologies such as

cloning are more like to provoke affective reactions of revulsion than celebrations of the potential of recombinant, biodigital sexual connections.

Parisi's text gestures towards a new machinic concept of the feminine that does not owe its identity to the masculine. In this regard, we might say that Parisi's microfeminine characterization of nature in relation to biotechnology poses anew the problem of how to live with/in freedom. What seems important to notice, however, is that the political purchase of her feminist perspective is derived from recognizing that technoscientific desires for order and control over nature are not entirely satisfied in contemporary biotechnology projects. Insofar as the desire animating scientific ventures such as the HGP is indeed masculine in some sense, this failure provides an opening for rethinking the politics of gender and technoscience. In effect, Parisi suggests that a gendered dialectic of modern science is leading us towards a reconsideration of the relationship of sex, gender, and science. Moreover, if biotechnologies such as cloning do indeed threaten to undo the natural order of (hetero)sexual reproduction, then they would appear to lead us beyond many of the presumed certainties of human life. It is therefore not surprising that recent genomic science has generated much discussion about the concept of 'posthumanism'. Indeed, if the human in disciplinary society was defined in terms of organic sex, then it would follow that the sexual micropolitics of genetic engineering takes us onto the terrain of posthumanism.

Posthumanism

Parisi's *Abstract Sex* shares much with Keith Ansell Pearson's *Germinal Life* (1999), particularly insofar as both texts seek to extrapolate the contemporary implications of Deleuze's biophilosophy. For Pearson, the challenge posed by Deleuze's work is that of 'thinking "beyond" the human condition' (1999:2) — whether that is characterized in terms of the 'overhuman', the 'transhuman', or the 'posthuman'. In many respects, this is a matter of locating the human, technology, and nature on an immanent plane conceived as an open system. Contemporary genomics, and especially the HGP, moves in this direction insofar as it erodes the specific distinctions that hold humanity apart from the rest of nature, as do new biotechnologies that facilitate the transmission of information across boundaries formerly considered unbreachable. At the same time, we can also note a recent movement towards defining the human in technological terms. As Deleuze puts it, 'In the societies of control... what is important is no longer either a signature or a number, but a code. ...Individuals have become "dividuals", and masses, samples, data, markets, or "*banks*"' (1992:5). Through codings and other informatic procedures, human being is increasingly opened up to technology.

In this context, we might wonder, as the title of a recent collection of texts on the social and philosophical implications of genetics states it, 'Is Human Nature Obsolete?' (Baillie & Casey, 2005). As the contributors to this volume make clear, the prospect that the answer to this question might be 'yes' has been met with varied responses of optimism, dread, and anxiety. At one extreme, there

are those who embrace the posthuman condition as an opportunity for human beings to leave behind the domain of natural evolution and to henceforth direct their own evolution. Pierre Baldi's *The Shattered Self* (2001) is a good example here. His analysis of the epistemological implications of genomics, bioinformatics, and other new biotechnologies, predicts the undoing of categories such as 'human nature' and the individual 'self'. Baldi points to the completion of the HGP and to the prospect of human cloning as the most significant recent events that have provoked this rethinking of our selves. He claims that 'human cloning challenges the stability of who we really are, regardless of whether or not we end up doing it' (2001:3). It is not a surprising move, for if the biological character of the modern human is defined in terms of its organic qualities, which are themselves, in turn, conceptualized on the basis of (hetero)sexual organization, then posthumanist discourses would seem drawn towards the post-organic, informatic notion of sex associated with cloning. When Baldi writes, 'From a functional standpoint, sex is on the verge of becoming entirely obsolete...' (2001:45), he is envisioning a time in which heterosexual intercourse, and the forms of identity associated with it, are no longer relevant to (post)human beings.

As Eugene Thacker (2003) points out, however, the optimistic embrace of biotechnology in posthuman discourses of this type tends to display a particular tension between the competing desires of transcending and retaining human identity. Baldi does not disappoint here. On the one hand, he advocates for a posthuman recognition of the fluidity of all life, suggesting that 'The boundary between the self and the other, the self and the world, the inside and the outside

