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A Milieu of Mutations: The Pluripotency and Fungibility of Life in Asia

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Abstract Contrary to claims that view the life sciences as having similar effects everywhere, I draw on research in the Biopolis of Singapore to examine how an assemblage of global and situated elements engenders conditions that crystallize scientific inquiries and orient social effects in the research milieu. I trace some of the intricate relationships among many things—researchers, governments, capital, populations, mutations, maladies, and emotions in the Asian tropics—that help crystallize an emerging biomedical frontier.

I call for a richer notion of biocapital that encompasses the creation of a spectrum of material and nonmaterial benefits. Scientific entrepreneurialism in Singapore, I suggest, cannot be reduced to profit-making but includes larger goals of self-knowledge, expertise, and security. I explore the interacting logics of pluripotency and fungibility that animate scientific practices in the Biopolis: trans-Asian collaborations; Asian genetic databases; state funding and legitimacy; and genetic pride and hope, all components in forming an emerging space and style of biomedical research. "Asia" and "ethnicity" are often invoked in different registers of geography, nationality, technique, population, disease, DNA, and customized medicine, depending on the context of research and presentation. The growing network of contingent associations among a constellation of scientific objects and values, I argue, transmits feelings of corporeal vulnerability and expectations for a new biopolitics of security.

Part of the research for this project was conducted when I was a visiting fellow at the Asia Research Institute (ARI) of the National University of Singapore (NUS) in 2010. I received a warm welcome from then ARI director Lily Kong; Gregory Clancey, the leader of ARI's STS cluster; and Chua Beng Huat, the chair of sociology/anthropology at NUS. Useful comments by Mike Fischer, Masato Fukushima, Gregory Clancey, Alfred Montoya, Jerry Zee, and Andrew Hao helped propel the paper through its many mutations. I thank Tae-Ho Kim, a medical historian of South Korea, for the use of his image of Leo Genomicus. Publication was supported by the "Asian Biopoleis: Biotechnology and Biomedicine as Emergent Forms of Life and Practice" Project, funded by the Ministry of Education, Singapore, and the Humanities and Social Sciences (HSS) Division of the Office of the Deputy President (Research and Technology) at the National University of Singapore (NUS), Grant Number MOE2009-T2-2-013.

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Research scientists are artists who push the boundaries of convention.... They are risk-takers seeking to develop biosecurity in a world of information flows and fungibility.

Edison Liu, Director of the Genome Institute of Singapore (2001–2011)

New sites of genetic science pose challenges to our thinking about how flows of global knowledge to different sociopolitical sites may create distinct science cultures. Drawing on anthropological research in the Biopolis, Singapore, I track science practices that weave intricate relationships among many things—researchers, governments, capital, populations, mutations, maladies, and emotions in the Asian tropics. This vibrating web of interrelationships among material and nonmaterial things crystallizes an emerging biomedical frontier. Indeed, the articulation of disparate global and situated elements in any setting engenders conditions that inform scientific inquiries and orient social effects in the research milieu and its surroundings.

Nikolas Rose (2007) observes that modern scientific techniques are rapidly increasing "our capacities to control, manage, engineer, reshape, and modulate the very vital capacities of human beings as living creatures" (3). He asserts that the intertwining of five features—molecularization, optimization, subjectification, somatic expertise, and economies of vitality—is shaping "the cartography of the present" (4–7). Rose discusses the implications of genomic science for the biopolitics of race in United States and Asia (155–86), but there is an overall suggestion that biomedical science has the same flattening effects everywhere.

