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ENVIRONMENTAL JUSTICE AND GENOMICS: Acting on the Futures of Environmental Health

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Technoscientific innovations may create multiple possible futures, only some of which are produced and/or sustained. Increasingly, sociological studies of technoscience endeavour to render visible the processes through which specific futures are envisioned and enacted (Brown *et al.*, 2000; van Lente and Rip, 1998). Such an intellectual quest demarcates a vast terrain, as evident in Adam's admonition that scholars of technoscience must explain

> how the future is created, contested, colonised and consumed; how it is materialised, managed and 'mastered'; how opportunities are created for some at the expense of others; how uncertainties, indeterminacies, and contingencies are handled and how the profit potential of innovative technologies with unknowable side effects is played off against caution and precaution (2000, pp. xii–xiii).

The purpose of such analyses is not 'to postulate on the probability of one future against another' nor to 'generate normative prescriptions about particular futures', but rather to illuminate the present tense 'activities of actors utilizing a range of differing resources with which to create "direction" or convince others of "what the future will bring" ' (Brown *et al.*, 2003, p. 4). Social movements focused on health and the environment are frequently among the actors engaged in envisioning and directing others towards particular futures through their advocacy efforts on behalf of specific forms of research, treatment modalities, or regulatory procedures (Epstein, 1996; Frickel, 2004; Brown *et al.*, 2003). This paper examines how environmental justice activists view and respond to potential futures

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made possible by the emergence of molecular genetics/genomics in the environmental health sciences.

Already, molecular genetic/genomic technologies and their applications in biomedical settings have provided an important site for the development of a 'sociology of technological expectations' and possible futures (Hedgecoe and Martin, 2003; Ling, 2000; Nelis, 2000). However, relatively less analytic attention has been paid to visions of and movement towards specific potential futures for molecular genetics/genomics in *non-medical* settings. In this paper, I focus on the emergence of molecular genetics/genomics in the arena of environmental health science, risk assessment, and regulation.[1] I find that locating sociological analysis in this arena provides an important vantage point for examining how social movement activists are envisioning and acting on potential genetic/genomic futures outside of the clinic. Moreover, the narratives of environmental justice activists enable an analysis of the relationship between emergent, molecular modes of knowledge production and new forms of regulation and governance focused on environmental health and illness. Indeed, as I detail in the coming pages, the expectant concerns of environmental justice activists focus not only on molecular genetic/genomic technologies *per se*, but on how the forms of knowledge that they produce could be used in environmental health risk assessment, regulation, and politics.

MOLECULARIZATION AND BIOPOLITICS

'Molecularization' refers to the ascendance of scientific practices that visualize, measure, and intervene in life at the molecular level (Kay, 1993). Generally speaking, the molecularization of the life sciences began in the 1930s (Abir-Am, 1987; Kay, 1993; Pauly, 1987); however, it has taken different forms and extended at different rates throughout various disciplines (de Chadarevian and Kamminga, 1998). The molecularization of the environmental health sciences, in general, and toxicology, in particular, is a more recent phenomenon (Shostak, in press). Drawing on Rose, I suggest that molecularization consists of not 'merely a matter of the framing of explanations at the molecular level. Nor … simply a matter of the use of artefacts fabricated at the molecular level' but rather a *reorganization* of the environmental health sciences, their 'institutions, procedures, instru-

ments, spaces of operation and forms of capitalisation' (Rose, 2001, p. 13).

Further, I contend that molecularization in the environmental health sciences poses the possibility of new forms of governance in the domain of environmental health and illness. As highlighted by the writings of Michel Foucault and his contemporary interlocutors, modes of knowledge production about human vitality are deeply implicated in the establishment of social orders and political governance (Castel, 1991; Flower and Heath, 1993; Foucault, 1978; Lenoir, 1997; Rose, 1996, 2001). According to Foucault, 'biopower' is that which brings life and its mechanisms 'into the realm of explicit calculation and ma[kes] knowledge-power an agent of transformation of human life' (1978, p. 143). Biopower operates in discourses of truth that form and take form in disciplines and institutions; at a given moment it may focus both on the body of the individual and/or the body of the population. The constituent elements of biopower today include 'knowledge of vital life processes, power relations that take humans as living beings as their object, and the modes of subjectivation through which subjects work on themselves qua living beings' (Rabinow and Rose, forthcoming).