has begun to blur, and ultimately may evaporate entirely' (2001:4). It appears here that what remains of the human should be regarded merely as one moment in the life of an open and complex system that has energy, information, and matter flowing through and beyond it. On the other hand, however, Baldi also wishes to affirm the power of technoscience to determine the constitution of an individual. He believes '... that if technology continues to progress at the current pace, within at most a few hundred years it will be possible, if desired, to produce any human being with any given genome specified on a computer' (2001:84). The effect of this image of reductionist genomics determining natural entities is to recoup the dissolution of humanism at a higher cognitive level where (post)humans retain control of nature through technology. Somehow the posthuman being deploys technology to control the natural world even as collapsing boundaries between nature, technology, and the human threaten the very coherency of such a project. Paradoxically, Baldi also argues that nature reasserts itself insofar as 'Unnatural evolution still obeys the law of nature and in many ways extends natural evolution' (2001:164). Notably, this (un)natural law also effects a recuperation of the gendered relation at the heart of modern science insofar as it reiterates the tension between a 'masculine' desire to control, and the discovery of its limits in an ultimately mysterious and 'feminine' nature.

At the other end of the posthuman spectrum we find a text like Francis Fukuyama's *Our Posthuman Future* (2002). Unlike Baldi, Fukuyama is quite explicit about the onto-theology of human nature that underlies his argument. His

claim is that 'human nature exists, is a meaningful concept, and has provided a stable continuity to our experience as a species' (2002:7). Moreover, he continues, 'there is a desperate need for philosophy to return to the pre-Kantian tradition that grounds rights and morality in nature' (2002:112). Rather than embracing the possibilities of the posthuman, Fukuyama's fear is that the new biotechnologies of the genomic era will destroy the concept of human nature and thereby undermine crucial forms of social organization that depend upon it.

Fukuyama defines human nature as 'the sum of the behavior and characteristics that are typical of the human species, arising from genetic rather than environmental factors' (2002:130). Immediately we can note that this presupposes that we are able to separate out the genetic from the environmental, and that the former is more important in defining the human condition. These are both problematic assumptions. Fukuyama's argument runs into further trouble when he seeks explain both the contents and existence of human nature in the following way:

We see colors, react to smells, recognize facial expressions, parse language for evidence of deceit, avoid certain dangers, engage in reciprocity, pursue revenge, feel embarrassment, care for our children and parents, feel repulsion for incest and cannibalism, attribute causality to events, and many other things as well, because evolution has programmed the human mind to behave in these species-typical ways (2002:143).

Even if we were to accept that 'human nature' is constituted by this list of cognitive facilities, the fact that Fukuyama draws upon evolutionary processes in explaining their existence raises the question of why we should now accept them as inviolable. If history is not yet at an end, then why freeze 'human nature' as it allegedly stands today? As Katherine Hayles has pointed out, 'The neat closure [Fukuyama's] argument achieves can be disrupted by the observation that it must also be "human nature" to use technology, since from the beginning of the species human beings have always used technology' (2005:144). In a sense, we might say that we have always been 'posthuman'.

Ultimately, Fukuyama presents us with a claim that is diametrically opposed to that of Baldi, but which also invokes a dialectic that resonates with the gendered desires of modernity. Reprising a central tension associated with modern science, Baldi enthuses over the potential for human beings to overcome nature and freely direct their own evolution, while Fukuyama is alarmed by this potential condition of freedom and wishes to reinstate nature as supreme arbiter of morality and propriety. Ironically, given his Hegelian belief that 'Much of politics centers on the question of human dignity and the desire for recognition to which it is related' (2002:149), it might be said that what troubles Fukuyama most is that humanity will indeed come to recognize only itself in nature as it takes control of its own evolution. Unsurprisingly, cloning is the first biotechnology that he would have banned. The reason being that it is 'a highly unnatural form of reproduction that will establish equally unnatural relationships between parents and children' (2002:207). Yet again, anxieties over technoscience come back to

the issue of (hetero)sex. We might say that as the 'masculine' desire of science is seen to dominate nature totally, the consequent disruption of (hetero)sexual order threatens to unleash an unsettling sense of freedom; hence the authority of 'feminine' nature must be reaffirmed.

According to Fukuyama, the potential consequences of intervening into process of 'natural' (heterosexual) reproduction are dire. He ends his book with the claim that 'the posthuman world could be one that is far more hierarchical and competitive than the one that currently exists, and full of social conflict as a result' (2002:218). His argument is that the rise of a genetic elite — who have been genetically engineered to be superior, and who can afford to do the same for their children — will set the scene for a 'full-scale class war' (2002:16). Presumably, we will all be better off in the more equal world that we inhabit now. Perhaps this is true. On the other hand, it might also be that the advent of genetic engineering, cloning, and other biotechnologies would disqualify freely produced 'natural genetic differences' as an explanation for social inequalities. From this perspective, it may be more appropriate to suggest that the maintenance of the (hetero)sexual order of nature is crucial to the stability of the current socio-economic order.