Anthropologists alert to variations of technology, politics, and ethics consider it necessary, for example, to ask whether the scientific objects and practices assembled in a particular research environment do in fact produce variable social and political outcomes. Instead of viewing science as a universal structuring force, I situate my inquiry in a particular context shaped by an assemblage of global and situated components (see Collier and Ong 2005), an emerging space of problematization, as it were, crystallized by the interaction of knowledge and solutions, opportunities and constraints, and populations and governance. In other words, science is a mobile global form, but the conjuncture of research practices, contexts, and objects shapes particular kinds of experimental outcomes. In this article, I explore how biomedical researchers weave a research milieu in and around Biopolis, Singapore, shaping a distinctive style linked to, yet different from, other science hubs in the world.[1]

This angle of investigation permits me to argue that an Asian entrepreneurial science is animated by a logic of pluripotency, one that goes beyond "life itself" to make "more of life." Borrowing the term *pluripotency* from stem cell science, I argue that a pluripotent logic animating scientific entrepreneurialism in Asia centers on

[1] Research in and around Biopolis, Singapore, was conducted in a series of summer trips from 2005 to 2009, and during a three-month spurt of intensive interviewing in early 2010.

converting an embarrassment of genetic riches into fungible values for regulating heterogeneous life.

This strategy goes beyond the kind of medical optimization that intends to radically reengineer human vitality (Rose 2007: 16). I identify a broader logic of optimization, enabled by molecularization and digitalization, that hopes to engender values not limited to material ends.

My approach questions as well an anthropological foregrounding of "biocapital" (Sunder Rajan 2006) and "biovalue" (Waldby and Mitchell 2006) as the major outcomes in the global convergence of capitalism and biomedical sciences. Without denying the many abuses and violations carried out under the auspices of corporate-driven science, I call for a richer concept of *biocapital*, beyond a focus on values of profit making. The great promise of biocapital (economically enhanced biotechnologies) surely transcends monetary capital to include a raft of material and nonmaterial benefits. For instance, researchers in the Biopolis (and elsewhere) are eager to capitalize on molecular biology, biostatistics, and populations not only to create patents but also to provide answers to causes of illnesses and discover diverse solutions to problems of life and living in their home region. In other words, scientific entrepreneurialism need not be limited to spinning out new drugs (not an easy or fast enterprise) but actually involves the painstaking creation of new knowledge that shapes social values and feelings as well.

To science journalists in the West, however, Biopolis is often presented as an exclusively neoliberal bioventure focused on research that translates from "bench to bedside," that is, a biomedical hub entirely devoted to speeding the conversion of laboratory findings into patents and products. Furthermore, the Singapore state, as venture capitalist to Biopolis projects, feeds this perception. But, as I have argued elsewhere, the neoliberal logic informs calculations not strictly for economic reasons (Ong 2006: 6–9). The pluripotent-fungible dynamic is hinted at by Edison Liu, the then-director of the Genome Institute in Biopolis.[2] In the epigraph for this article, Liu expands on a notion of scientific risk-taking beyond sheer economic optimization. Liu urged researchers to be entrepreneurial risk-takers in a world dominated by Big Pharma and Western research institutions prospecting for biological resources on a new frontier of biomedical research. He emphasized the need to coordinate political control over knowledge and expertise on the manifold powers of life in Asia that ought not be dominated by global drug companies. As the leading spokesman for Biopolis, Liu tried to realize his vision by building trans-Asian scientific coalitions to gain knowledge of surrounding life forms and shape the fungible values that can contribute to health and security in the region (see Fig. 1).

Below, I explore different realms in which researchers in the Biopolis exercise entrepreneurialism by forming translocal collaborations, building genetic databases, competing for funds and legitimacy, and generating genetic self-knowledge and hope, all components in shaping an emerging space and style of biomedical governance. I first trace the Biopolis complex as an "elastic laboratory" that enrolls a diversity of

[2] Edison Liu, a leading oncologist and leader of HUGO, was the leading scientist in the Biopolis during its first defining decade. Unless otherwise specified, all quotes from Liu were taken from an interview conducted in Singapore on 26 April 2010. Except in the case of Liu, a key informant who was a public figure, all other informants have been given pseudonyms to disguise their identities.