In contemporary society, biopower shapes political struggles, as they increasingly centre on 'the specific ways in which … aspects of … human vitality [are] problematised, and the contests over these problematisations, over the forms of knowledge, regimes of authority, and practices of intervention that are desirable, legitimate and efficacious' (Rabinow and Rose, forthcoming). Of particular importance to my analysis, Rose suggests that when the dominant form of knowledge production or 'regime of truth' in a society becomes molecular, 'biopolitics now … is waged about molecules, amongst molecules, and where the molecules themselves are at stake' (Rose, 2001, p. 17). This suggests that in the future, molecularization in the environmental health sciences might compel actors interested in environmental health and illness to orient their activities to the molecular level. This could also have significant implications for the environmental justice movement, which, as I detail below, is organized and oriented to a macro-politics linking race/ethnicity, socioeconomic status, and environmental exposures.

Moreover, social scientists observe that molecularization may instantiate new forms of individual and group subjectivities (Novas

and Rose, 2000; Rabinow, 1992/1996). For example, Novas and Rose have argued that the 'key event' in the emergence of the contemporary scientific category 'genetic risk' is 'the creation of the person genetically at risk' (2000, p. 485). Through specific practices, such as genetic counselling, such persons may 'rethink their relation to their families' and/or 'reshape their form of life—lifestyle, diet, leisure activities, alcohol, smoking—which also reshapes their relations with those with whom they interact' (Novas and Rose, 2000, p. 490). Thus, being identified as genetically 'at risk' is a productive identification enabling individuals to assume the specific practices of 'responsible genetic subjects' (Novas and Rose, 2000, p. 504).

Innovations promised by scientist entrepreneurs advocating for the molecularization of the environmental health sciences include quicker toxicological assessments, more certain 'molecular' identification of chemical classes and chemical exposures (including mixtures), and the identification of individuals and subpopulations who are genetically susceptible to chemicals in the environment (NCT, 2002; Olden and Wilson, 2000; Olden, 2002; Paules *et al.*, 1999; Perera, 1997; Simmons and Portier, 2002). If successful, these applications of molecular genetic/genomic technologies could engender a fundamental shift in the conceptualization of environmental health and illness—and its regulation—in the United States. This shift is nowhere more visible than in the potential of molecular genetic/genomic technologies to identify individuals and subpopulations genetically susceptible to the harmful effects of environmental exposures, either by virtue of inherited genetic traits or DNA damage resulting from previous exposures. To date, the primary logics of control for environmental health has been the assessment and regulation of the ambient environment—the air, water and soil. Related, the classification and regulation of *environmental chemicals*, rather than the classification and regulation of persons and subpopulations, have constituted the dominant logics of control for protecting human health vis-à-vis the environment. In contrast, molecularized approaches within the environmental health sciences tend to focus within the human body and at the molecular level (e.g. on DNA, genes, gene expression) and on differences between individuals (Hattis, 1996). Thus, they may extend the locus of control for environmental health and illness 'from enhanced control over external nature (i.e. the world around us) to the harnessing and transform-

ation of internal nature (i.e. biological processes of human and nonhuman life forms)' (Clarke *et al.*, 2003, p. 164). Indeed, even while the current regulatory regime remains focused on the ambient environment, environmental policy analysts report that they are beginning to anticipate 'moving environmental regulation inside the human body' (field notes, 2002). Such a potential biopolitical future is of increasing concern to environmental justice activists.

MOVING TOWARDS ENVIRONMENTAL JUSTICE

Most histories of the environmental justice movement (EJM) mark its initiating and 'defining moment' as the September 1982 protests against the siting of a toxic chemical disposal dump in Warren County, North Carolina (Bryant, 1995, p. 4; Bullard, 1994, p. 5; Di Chiro, 1995, p. 303). There had been social movement activism around toxic contamination before this event, such as the struggle against the Hooker Chemical Company at Love Canal, New York in the late 1970s. However, the Warren County protest was 'the first time in history that poor African Americans banded together—with the support of civil rights and environmental groups on a national level—to fight an environmental battle affecting a poor, minority community' (Newton, 1996, p. 2).

The EJM is now a multi-organization network involved in informing, assisting, organizing, and advocating with communities endangered by environmental conditions, proposing research and policy agendas, and insisting on new approaches to the creation and management of hazardous wastes. Many of these organizations work at multiple levels of government and meet together to share and develop agendas, strategies, and tactics oriented to 'protect[ing] the environment and health of all, including those living in communities of colour and places that are economically exploited' (Shepard *et al.*, 2002).