For Fukuyama, biotechnology threatens human complexity and diversity because it takes an instrumental approach to human nature. This is a fair concern, but we can question whether it is the only possible outcome of contemporary genomics. Discourses of posthumanism, whether they are celebratory like Baldi's or denunciatory like Fukuyama's, tend to be somewhat

one-dimensional in their fascination with genetic codings and the transcending of human nature. Both may be guilty of circumscribing the posthuman too narrowly in terms of human control over nature. In effect, they celebrate or denounce a concept of the posthuman that neglects any other sense of the danger or freedom that might possibly accrue to human beings through a biotechnological intervention that opened up new possibilities in relation to nature or life.

From a different perspective, Thacker is critical of what he calls 'extropian' posthumanist discourses, which, like both Baldi and Fukuyama's, are premised upon the belief that advances in technoscience will allow human beings to transcend the natural limitations of their biology. He argues that both advocates for this popular posthumanism and their critics alike are dependent upon a certain notion of what it means to be 'human' in their speculations on possible posthuman futures. For Thacker, such positions tend to neglect the question of whether contemporary biotechnologies are in fact undermining fundamental categories such as 'body', 'organism', or 'life' in ways that call for new modes of thinking. Against the pervasive assumptions of posthumanist discourses that biotechnology is leading humanity away from nature and materiality, he claims that, 'Instead of being focused on disembodiment and virtuality, biotech research's approach to informatics is toward the capacities of information to materialize bodies' (2003:88). Picking up on this point, I want to consider the possibilities for rematerializing a posthuman concept of 'sex' through a discussion of Thacker's concept of 'biomedia'.

Thacker employs the term ‘biomedia’ in order to conceptualize the body as it is materialized within the intersecting discourses and practices of genomics, computer science, and informatics. He notes that ‘The “goal” of biomedia is not simply the use of computer technology in the service of biology, but rather an emphasis on the ways in which an intersection between genetic and computer “codes” can facilitate a qualitatively different notion of the biological body — one that is technically enhanced, and yet still fully “biological”’ (2004:6). Rather than viewing technoscience simply as a tool that enables human control and domination of life, the concept of biomedia references the technicity of nature itself. Echoing Spinoza and Deleuze, Thacker comments, ‘...what we find with biomedia is a constant, consistent, and methodical inquiry into this technical-philosophical question of “what a body can do”’ (2004:6). Here, the technological question is neither divorced nor reduced to the ontological question — on the contrary, a body is what a body is able to do.

From another perspective, biomedia might perhaps be thought of as the material realization of the informatic body first hinted at in Mendel’s pea experiments. In biomedia, biological information is translated across different bodies, thus loosening the strictures of specificity and organic integrity. The success of this translation process is dependent upon an ‘...informatic protocol, in which the principles for managing data are the means by which biomedia recontextualize the biological domain’ (2004:16). Although Thacker does not conceptualize it as such, this process of biomediated recontextualization might well be seen as generating a mode of sexual connection that subverts the quasi-

teleology and onto-theology of (hetero)sexual difference and the social arrangements that depend upon it. If biology has traditionally defined 'life' in terms of the sexual organization of the organism resisting death, then the nonorganic, productive life that emerges out of biomedicine seems to draw the concept of 'sex' further away from the meaning it once held in reserve.

One of Thacker's key points is that bioinformatic protocols should not be regarded solely as disembodied mechanisms that reduce life to genetic codes. Rather, he suggests that there is a fundamental tension over the status of materiality at work in the practices of contemporary biotechnology. On the one hand, data and patterns of relationships are abstracted and translated intact across different material bodies. Yet, on the other hand, biological information does not simply remain the same throughout this process, as it is always open to the medium of translation. As Thacker points out:

This is further complicated by the fact that, with biomedicine, the aim or application is not to move beyond the material substrate, but to constantly appear to return to it, in a self-fulfilling, technical optimization of the biological, such that the biological will continue to remain biological (and not 'technological') (2004:28).

The 'information' that moves from one body to another is simultaneously technological and biological. What is important to note here is that biotechnology ultimately defers to the agency of 'life itself', even as it reveals the latter to be inorganic, and even as it deploys discourses of control over the natural world.