Fig. 1 "Panthera Leo Genomicus" prowls the lobby of the Genome Institute of Singapore. This sculpture of a lion (symbol of Singapore) tattooed with DNA symbols is designed by Edison Liu. Photo credit: Tae-Ho Kim

local and transnational connections for building expertise centered on biomedical research targeting populations in Asia (though not exclusively). Second, I discuss the feverish tracking of genetic variations in Asia in order to build up databases and of mutations associated with fatal diseases; that is, scientific practices help shape an emerging trans-Asian field of biomedical science. Third, I show that scientific entrepreneurialism includes interdisciplinary competition to sustain ongoing state funding and draw corporate interest. Fourth, I link the search for Asian mutations and biomarkers to the transmission of affective values of genetic pride and hope. Scientific practices often invoke *Asia* and *ethnicity* in different registers of geography, nationality, population, disease, DNA, and customized medicine, thus forming contingent associations among a constellation of scientific objects and values that can stir feelings of corporeal ownership and expectations of a new biopolitics of security.

1 Biopolis and the Elastic Laboratory

Singapore is a small city-state that, at the turn of the new century, decided to make the life sciences a strategic area for political investment. The goal is to found "a world-class scientific research" environment that would contribute to the rise of "a vibrant knowledge-based Singapore" (Agency for Science, Technology, and Research 2012). Investment in the life sciences is framed as a way of making new claims of the Biopolis as an emerging biomedical hub in Asia, and focusing on generating transnational, and especially inter-Asian, collaborations to undertake research on major diseases menacing populations in the Asia-Pacific region.

How is Biopolis emerging as a global node configuring a biomedical infrastructure that stretches beyond Singapore? Since its emergence in 2003, the Biopolis complex has built up expertise in cutting-edge scientific research, including infectious diseases, molecular biology, stem cell research, and nanotechnology. These forms of research are not discrete endeavors but parts of interacting research networks linked to hospitals and clinics, and even the military, both at home and overseas, especially in East, Southeast, and South Asian countries. Although initiated by the Singapore government with the goal of fueling economic growth and cutting health costs, the Biopolis complex has grown into an emerging scientific network, enrolling foreign and local scientists in the work of converting the diversity of life in the tropics into fungible assets. Crucial components of this scientific expansion include a decade-long funding stream guaranteed by the Singapore government, the building of "nirvana-like" scientific facilities, and generous financial support that frees researchers from applying for money. But, as we shall see, scientists work under intense pressure because continuing state funding has become less certain for the next decade.

Biopolis is a node constituted by transnational networks for scientific education, pharmaceutical activities, collaborative research, and customized medicine that span the region and the world. In terms of biomedical expertise, world-class scientists come from all over the world, especially the United States and Great Britain. World-class research institutions have relocated to Singapore to train new generations of scientists. Examples include the Duke University–National University of Singapore (NUS) Graduate School of Medicine; Singapore MIT Research and Technology (SMART) Center; the Stanford-Singapore Biodesign program; the Johns Hopkins Singapore cancer center; and many more partnerships with institutions in Europe and Asia. Drug corporations are a major presence in Singapore. GlaxoSmithKline has long manufactured drugs here, and it recently opened a center for research in cognitive and neurodegenerative disorders. Also at Biopolis is the Novartis Institute of Tropical Diseases, focused on drug discovery and vaccines. Singapore is also an important site for contract research organizations (CROs) that conduct clinical tests for drugs mainly intended for Asian health markets. Because of Singapore's reputation for high standards in biomedical research, many CROs from China have relocated here. Indeed, myriad state-private partnerships propel the growth of a biomedical research infrastructure dedicated to shaping emerging biomedical sites for experimental drugs.

But despite its commercial thrust, the strategic focus on the life sciences underpins an emerging vision of vital politics, one that recasts the well-being of citizens in relation to expertise on Asian bodies and diseases, and thus fuels the need to establish the profiles, patterns, and probabilities of life in a global region. For instance, the Duke University medical school here is developing a new Center for Disease Control (CDC)–style center that will lead the fight against infectious diseases in the Asian ecology. The goal is to build an epidemiology program in Asia and train local health workers (in Thailand, Vietnam, Malaysia, Indonesia, Sri Lanka, India, and elsewhere) to detect new diseases and do their own diagnoses (apart from the CDC in Atlanta). Despite its squeaky clean image, Singapore receives over 40 million microbe-carrying visitors each year and is thus an ideal site for an Asian CDC.