Additionally, the EJM has been successful in developing and promulgating 'environmental justice' as an analytic framework for 'uncovering the underlying assumptions that may influence environmental decision making' and analyzing and promoting 'strategies to eliminate unfair, unjust and inequitable conditions and decisions' (Bullard, 1994, p. 10). In 1994, President Clinton signed Executive Order, 12898, which states that

> To the greatest extent practicable and permitted by law … each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health and/or environmental effects of its programs, policies and activities on minority populations and low income populations in the United States … (Section 1-101).

Following this order, environmental justice has been taken up as a concern across the federal government, though it is defined varyingly by different government agencies.[2]

Activists in the environmental justice movement focus their analysis and actions on the political, economic, and social structural factors that make race and SES important determinants of environmental exposure and environmental health effects (Brown, 1995, p. 15; Lavelle and Coyle, 1992; Mohai and Bryant, 1992). From an environmental justice perspective, race, socio-economic status, political disenfranchisement, and associated disparities in environmental exposures are the most significant sources of susceptibility to environmentally associated diseases. This contrasts markedly with the emergent genetic/genomic foci of the contemporary, molecularizing environmental health sciences.

MOVING TOWARDS GENETICS/GENOMICS

Beginning in the 1970s and accelerating throughout the 1980s and 1990s, environmental health scientists increasingly incorporated molecular biological technologies and concepts in their research on the etiology and progression of environmental illnesses (Frickel, 2004; Shostak, 2003b). During this time, genetic/genomic subdisciplines of epidemiology and toxicology, including molecular epidemiology, environmental genomics, and toxicogenomics emerged as the 'big news' (Park, 1952) in the environmental health sciences. Using molecular biological and genomic tools, these practices have focused environmental health research at the molecular level and within the human body (Shostak, 2003b).

There are two primary ways in which these new approaches to environmental health and illness focus environmental health research at the molecular level. First, each of these sciences seeks to identify

and characterize *intrinsic* (i.e. inherited) genetic variations that may shape individual and subpopulation differences in response to environmental exposures (Perera, 1997). Environmental genomics is defined by its goal of identifying 'environmental response genes'—those inherited genetic variations that may affect individuals' responses to environmental exposures (NIEHS, 1997). In molecular epidemiology, 'why similarly exposed people do not get the same diseases is a target question … in most disease systems, susceptibility markers are being identified and evaluated' (Schulte and Perera, 1993, p. 7). Likewise, toxicogenomics focuses, in part, on the study of 'the relationship between genetic variability and toxicant susceptibility' (Nuwaysir *et al.*, 1999). At an institutional level, major initiatives focused on genetic susceptibility to environmental exposures include the Office of Genomics and Disease Prevention at the Centers for Disease Control, the Environmental Genome Project of the National Institute for Environmental Health Sciences (NIEHS), and programmes at academic research centres, such as the Center for Environmental Health and Susceptibility at the University of North Carolina.

Second, molecular epidemiology and toxicogenomics focus on the effects of environmental exposures at the molecular level, i.e. on DNA, genes and gene expression. Molecular epidemiologists have been particularly interested in developing and evaluating biomarkers of *dose* and of *effect* (Hemminki *et al.*, 1996; Perera and Weinstein, 1982, 1999). Molecular biomarkers of *dose* enable epidemiologists to measure the actual level of a compound within the body and/or the amount of a compound that has reacted with specific cellular macromolecules; molecular biomarkers of *effect* identify early biological effects resulting from exposures (Perera and Weinstein, 1999, pp. 518–519). Researchers working in toxicogenomics are especially interested in identifying gene expression profiles that may serve as 'fingerprints' or 'signatures' identifying specific chemical exposures and their effects within human bodies (Hamadeh *et al.*, 2002a, 2002b; Nuwaysir *et al.*, 1999). At the same time, these technologies can be used to identify 'persons at risk' from *acquired* genetic susceptibilities/damage. Molecular epidemiologists see this capacity as a new means of disease prevention, as individuals with acquired genetic susceptibilities/damage might be appropriate candidates for interventions, such as surveillance for early detection of disease,

chemoprevention, or behavioural modifications targeted at interrupting the progression from exposure to illness.

Molecular genetic/genomic technologies in the environmental health sciences are polyvocal, that is, they have the potential to speak of varied aspects of the relationships between the human body, the environment, health and illness. Related, they may be applied in a wide variety of approaches for intervening in environmental disease processes, including both policy level and individual, biomedical approaches (Christiani, 1996). As such, environmental justice activists are faced with the challenge of negotiating multiple possible futures for environmental health science, politics, and governance.