Thacker reveals the nature of this deferral to 'life itself' through a discussion of contemporary nanotechnology, which is an exemplary instance of the desire behind molecular biotechnology insofar as it aims to manipulate and control life at the atomic level. He argues that even though nanotech bodies may be characterized as 'postvital' or 'postnatural', there is still 'a return to the vitalist reserve of a life force beyond human knowledge, which serves as both the foundation and the origin of the study of life' (2004:136). This act of recuperation allows the vitalist legacy of biological thought (running back at least as far as eighteenth-century natural history) to remain in play. We might also say that nanotech, like other forms of biomedica, suggests a return of the 'photographic' insofar as it desires to be a technology that allows nature to present itself in its own time. Nanotech's relation to the body, as Thacker characterizes it, '...is also a return to the dream of being able to make the "truth" of the body show forth, to in effect materialize the truth of the natural, biological body, its very materiality' (2004:137). We are perhaps again witnessing a moment in which we are challenged to rethink the relation of technology to nature. Just as the early photographers of the nineteenth century were unable to decide if their pictures were produced by their cameras or by nature itself, so the concept of 'biomedica' points to an ambiguity in the ontological status of those forms of life produced through biotechnology. In this sense, contemporary biological technoscience does not represent a radical break from the past, but rather embodies the same tensions around questions of control and authority that have characterized the technovision of modern science in relation to nature.

The question of what it means to be human is also at stake in nanotechnology, which may be regarded as a posthumanist discipline insofar as it figures life in terms of the interaction of informatic codes that do not respect the division between human and nonhuman. Thacker suggests that '...nanotech provides the opportunity for thinking about the body as biomechanical... a redefinition of the body as both natural and technical matter' (2004:139). While nanotech seems reliant upon a mechanistic and reductionist framework, it is not simply a matter of the imposition of control over nature, as the technology itself becomes incorporated into the biological. Again, this might well be understood in terms of Heidegger's characterization of modern technology. Nanotechnology manifests a desire to enframe and control nature at the very smallest, most fundamental levels by presuming that the principles of mechanical engineering apply to 'life itself'. Yet, at the limits of its technovision, another form of vision appears. While Thacker notes that 'the body as a noncausal, networked, multi-agential, and ontogenic system is excluded from the concerns of nanodesign' (2004:139), this may actually be the picture of nature that is generated by the logic of its approach. Insofar as nanotech and other biotechnologies work, intentionally or not, to efface the boundary between the natural and the technological, they allow a certain insight into both the material and technical complexity, and the informatic permeability and openness inherent in the constitution of life. Hence, the task at hand is not to reject the reductionism of molecular biology out of hand, but to follow the paths it opens towards a different understanding of the relation between nature, technology, and humanity.

Thacker identifies 'systems biology' as a promising alternative to the genetic reductionism that still governs mainstream molecular biology and commercial approaches to biotechnology. In part, the increasing prominence of systems biology can be traced to the need for new ways of making sense of the surfeit of data produced by the HGP. For Thacker, while it fully subscribes to an informatic view of the body, 'The twist... is that, with the aid of new computing technologies, systems biology rematerializes the exchange of matter and energy in novel ways' (2004:157). The emphasis here is on nonlinear relations rather than on 'things' such as genes that act as 'causes' of phenotypic traits in any simple sense. In the post-HGP environment, it has become more apparent that genomics requires a better understanding of the myriad relations that are involved in the production of both human beings and other natural entities. It might be said that what is required is a reconceptualization of the body that moves away from the limitations of organismic thinking, and towards an understanding of open systems. In this regard, Thacker proposes that 'The body of systems biology is not anatomical in that it does not presuppose a whole that is constituted by its parts in a fixed, functional manner. However, we are also led to a model of the body that is equally different from the bioinformatic body of DNA and molecular genetics' (2004:160). In contrast to these traditional models, Thacker refers to the body as materialized by systems biology as a 'biomolecular body'. On this model, the body is 'distributed', 'in parallel', 'dynamic', and 'focused on relations over substance/structure' (2004:162). This gives us a very different sense of what the posthuman might look like as compared with popular

accounts that emphasize human specificity and control. It becomes a matter of attempting to think the body beyond the organism, and of moving towards a different understanding of life that is no longer beholden to an ontological division between the organic and the nonorganic, the human and nonhuman, or the natural and the technological.