Another area of inter-Asia collaborations is in research on "Asian-style cancers," which draws biomedical data from many sites, especially the People's Republic of China. There is, for instance, the Asia-Pacific Hepatocellular Carcinoma (APHC) trials group to link researchers on liver cancer and share patient samples across many sites. Furthermore, Singapore-based researchers are reliant on the Beijing

Genome Institute in Shenzhen, China, to sequence genes of human and nonhuman life forms. We thus see that researchers in Biopolis innovate through collaborations across fields and countries, thereby building networks of biomedical expertise and data that will impact lives in the region. This strategic assembling of scientific actors, research institutions, sites, and biomedical projects creates a distinctive modality oriented to life, risks, and opportunities for improving life chances. The results of trans-Asian research collaborations are increasingly published in the world's leading science journals. Besides their good reputation, the English-language skills of Singapore-based researchers are especially useful to mainland Chinese scientists who wish to gain more international exposure for their scholarship.

In sum, we find an elastic laboratory dedicated to assembling novel scientific actors and objects: research partners, collaborating institutions, medical records, disease samples, and others from multiple sites within Asia and from around the world. In short, the elastic laboratory is a new model in the Asian context for the reorganization of biomedical science today.

2 Mapping Genes and Mutations

Another entrepreneurial and optimizing drive is found in the accumulation of mutations from human and other living forms in the Asian ecosystem. The new genomics (computational genomics) seems to configure a new space of biological research focused on Asian bodies floating in a milieu of genetic variations and mutations. This research problem space is in part defined by an imagined ecosystem within digital associations that can link human genetic variations, migration flows, and disease variability, that is, crucial information that is foundational to the development of personal medicine. From the vantage point of Singapore, the chosen field of practical application is the broader ecosystem, and scientific practices select populations, bodies, and tissues as the value-bearing objects to be investigated.

As George Canguilhem has observed, there is nothing unusual or new in this pragmatic turning to the immediate environment to discover and related objects of scientific value.[3] Given the research milieu of Biopolis, the range of biological forms under observation acquires "Asian" diacritics in multiple registers. When associated with sample groups, diseases, mutations, and novel drugs, *Asian* or *ethnicity* can mean different things: research tool, biomarker, political, or ethical value, depending on the context of deployment of these terms. Against claims about "pharmaceutical reason" being entirely devoted to profit-making (Lakoff 2005), I show that population and medical genetics proliferating in the Biopolis milieu are involved in an unprecedented task of mapping the genomic profiles of populations in Asia, thus building a new knowledge resonant with emotions of corporeal ownership and expectation.

Geneticists and bioinformaticians in Singapore have been quick to focus on the genetic diversity of the region. Improvements in assaying technology make the

[3] "The milieu proper to man is the world of his perception—in other words, the field of his pragmatic experience, the field in which his actions, oriented and regulated by the values immanent to his tendencies, pick out quality-bearing objects and situate them in relation to each other and to him. Thus the environment to which he is supposed to react is originally centered on him and by him" (Canguilhem 2008 [1965]: 118).

sequencing of genomes faster and cheaper, permitting the digitalization of more and more human and nonhuman living forms. During his tenure at the Genome Institute, Edison Liu was a major proponent of computational genomics and genome-wide association studies (GWAS). A GWAS is a scan of the entire genome for association with a disease or trait. In the past decade, as the director of the Genome Institute and Singapore's public face of the biomedical sciences, Liu has tried to promote computational information that statistically links at-risk groups to particular diseases in Asia as a way to develop and control genetic data important to the scientific, economic, and social interests of peoples in the region.

Soon after he was recruited from the National Cancer Institute in the United States to lead Singapore's biomedical project, Edison Liu formed the Pan-Asian SNP Consortium.