RACE, RESPONSIBILITY AND RISK ASSESSMENT: ENVIRONMENTAL JUSTICE ENCOUNTERS GENOMICS

In February of 2002, environmental justice activists from across the country gathered in New York City to attend a conference and symposium on human genetics, the environment, and communities of colour. The event was organized by West Harlem Environmental Action (WE ACT), an environmental justice group based in Northern Manhattan, with sponsorship from the Columbia University School of Public Health, the NIEHS, and the US Environmental Protection Agency (EPA). As attendees noted throughout the two days, it was a 'groundbreaking' meeting, the first national gathering addressing genetics/genomics organized by and for the environmental justice movement. During the first day, activists were briefed by speakers from the environmental health sciences, medicine, law, and academia on current research on genetics/genomics and its potential implications for the future of studying, preventing, treating, and regulating environmental health and illness. The second day was a symposium, attended primarily by activists, who gathered in small working groups to discuss the implications of genetics/genomics research in the environmental health sciences for communities of colour and the environmental justice movement. This meeting put genetics/genomics on the agenda of the environmental justice movement.[3]

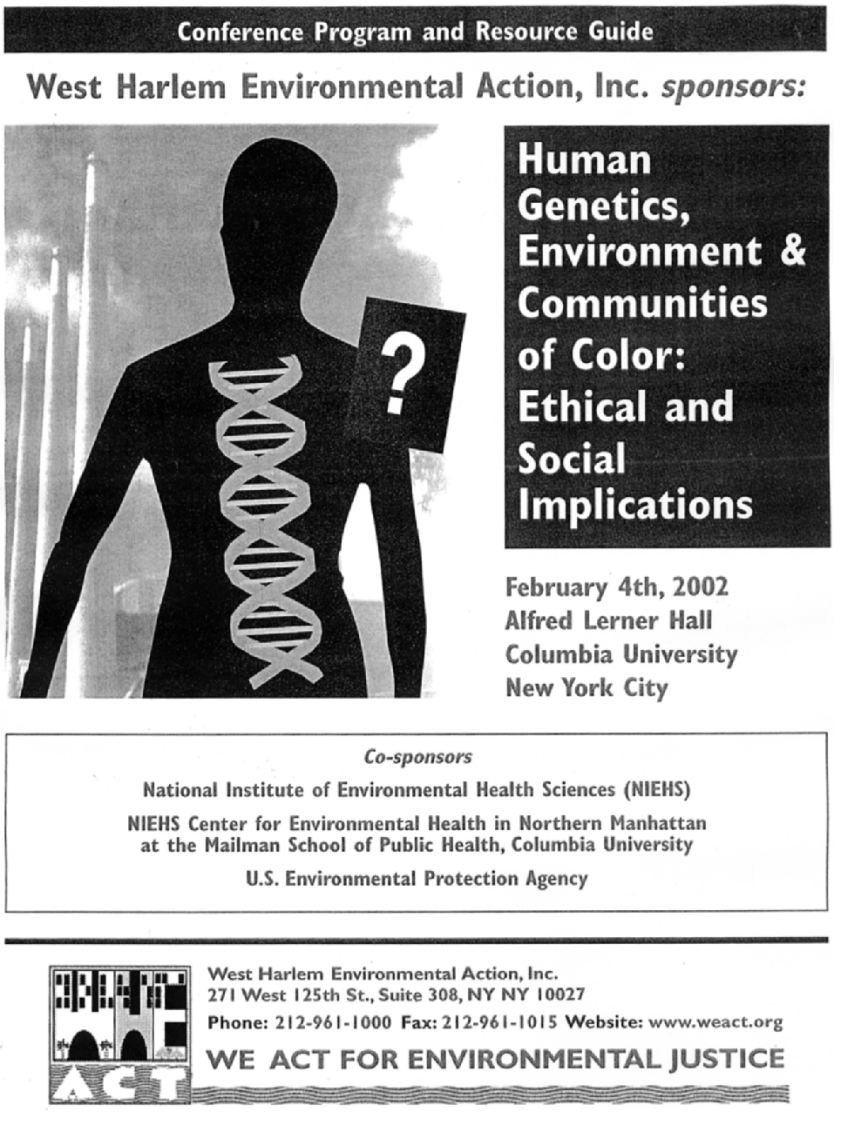
The WE ACT conference was a staged intersection, that is, a meeting 'which intentionally brought people together from diverse social worlds for the express purpose of persuasion and public

adjudication' (Garrety, 1998, p. 403). It was a forum in which activists, scientists and policymakers attempted to build momentum and gain legitimacy for their visions of the future of environmental health science and governance. As such, the interactions between conference organizers, sponsors, and attendees provide a vista onto their different perspectives on the promises and perils of possible environmental health futures. Three dimensions of the future of environmental health, illness, and justice emerged most prominently, both at the WE ACT conference and in my subsequent interviews with environmental justice activists: the meaning of race, the locus of responsibility for environmental health and illness, and the contradictory potentials making claims about environmental health and illness with molecular biomarkers.