In thinking about the relations between biological, technical, and social systems, we perhaps have the opportunity to reintroduce questions concerning sex and gender. Although he does not draw the implication himself, Thacker's concept of biomedica, along with his discussions of nanotechnology and systems biology, have obvious (albeit uncertain) significance for the concept of (hetero)sexual difference that has governed the organicism of modern biology. The sexual relations of the biomolecular body would seem to be more in line with Parisi's notion of 'abstract sex' than with the heteronormative couplings required to reproduce an onto-theological natural order. With this in mind, I suggest that a 'posthuman' bioethics, which strives to be appropriate to the nonlinear relations and open systems of the biomolecular body, needs to be aware of the critical potential of the unnatural sexual relations enabled by biotechnologies. The individual, organic body is a (hetero)sexual body, and this logic is what sustains it through time and in its relations with other bodies. (Hetero)sexual difference maintains the body as a closed system by positing deterministic relations between ontology and action, the biological and the social. The question is: what does the informatic sex of the biomolecular body allow us to imagine in regard to freeing up the natural, technological, and social relations that constitute our lives.

For Thacker, an alternative 'bio-ethics' would recognize that 'emerging biotechnologies are transforming our basic notions of "body", "nature", and the "human"' (2004:176). By adding 'sex' to this list, we can perhaps gain a useful perspective on the divergence of contemporary genomic science from the biological tradition, which has always been beholden to the limitations of organism-centric theories. In considering the structure of modern biological thought — in both its genetic and evolutionary traditions — it may be worth our time to reflect on the fact that natural bodies have generally been defined in organic terms premised upon relations of (hetero)sexual difference. As discussed above, this structural feature of biological discourse has served to foreclose alternative readings of nature such as that advanced by Bagemihl with his concept of 'biological exuberance'.

Indeed, in many respects, Thacker's 'bio-ethical' position is very much in line with that put forward by Bagemihl insofar as the intention is 'to take literally (that is, in its materialization) the notion of an ethics related to and informed by bodies' (2004:184). Where Bagemihl draws on the work of Bataille, Thacker (like Parisi) turns to Spinoza/Deleuze. He notes, 'Deleuze's Spinoza always comments that we do not know what a body is, or what a body can do. This is never more true than in the technosciences, where new developments daily redefine the boundaries of the body/technology, natural/artificial, subject/object' (2004:185). It is not a matter of technological determinism, but rather of how biotechnology can serve to free up the potentials inherent to matter itself as it enters into social theory. While contemporary biotechnologies often seek to

control what it is that bodies can and may do in the interests of commodification and profit, they may also offer the chance for nonorganic bodies to make libidinous connections that take them beyond the strictures of (hetero)sexual difference.

With this reference to Spinoza, we are returned to the late seventeenth century, to a time when natural bodies were beginning to feel pull of the competing, and yet deeply congruent demands from Christianity and modern science. Both put forward the demand that sexually differentiated bodies bear witness to a greater truth, a secret that was putatively lodged within their organic natures. Spinoza's voice was a dissonant one, however, as he sought to affirm the potential of bodies not merely to be known, but to know. Today, it may be that emerging biotechnologies are again making it possible to conceptualize what it is that bodies may know. I suggest that the challenge for social criticism in relation to technoscience is to enable the emergence of new bodies of knowledge beyond the quasi-teleology of (hetero)sexual difference, and to understand how these bodies may affect the web of social relations in which they find themselves located.

The Becoming of Sex

The question of what bodies may know, or of what they may do, can perhaps be connected to recent tendencies within contemporary technoscience towards an understanding of nature and life in terms of complexity, nonlinear relations, and emergent properties. Just as Thacker points to the rise of systems

biology, Norton Wise claims that there has been a 'sea change' in the character of much recent scientific explanation, whereby 'in place of reductionism we see a new focus on understanding how elementary elements get built up into complex ones' (2004:1). What might 'sex' become within the open framework of a nonlinear, post-reductionist biology, and what would this mean for the relation of gender to science? Undoubtedly there is potential here for dislodging simplistic but persistent beliefs concerning the nature of sex, of gender, and of science. Yet, we should not be too quick to presume the emancipatory potential evident here. As Stengers points out, 'For some years, the theme of complexity has played an ambiguous role in discourses on science. It allows one both to defend science against the charge of "reductionism" and at the same time to envisage science's conquest of what until now had escaped it' (1997b:3). If the latter position holds sway, then the onto-theological desire animating science remains unchanged.