In a gentle rebuke of the HapMap's limited survey of only two groups from Asia (and European and Nigerian samples), the Pan-Asian SNP initiative seeks to bring the diversity of the region's population under the molecular gaze. Instead of earlier Human Genome Organization (HUGO) projects to look at humanity as a whole, the Pan-Asian initiative seeks to examine the genetics of specific Asian ethnic groups that number more than half of the world's population. The consortium aims to map single-neucleotide polymorphisms (SNPs) in the genome sequence of each nation's participant group so as to discover differences in the genetic history of Asian populations. The collective goal is to create an Asian public database of 50,000 genetic differences or expressions (SNPs) that would also compile ethnic variations in predispositions to certain diseases or responses to certain drugs. By the end of the decade, the network of initially ten, and now seventeen, countries connected researchers in China, India, Indonesia, Japan, South Korea, Malaysia, Nepal, the Philippines, Singapore, Taiwan, and Thailand, among others, in a scientific consortium to discover the "genetic architecture of Asian populations." The main findings of the consortium were published in a *Science* article under the title "Mapping Human Genetic Diversity in Asia" (HUGO Pan-Asian SNP Consortium 2009).

Besides the construction of *Asian* around genetic variations, the sampling of groups tested for SNPs also constructs ethnic associations. The consortium deploys ethnicity as a differentiating feature in two ways. First, medical institutions in each participating nation draw "population-focused" blood samples from ethnic and cultural collectivities (many of whom are aboriginal groups) to be scanned for "genetic variations." By thus using cultural groups as sample populations, the SNP findings explicitly link genetic origins and diversity to ethnic, geographical, and linguistic categories. In other words, samples drawn from seventeen Asian countries have relied on cultural, ethnic, geographic, and linguistic categories for locating target populations that contribute blood samples and are then subsequently defined as genetically varied. The statistical lining up of ethnic and geographical codes in SNP findings therefore gives genetic weight to preexisting forms of cultural identity and beliefs in ethnic differences.

Second, ethnicity is used as a tool to identify groups, but without the suggestion of racial determinism in mutations. Indeed, population geneticists prefer the terms *ancestry* or *ethnicity* to *race* for the identification of complex interactions between conditions of living within specific environments that influence a person's genetic variation (Jorde and Wooding 2004). Ancestry is a code that captures gene-environment interactions that may be linked to disease susceptibility in a particular ecosystem. Liu explains gene-environment interactions or complex pathways involving genes and exposure: "Just as families share certain genetic characteristics, like eye color or curly hair, Pan-Asian scientists believe that regional Asian populations share unique genetic variations that go back thousands of years. The study will give scientists a 'genetic map' of human history in Asia, showing how nearly half of the world's population migrated throughout the region and settled to form the distinct cultures that we know today" (Liu 1997). Genetic research is embedded in a historical cartographic project for tracing flows of migrants and mutations that attest to the genetic diversity of populations in the region.

Liu informed me that mapping "migrant histories converging in the present will help us to account for mutations in Asian environments."[4] The quest is to open up a conceptual space for the analysis of genetic differences in Asia and thus promote scientific solidarity across Asian countries, rich and poor in biomedical expertise, in a common enterprise for improving genetic knowledge of diverse populations. In fact, we can think of the multicountry Pan-Asian initiative as a genomic technology of governing as it promises to be a fundamental resource for the better administration of health in conditions of population variability. In 2011, an official report on a key finding of the consortium states: "Southeast Asia was the major geographic source of East Asian and North Asian populations." It goes on to say that the geographical and linguistic basis of genetic subgroups in Asia "clarifies the need for genetic stratification when conducting genetic and pharmacogenomic studies in this continent" (Kumar 2009). Studies of ethnic-specific genetic variation and disease predisposition contribute to genetic databases needed for the development of pharmacogenics. Member countries in the SNP consortium are thus taking an entrepreneurial, preemptive action to assemble a rich genomic database. I have used *biosovereignty* to describe an Asian response triggered by the threat of Big Pharma prospecting for research values inherent in biological resources in this part of the world (see Ong 2010: 40).[5]

In a world of knowledge flows, the Pan-Asian network is an inter-Asian system of stewardship for securing biofutures for populations in the region. An Indonesian molecular biologist remarks on the biosecurity value of the genetic mapping: "For our country, a huge archipelago with more than 500 ethnic populations, such data is of public health importance and has had an immediate impact in the study of disease distribution" (Kumar 2009). In other words, for member countries, the SNP database is a political technology that permits better monitoring of a continuum of the genetic susceptibilities of at-risk groups and, hopefully, potential strategies for health interventions.