☐ *Meaning of 'race'*

The current and future meaning of 'race' is a central concern of environmental justice activists. The meaning of race is often inextricable intertwined with biopolitics. Historically, 'race, together with health, and in variable relations with it, has been one of the central poles in the genealogy of bio-power' (Rabinow and Rose, forthcoming). Genetics/genomics raises questions regarding where and when knowledge about biology and health has the power to transform the meaning of race, in what ways, and with what consequences (Rabinow and Rose, forthcoming). These are matters of profound concern to environmental justice activists.

In articulating their concerns about genetics/genomics and the meanings of race, activists point particularly to research on subpopulation variations in susceptibility to environmental exposures, which use racial categories in both the conduct and reporting of research (e.g. Calabrese, 1996; Gilliand, 1997; Kalow, 1991, 1993; Renwick, 1996). Activists are especially critical of the possibility that contemporary genomic research will be used to create a next generation of scientized definitions of racial groups and usher in a new era of molecularized scientific racism. Invoking the abuses of the Tuskegee syphilis study (Jones, 1993; Reverby, 2000) and the 'biocolonialism' of the Human Genome Diversity Project (Reardon, 2001), participants of the WE ACT conference warned against research on intrinsic genetic susceptibilities as 'racism in a new cloak'. As one



Credit: West Harlem Environmental Action and Edward Towles (design).

activist at the WE ACT conference stated, 'I just hope that the primary outcome of all of this is not to say that some people are more susceptible than others. I'm concerned about science saying to Black people: "You're sick from this exposure because you're genetically susceptible" '. A second activist warned conference participants that

'We cannot get caught in the trap of deepening the discussion about genetics and our illnesses'.

At the same time, the emphatic statements made by scientists that 'race does not exist' are of great concern to environmental justice activists. They argue that while the concept of race has no valid *biological* basis, it must be recognized as a *socio-political* category with significant consequences for communities of colour, perhaps especially in the area of environmental health. This tension was most evident when an activist at the WE ACT conference expressed concern that she 'hadn't heard anything about how environmental health genetics research was addressing the race issue' and was told by a scientist that 'I can't answer that. I don't do the race thing, because I am a scientist. Race is a social construct. I can't do anything with it'. For the next several minutes, the room resounded with angry testimonials from activists about the many ways in which, in the words of the conference summary, 'the harsh realities of racism cannot be erased by a simple declaration that genetics proves that there is no such thing as race' (WE ACT, 2002). Chief among these is, of course, the raison d'etre of the environmental justice movement—racial disparities in environmental exposures and in the incidence and prevalence of environmentally associated diseases.

☐ *Locus of responsibility for environmental health and illness*

Related, environmental justice activists are concerned that genetic research in the environmental health sciences may have profound consequences for future understandings of the locus of responsibility for environmental health. In the arena of environmental health and illness, genetic/genomic research often focuses on the identification of genetically susceptible individuals and sub-populations, who might be asked to act, as 'responsible genetic subjects' (Novas and Rose, 2000), on the knowledge of their susceptibilities in particular ways, including biomonitoring, chemoprevention, or 'life style' modifications. Environmental justice activists are particularly concerned that the identification of individuals or subpopulations at genetic risk for adverse effects following environmental exposures may 'shift the perception of who is responsible for environmental health problems from polluters to the individuals living in polluted environments'. Such a shift would undermine the work of the

environmental justice movement to reduce environmental exposures. As this activist elaborated:

> [Say] we're struggling against the citing of the Home Depot in East Harlem. Not that this is actually happening, but this is a very plausible scenario. You hear this counter-argument, when you talk about not adding new environmental burdens to a community that has the highest asthma rate in the city and among the highest in the country … that this is a community comprised of people who are Puerto Rican and various Latino descents, and it's a genetic thing. Like people there have asthma because it's in their genes and the environment is less of a factor.