It may even be that, like the HGP, the new biology of complexity and emergence reiterates, in significant respects, the 'photographic' structure of desire that characterizes modern science's quest for control over nature. Recall that the photographic process was conceived in the context of an epistemological crisis brought on by a pervasive awareness of the historicity of nature. The science of the late eighteenth-century was faced with a world that appeared increasingly complex and hard to classify as the former certainties of an onto-theological natural order were undermined by the passage of time. In this context, the desire to photograph might well be understood as a desire to capture the complex,

emergent properties of nature as they freely presented themselves. Photography, as a paradigm for the thought of nonlinear temporal relations in the modern world, offers both the seductive promise of simplified, objective scientific knowledge and control, as well as the frustration of never being quite being adequate to its desire. It is the latter that gives us a glimpse of complexity both within and beyond the limits of technovision, and in this way opens up an emergent picture of nature as an event of becoming. An image is produced that offers itself as a resource to critical thought. The task is to foster those moments of relative freedom when technoscience allows us to see in a different way.

A critical perspective that hoped to go beyond the prosaic thinking evident in popular images and discourses on genetics (as evidenced in chapter four) would also need to affirm the value of nonscientific perspectives, and to show how technoscience opens up nature to other modes of thought. For it may be that technoscience is never quite able to grasp the event of nature as it freely produces the new. As Brian Massumi writes, 'Scientific endeavor begins in the afterstrike, at the point when enough distance from the situation's liveliness can be taken that it becomes practical to *suspend lived belief* (2002:232). Science must step out of the flow of time, and as a result 'it can be argued that science *misses nature by design*' (2002:236). Massumi's account draws upon that of Deleuze and Guattari, who invoke the cinematic (but also photographic) metaphor of a 'freeze-frame' to describe the action of science upon the chaos of the world. They write that 'It is a fantastic *slowing down*, and it is by slowing down that matter, as well as the scientific thought able to penetrate it with

propositions, is actualized' (1994:118). The HGP may be regarded as 'photographic' insofar as it desires to freeze the genome, to slow down its informational interactions so that they may be captured by scientific observation. At the same time, however, genomic technovision experiences its limits in what is concealed by the static picture of nature thereby produced, thus opening up the possibility of a different type of body and a different type of vision. Recent developments in the science of complexity and biological emergence perhaps suggest that something like the ambiguity inherent in early photographic desire is being recovered. Elizabeth Grosz, for example, has proposed that such research raises the possibility of 'thinking the new' insofar as it provides us with a picture of life in terms of 'direction without destination' and 'movement without prediction' (1999:19). It may perhaps also offer the chance to embrace our freedom by relinquishing the desire for absolute control over nature.

While different technosciences remain limited by their own perspectives on the world, they also offer resources for other ways of seeing, and of thinking. These alternative optics might be something like the 'machinic vision' which John Johnston has described in relation to digital information technologies. Also drawing on Deleuze and Guattari, Johnston notes that 'machinic' implies relations among heterogeneous parts which make up an 'assemblage' that is neither mechanical nor organic. He describes machinic vision as '...not so much a simple seeing with or by means of machines... as it is a decoded seeing, a becoming of perception in relation to machines that necessarily also involves a recoding' (1999:28-9). Implied in the notion of machinic vision is a moment of

`deterritorialization' whereby the epistemological order of things is put into question. Some form of machinic vision — constituted through critical reflection on technoscience and its products — might be what we need today in order to see what `sex' is becoming under the sway of biotechnologies and informatics. In a sense, this would mean reconceiving biotechnologies as machines that disorganize bodies, and which allow a distributed, nonorganic vision that can envisage new relations of energy, matter, and information, as they constitute bodies as open systems.

Geoffrey Batchen argues that `Photography will cease to be a dominant element of modern life only when the desire to photograph, and the peculiar arrangement of knowledges and investments that that desire represents, is refigured as another social and cultural formation' (1997:216). If the technovision of biological science is indeed `photographic' in some sense, then machinic vision might perhaps be characterized as technovision at the limits both of modern science and the society of which it is a part. It might be seen as an intimation of a different relation between knowledge, nature, and the human subject. It might be a step towards affirming the freedom of life — its biological exuberance — beyond the categories of (hetero)sexual difference and gender. This would imply a critical perspective on science that was sensitive to the ways in which its technovision draws upon and reiterates gendered social structures, as well as those of race and class, and would figure its political considerations accordingly. It would also realize that the `death of God' is still in question. In the recombinant translation of bioinformatics across different forms of life, I think that

it is possible to see that genomic vision holds the potential for a deterritorialization of the organic body governed by (hetero)sexual difference. At the same time, however, its location within social-cultural-technological assemblages may block the decoding of perception unless critical attention is given to these relations.