At a regional level, the mapping of Asian genetic variations engenders for the first time an inter-Asian scientific project, with all the attendant risks and mistrust connected with overcoming differences in national power, expertise, and resources. Officially, the Pan-Asian SNP project is "a model of scientific collaboration" between more and less developed Asian countries for orienting population genetics in the

[4] Edison Liu, interview, Singapore, 6 June 2006.

[5] Asian national institutions are concerned about taking a lead in building genetic databases as a leverage against drug companies. Meanwhile, there are many kinds of public-private partnerships between Asian universities and global companies, but state agencies try to maintain control of genetic information and selection of private partners in research projects. See Ong (2010).

direction of health-related problems. The unifying effects of a network devoted to seeking mutations extend from an imagined scientific geography and trajectory of human history. In the words of an Indian member, this sharing of biological data shows "that the people of Asia are linked by a unifying genetic thread" (Kumar 2009). The SNP Consortium is therefore a border-crossing and pathbreaking endeavor that capitalizes on the biological riches in the region in order to build a depository of Asian mutations that creates scientific and political values.

Beyond the study of populations, medical genomics in Singapore seeks to trace correspondences between genes and diseases. Genome-wide studies digitally plot associations between ethnic-specific groups and serious illnesses such as chronic inflammatory diseases (CIDs), cancers, diabetes, and hepatitis B. By finding "ethnic associations," physicians can differentiate groups according to differences in chemical resistance or allergies in relation to specific drugs. With innovations in assaying technology, the momentum of GWAS is to assay genetic variations across heterogeneous populations not only in Asia but elsewhere in the developing world.

How do we account for the robust and roaring nature of genome-association research in Singapore, where molecular biology is hailed as the wave of the future? What accounts for the explosion of bioinformatics in Asian sites? Indeed, key scientists in Singapore are among the first to note the limited scientific added value of GWAS, even while insisting that there is an important role for GWAS in building up biomedical research in adjacent domains. When asked in 2010 to elaborate on this paradox, Edison Liu notes that "GWAS is like *Cliff Notes* but the nuances are all gone. . . . The primary determination is sequence to function, and predictive genetic variants have low frequency of about 10 percent. DNA sequencing errors caused by the equipment make it hard to determine which gene causes a particular disease." In other words, Liu continues, GWA studies do not yield an underlying pattern. No single gene or genes account for more than a tiny fraction of cases. "Genetics knows no big distinction (when it comes to racial categories). It is a matter of gradations of difference, of how every population has experience of all diseases, except for the different effects of diseases (across populations)." In actuality, there is a series of finely graduated distinctions along a long continuum of genetic mutations. This means that presumed ethnic differences registered in GWAS maps are gross categories, and further stratification of genetic differences is necessary for findings that are useful for refining therapeutic interventions. In Liu's view, GWA studies are not deployed as a crude instrument in predictive medicine but as a map of genetic variations, that is, knowledge that helps refine the calculation of risks in susceptibility to both diseases and drugs.[6]

The entrepreneurial push on GWAS in Singapore is part of a concerted effort to open up a whole new field of research that centers on mapping of genome-scale associative studies of populations of non-European descent. Indeed, Singapore-based GWAS experts hope to refine techniques used for tracking Asian populations in order to meet the challenges presented by high levels of genomic diversity in Africa. An enthusiastic young Singaporean biostatistician with research experience in Africa,

[6] Genome-wide studies are vitally important for providing clues for biological research on cellular processes to determine the molecular profiles of patients.