Likewise, environmental justice activists fear that in the future genetics/genomics will be used to *individualize* the focus of environmental health analyses and interventions. For example, as this activist described in an interview, because molecular measurement techniques focus within an individual, rather than the air shared by many individuals, they privilege individual level approaches to environmental health and illness:

> The fear that I have with … genetics research … is shifting the perception of responsibility and the burden of responsibility back onto the individual. That's one of the reasons I'm so resistant to this concept of genetic tools. The air that we breathe is a shared resource, a shared legacy, a shared human right. Also, its composition is determined by multiple external agents and factors, including people who pollute or entities that pollute … So [taking measurements of the air] is a way of pinpointing … that responsibility for individual health is often not in the hands of the individual. The whole thing with genetics is that it goes in the opposite direction, it shifts the focus away from polluters, it shifts the focus away from sort of common and shared environment, and puts it back on the individual.

Speaking at the WE ACT conference, sociologist Troy Duster referred to this shift as the 'fracturing of the public health consensus'. Duster argued that

> The public health consensus was based on the idea that the environment had to be cleaned up, that we are all vulnerable to disease, so it is in our common interest to clean it up. The past 30–35 years of genetics is fracturing this consensus by emphasizing differential vulnerability to diseases.

Again, the concern is that focusing on individual or sub-population genetic susceptibility ultimately will divert resources, analysis and interventions away from the role of social, political, and economic factors associated with environmental exposures and their effects in the production of human health and illness. As this activist commented at the WE ACT conference: 'The NIEHS is increasing its spending on studies of susceptibility and vulnerability, because this is supposed to improve health. Will the growing focus on genetics shift resources?'[4]

For all of these reasons, environmental justice activists have begun to critique the increasing investiture of federal funding in environmental health research on genetic variations in susceptibility and raising the question of whether this represents 'the kind of science we need'. As one activist at the WE ACT conference stated, 'If the conditions that Native people suffer from are a result of gene–environment interaction, then they are preventable by changing environmental conditions. So, spending money on genetics research is misguided'. Especially in the context of limited resources for environmental health research and interventions, activists argue that priority should be given to 'improving the health and quality of life for people *today*' by assisting communities that are 'living under toxic assault' rather than investing in a molecular genetic/genomic future.

☐ *Making molecular claims*

At the same time, some environmental justice activists are interested in the possibility that molecular genetic/genomic technologies, particularly those emerging from the field of toxicogenomics, might enable activists, in collaboration with scientists, to ascertain the chemical body burden of individuals living in exposed communities, and measure and document the effects of those chemicals within the human body. Body burden testing can be done without molecular technologies; however, scientists envision a future in which microarray technology will enable them quickly and efficiently to ascertain

chemical exposures via molecular 'signatures'. This may enable scientists to meet the challenge of an activist at the WE ACT conference: 'we should focus on exposure, focus on how that changes our genes—rather than on environmental response genes'.

Environmental justice activists express mixed feelings about these potential applications of genomic technology. On the one hand, many believe that body burden testing is critical to proving that environmental exposures are a public health problem. As this activist stated in an interview, 'The technology that people are excited about is body burden testing. This is the testing that people want. People are making the connections and saying "hey, these refineries are pouring stuff into the air and I want to know what's inside of me!" '. Another activist stated, 'we would give anything if we could get an accurate sense of how much diesel a person or individual has been exposed to … I like the idea of biomarkers, especially because … exposure assessment is so expensive and difficult'. Related, body burden measurements may be instrumental in generating the political will to limit environmental emissions. In the words of this activist, 'It would motivate people to take action … knowing that they have chemicals in their bodies gets people motivated to do something'.

Already, there are examples of communities involved in environmental justice struggles turning to molecular analyses as a means of validating their claims regarding the damage wrought by toxic exposures. In January 2000, the Agency for Toxic Substances and Disease Registry (ATSDR) reported an analysis of biologic samples given by 58 residents of Midway Village, in Daly City, California (Pence, 2000a). This study was undertaken after more than a decade of activism by residents of Midway Village who allege that polynuclear aromatic hydrocarbons in the soil beneath their housing project are responsible for the myriad illnesses they experience and that they should be relocated and compensated for their medical expenses (Pence, 2000a). The ATSDR reported the finding of a higher than 'normal' level of chromosomal abnormalities and genetic polymorphisms (though 'normal' was not defined in the report; Pence, 2000a, 2000b). Scientific assessment of the report was cautious, however, the initial *political* response to the report was less equivocal. The US EPA urged the state regulators to retest the soil around Midway Village; the district's legislator requested that the Cal EPA

Midway Village.
Credit: Greenaction.