If the politics of gender and science are dependent upon the continued production of (hetero)sexual difference, then the role and potential of technoscience in the reproduction or disruption of (hetero)sexed and gendered subjectivities demands our attention. I suggest that a critical politics of gender and science today should begin from within the culture of technoscience itself; otherwise, we risk failing to grasp the internal relations and mutual co-production of science, sex, and gender, and therefore of being restricted to critical perspectives that locate gender politics outside of the 'essence' of technoscience. It is perhaps a question of how to think both with and against the current of contemporary biological science, and of asking what it may allow us to see at the limits of its own visions of life.

This chapter, like this dissertation as a whole, does not present an argument that genomics, cloning, or biotechnology are necessarily good or bad; rather, the point is that while there are clearly dangers involved with the capacity of technoscience to facilitate capitalist penetration, control, and commodification of the subindividual level of life, as well as the potential for reaffirming and reproducing sexual, racial and socioeconomic class-based inequalities, genomic science and biotechnology also offer resources for thinking differently, and for undermining naturalized structures of inequality. More specifically, I have argued

that by paying attention to the ambiguous place of 'sex' in the constitution of genomic vision, we can discern the outlines of an alternative politics of gender arising from within the tradition of biological thought. This dissertation has attempted to highlight some of the key moments informing the historical relations of (hetero)sexual difference and genetic science as a means of disrupting conventional understandings of the relation of science and technology to nature. By returning to the prehistory of biology in eighteenth-century natural history, I have argued that a certain onto-theological notion of (hetero)sexual difference both informed the constitution of biological science, and continues to influence its conceptualization of nature today. I also suggested that there is more than mere coincidence at work in the contemporaneous emergence of biology and photography in the early nineteenth century. By theorizing modern technoscience in terms of a peculiar form of 'photographic' vision, I believe that we gain a useful perspective on both the limits and the concealed possibilities of genomic visions. The tensions inherent in this scientific/photographic mode of viewing the natural world are apparent in key texts — Mendel, Schrödinger, Wiener — that have informed molecular biology and the HGP, and by reading these tensions in gendered terms we gain a different understanding of the relation of gender and modern science. In this regard, my argument throughout this dissertation has not been that science *is* masculine, but rather, that in biological science we can locate a certain form of desire for knowledge and control over nature that reiterates the structure of masculine desire. Moreover, in both cases, this desire runs up against its limits insofar as it surreptitiously relies upon a notion of the

feminine figured as representative of natural authority. In effect, I argue that both modern science and the concept of (hetero)sexual difference that underlies out modern gender concepts respond to one of the central problematics of modernity — the need to reconcile the desire for control over nature with the desire to submit to the ultimate authority of the latter. In the end, it may be that the relation of (hetero)sexual difference to both biological science and onto-theology will need to be confronted if we are to envision new networks of relations between nature, technology, and culture that will allow us to dwell more contently in freedom.

Notes

¹ The same two scientists later (in May 2005) announced that they had developed a new and highly efficient method for human embryo cloning. This is currently in doubt, however, with recent revelations that some of the data for the later article had been faked. Interestingly, much of the debate has focused on the authenticity of a series of photographs included as evidence within the article.

² Different perspectives exist on the question of whether a cloned embryo does actually have the potential to become a human being. Many scientists argue that imprinted genes are not properly expressed in cloned human embryos, and thus the potential for a successful pregnancy is very low or perhaps nonexistent.

³ See chapter one for a fuller discussion of Butler's work.

⁴ William Miller (1998) also associates cloning with the uncanny. Miller, however, regards uncanniness simply as a synonym for disgust or revulsion and conflates the three terms. In contrast, my argument here is that the uncanny belongs to a quite different affective register.

⁵ See chapter two for more on the relation of photography and death.

⁶ For more on Butler, Freud, and the 'uncanniness' of drag, see Garlick (2002) from which the above account is, in part, drawn.

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