Yik-Ying Teo, is leading a study aimed at “the fine mapping of causal variants” in diverse African populations (Teo, Small, and Kwiatkowski 2010). By helping to spearhead genome-wide association studies in Africa, Professor Teo and his compatriots are competing to bring a greater diversity of the world’s population under statistical scrutiny for genetic determinants of complex diseases. There are substantial institutional links between GWAS in Singapore and the Beijing Genome Institute (BGI) in Shenzhen, China, which has been called the world’s sequencing factory. In short, prominently led by the SNP Consortium, the proliferation of GWAS projects has put Singapore on the map as a major center of bioinformatics. By seeking mastery of bioinformatics on genetic diversity among populations in Asia, Africa, and other continents, GWAS technology is building up genetic databases outside North Atlantic sites. In short, the explosion of computational genomics pushes boundaries of genetic research not only in Asia but also promotes algorithmic data mining to open up Africa as a field for Asian scientific expertise.

3 Competing for State Funding and Big Pharma

Scientists in Biopolis are also risk-taking researchers in that they need to compete for resources, reputation, and publicity. Scientists must respond, on the one hand, to public demands for accountability and, on the other, to the pressure to attract corporate investments for their particular programs. This neoliberal aspect of biomedical research informs efforts to re-present scientific findings outside the lab, often in ways that shape the affective appeals of customized medicine and new drug markets that are responsive to the ethnic and biological variability of populations in Asia.

Despite the view that the Singaporean government is generous in funding research, scientists have to become entrepreneurial in presenting their research as highly relevant to the Asian taxpayer. At the heart of the Biopolis complex, there is a conflict between the metrics-driven funding logic of Singapore’s technocrats and the goal of growing an “incubator” of biosciences. The Singaporean government has spent over US$5 billion for the first phase of Biopolis (2001–11), but the next decade of funding seems less ironclad, as innovative products have not kept up with high expectations. The performance of Biopolis researchers has been indexed by some attention-getting devices, especially in bioengineering: insect robots for drug delivery systems, a Microkit disease-detection system, a bioartificial kidney, a diagnostic microchip. But in some fields, such as pharmacogenomics, innovative outcomes need a longer time to become successful therapies.

Before he resigned in the fall of 2012, a casualty no doubt of funding wars, Edison Liu remarked that “scientists in Singapore must answer to their state paymasters.” He sought to capture a guaranteed stream of state funding for the next four decades. In his view, researchers need at least fifty years of guaranteed support before they can sustain a high level of innovations to put Singapore solidly on the global scientific map. Scientists need time to explore research trajectories, make discoveries, and produce marketable products. In pharmacogenomics, GWAS statisticians and molecular biologists compete to make their case for the relevance of their research to Asian subjects. In Singapore’s results-driven environment, can intricate experimental work be nurtured when the tendency is to view quantitative data as more legitimate?

In what ways have the terms *Asian* and *ethnicity* been invoked as affective categories that can build public legitimacy for enormously complex and expensive research?

Medical genomics promises to close the gap between ethnic-specific forms of major diseases, such as cancers, and the development of customized medicine. Human geneticists have become entrepreneurial in collating the multiethnic databases and identifying biomarkers in order to attract investments by drug companies in promising lines of research. Building on Singapore's well-kept multiracial medical records, medical geneticists provide a template of the spectrum of Asian DNA, based on the use of ethnic labels in hospital records of populations identified as Chinese, Indian, and Malay. Existing medical records and new GWA studies track risk associations between Indians and heart diseases; Chinese and hepatitis B; Malays and diabetes; and Asians and gastrointestinal diseases. By drawing associations between SNPs and diseases, the goal is to identify new drug targets. A doctor explains how Singapore's biomedical research has larger implications for populations beyond Biopolis. "The Pan-Asian SNP consortium and the Singapore Genome Variation project will help us interpret the data so that we know what populations in Asia we can extend our findings to, and which part of the genome we should be studying in relation to these ethnic groups."[7]

In other words, there is creativity in the building and management of a pan-Asian knowledge architecture. For researchers, genetic data from Singapore's ethnic groups can be turned into fungible assets, especially if such knowledge can provide DNA clues to major populations in Asia. Diagnostic databases assembled in the Biopolis allow both condensation (Singaporean patient records as a microcosm of Asian populations at large) and stretching (Singapore's findings extrapolated to Asia's majority populations) of genetic information that promises to create an Asian-specific biomedical diagnostic. Such a critical concentration of knowledge and expertise on Asian bodies and diseases is important for promoting Biopolis as a center for the future of pharmaceutical science in the region.