Department of Toxic Substances Control convene to take testimony from toxicologists and Midway Village residents and stated that his staff would investigate the possibility of relocating residents (Pence, 2000b). In 2001, Cal EPA announced that the contaminant levels in the soil at Midway Village easily met the regulatory limits set to protect human health and closed their investigation into the resident's claims (Pence, 2001).[5] Nonetheless, Midway Village is cited by environmental justice activists who are investigating the translation of molecular biomarkers of exposure for use in their efforts to reduce and/or eliminate environmental exposures (field notes, 2/2002; Public Interest Biotechnology, 2004; see also Warhurst, 2000).

However, at the same time, environmental justice activists are concerned about the post-hoc nature of body burden testing and

molecular biomarker technologies. During an interview, this activist elaborated,

> The example … is lead. With children, we take a blood sample and analyze and determine how many mcg [of lead] they have in a dl of their blood, and then we issue a proclamation regarding the extent of their exposure. This is a very frightening way to assess it. You know, from a health perspective, *basically you're using a child as a monitor for lead*. By the time it has gotten to that point, it's almost too late … The public health agenda needs to be intervening much earlier in the whole process of lead exposure. We can't wait until the exposures have already happened, and then treat the problem.

Her comments again highlight the possibility that such techniques might result in the conceptualization of environmentally associated diseases as individual, medical problems, rather than matters of community concern to be addressed by public policy.

Activists also express deep scepticism regarding the claim of scientist entrepreneurs that application of molecular technologies, such as microarrays, will result in more efficient regulation and improvements in environmental health. In particular, they problematize scientists' underlying assumption that scientific risk assessment actually protects the public from the health consequences of environmental exposures. For example, in response to an EPA scientist's assertion that better information on gene–environment interactions would improve environmental health regulation, this activist countered, 'To the question "[environmental health] is it genes or is it the environment"? I would say that the answer is "Neither, it's politics and power" '. As such, he questioned the ultimate worth of generating more scientific data on genes, the environment, and their interactions.

□ *Acting on the future*

In response to these concerns, environmental justice activists are developing an agenda for shaping the future of environmental health science and governance in the US. First, environmental justice activists have called on scientists to extend a 'community based participatory research' approach to environmental health research, in

general, and to the field of environmental genetics/genomics, in particular (Sze and Prakash, 2004). For example, the recommendations which emerged from the WE ACT symposium in 2002 include incorporating community oversight and agenda setting in environmental genetic/genomic research and building truly egalitarian and ongoing partnerships between scientists and communities of colour (Sze and Prakash, 2004, p. 744). The goal, according to these activists, is a 'transparent, collaborative approach' which will 'maximiz[e] promised benefits' of genetic/genomic research within traditionally disenfranchised communities (Sze and Prakash, 2004, p. 744).

Second, many environmental justice activists wish to see the future of environmental health and illness governed by the precautionary principle, both as an alternative to risk assessment *and* as the governing principle for the development of genetic/genomic technologies within the environmental health sciences. They contend that science, in general, and risk assessment, in particular, are inherently subject to uncertainties and ambiguities that are exploited by industry in order to forestall regulation, thereby compromising public health, especially among those made vulnerable by social, political, and economic forces (Ong and Glantz, 2001; Proctor, 1995; Markowitz and Rosner, 2002). As such, they hope to persuade environmental health scientists to adopt a precautionary approach to environmental health research and regulation (Sze and Prakash, 2004, p. 744).

CONCLUSIONS

This paper describes the responses of environmental justice activists to future practices of knowledge production and governance made possible by the emergence of genetic/genomic approaches within the environmental health sciences. Historically, the environmental justice movement has focused its analyses and actions on social and political inequalities and their consequences for disparities in environmental exposures and health status. In contrast, emerging technoscientific practices in the environmental health sciences focus within the human body and at the molecular level, where they endeavour to assess genetic susceptibilities and individual risks of adverse health outcomes following environmental exposures. As

detailed in the preceding pages, environmental justice activists express concern that molecular genetics/genomics will provide a basis for the emergence of new, and potentially racialized, categories of 'genetically susceptible' persons. They fear that this would result in the shifting of the locus of responsibility for environmental health and illness. Specifically, such a molecularized approach could lead to a future in which environmental health and illness are individualized (cf. Brown *et al.*, 2003) and biomedicalized (Clarke *et al.*, 2003) matters.[6] For all of these reasons, environmental justice activists increasingly are calling for community oversight, agenda setting, 'participatory research', and the precautionary principle to guide the development of environmental genetic/genomic science and governance.

At the same time, as I have described above, a subset of emerging genetic/genomic technologies hold appeal for some environmental justice activists. They see in toxicogenomics, for example, a new, molecular means of substantiating their movement's claims about the relationships between environmental exposures and the health and illnesses of exposed communities. As noted by Beck, risk societies are scientized societies: 'So long as risks are not recognised scientifically, they do not exist—at least not legally, medically, technologically, or socially and they are thus not prevented, treated, or compensated for …' (1992, p. 71; cf. Wynne, 1996). Therefore, in the future, environmental justice activists may feel compelled to consider the possibilities afforded by the molecularization of the environmental health sciences. If some activists continue to choose to resist molecularization *in toto* while others explore what molecularization may offer environmental justice activism, one may expect to see a biopolitical cleavage within the environmental justice movement itself. However, both approaches highlight the emerging ties between knowledge about human vitality and its governance in the arena of environmental health and illness.

Indeed, on the whole, this analysis calls attention to the relationship between genetic/genomic knowledge production and approaches to environmental health risk assessment and regulation, that is, between knowing and governing human vitality in regard to environmental health and illness (Castel, 1991; Flower and Heath, 1993; Foucault, 1978; Lenoir, 1997; Rose, 1996, 2001). As highlighted by the narratives of environmental justice activists, what is at

stake in the emergence of environmental genetics/genomics is both how scientific research is conducted and how it is used to make decisions in both clinical and regulatory settings. Therefore, in seeking to secure a voice for the environmental justice movement and its constituencies in the future of environmental governance, activists are increasingly calling for community based participatory research approaches to environmental health research, in which the needs of and potential benefits to the community guide knowledge production practices. That is, in seeking to shape the future of governing environmental health and illness, environmental justice activists are attempting to achieve a more active role in shaping the future of scientific knowledge production.

As with many instantiations of genetic/genomic practices in contemporary society, 'the jury is still out' as to whether new modes of molecular genetic/genomic knowledge production and governance will take hold in the environmental health arena. Moreover, even if they do, 'there is no technological determinism here: multiple responses are possible' (Rabinow and Rose, forthcoming). Therefore, how contemporary social movement contestations and/or co-optations shape the vital politics of environmental health and illness over time is a matter that deserves ongoing analytic attention. As scientists, activists, and other interested parties pursue their visions of specific futures for genetics/genomics in the environmental health sciences, their actions and narratives will continue to provide an important site for sociological analysis of the emergence of new forms of knowledge, power relations, and modes of subject-making governing environmental health and illness in the United States.

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□ *NOTES*

1. This analysis draws on data from a multi-sited ethnographic project on disciplinary emergence in the environmental health sciences, conducted from September 2000 through to September 2002. The primary mode of data collection for this project was in-depth qualitative interviews ($n = 59$) with environmental health

scientists, environmental health risk assessors and regulators, and environmental justice activists. Respondents were identified through an intensive review of the literature (Shostak, 2003a), from the participant lists of environmental health focused conferences and symposia, and through snowball sampling. Primary data were also gathered in field notes, as I attended a variety of conferences, meetings, and symposia focused on the environmental health sciences and environmental justice. Additionally, for three months, I conducted participant observation as I worked as an intern in the Program in Environmental Health Policy and Ethics at the National Institute of Environmental Health Sciences (NIEHS). All of the data detailed above were entered into the qualitative data analysis software package *Atlas.ti*. They were then coded and analyzed using the general principles of grounded theory (Glaser and Strauss, 1967; Strauss, 1987; Strauss and Corbin, 1998).

2. For example, the definition of 'environmental justice' offered by the Department of Health and Human Services focuses on the health *effects* of pollutants, while the Environmental Protection Agency's definition of environmental justice emphasizes equity in the *processes* through which risks are distributed.

3. In October 2002, genetics/genomics was one of the 'issues' addressed by the movement's national agenda-setting summit, the Second National People of Color Environmental Leadership Summit.

4. The NIEHS also has an extensive environmental justice programme.

5. This assessment remains highly contested.

6. Moreover, the differential resources available to individuals 'at risk' may produce new forms of inequality, as 'the new genetics meets the old underclass' (Kelly, 2003).

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