This big-picture framing of medical genomics leverages flows of state money and also draws in drug companies. Ethnic-specific diagnostics serve pharmaceutical logic because they fine-tune the scaling of potential patient samples for appropriate therapeutics. GWAS findings can be refined to produce stratified or graduated information that better guides the ultimate goal of connecting the right drug to the right patient. With GWAS as a guiding tool, drugs can be determined as safe or dangerous for some patients but not others, depending on their ethnic group. Thus, GWAS mappings are essential to the growth of pharmacogenomics in that they help make clinical trials (which can be very expensive and time consuming) more likely to succeed.

The proliferation of GWA studies, therefore, is a way to position Singapore as a leading center for running clinical research projects by creating multiracial data that will open up a realm of biomedical research beyond the North Atlantic world. Big drug makers—Pfizer, Johnson and Johnson, Bristol-Myers, and GlaxoSmithKline—are increasingly shifting to Asian sites for developing diagnostics, therapies, and markets. From the perspective of Big Pharma, falling prices for aging drugs and the slowdown of health markets in Western sites have raised the cost of drug development. By

7 E-mail message: SET, 26 April 2010.

contrast, there is tremendous potential for the growth of health markets in Asia, even though new drugs for diseases prevalent in the region are still many years away. By recentering future pharmaceutical growth in Asia, drug companies exert a big influence on the race to discover biomarkers in patients suffering from serious diseases prevalent in the region. Biomedical data and research in Asia are potential sources of profits in the future, with China's drug markets growing at 25 percent per year, compared to 2–5 percent in the West (Wang and Rockoff 2010). Corporate interest first drawn by genome-wide associative maps is also stirred by the prospects of new molecular findings and potential cures for fatal diseases, not least, cancer. In a fundamental sense, Biopolis entrepreneurialism involves the creation of a new niche of global life sciences that promises a bright future for Singapore's knowledge economy. However, given the high stakes and high costs of such scientific ambitions, the life sciences have to be legitimized to the tax-paying public.

4 Animating Genetic Pride and Hope

Colorful maps of genetic subgroups in Asia can make a case for genetic stratifications and their relevance for the development of customized medicine for diverse populations.[8] But for DNA studies to be fungible as a public good, scientific discourses have to animate feelings of corporeality and expectations. Digital correspondences between "Asianness" or "ethnic" mutations and diseases can stir both a sense of shared biological frailty, on the one hand, as well as optimism for cures, on the other. Genome-wide findings are often mentioned in the news media, and they have become the public face of genomic sciences in Singapore. The Pan-Asian SNP network, in particular, has built up the image of the life sciences as at the service of Asia's ethnic-differentiated groups, taking into account their migration histories and producing enhanced self-knowledge.

As Singapore's chief science spokesman in the later 2010s, Edison Liu was not shy in making a case for how genetic mapping creates ethical value for marginalized peoples. He made a refreshing case that while the correlation of ethnicity, environment, and mutations has been judged as victimizing minority groups, the tracking of their genetic variations is a scientific endorsement of their unique biological histories. Liu noted in 2010 that genetics has had a disastrous recent history of awkward connection to eugenics and genocides. But the Pan-Asian SNP network, organized by scientists in Asian nations, "is a way to repudiate old racist ideas about backward peoples." After all, he argued, the multicountry SNP study is also inclusive of indigenous populations. The search for genetic identities of diverse populations has pried open access to indigenous groups in a way that is novel. The SNP network constructs a new relationship between scientists and aboriginal populations by promising them scientific and ethical values from cooperating with science. In some Asian countries, researchers collect samples from aboriginal groups by encouraging their leaders to exhort their people to be part of the scientific project. Indigenous leaders help control the data analysis and thus engage in a form of self-discovery about their own migration

[8] See map, Kumar 2009.

history and biological difference from other peoples. Liu claims that tracking mutations among indigenous groups in the Philippines is only one example of how SNP researchers have generated "genomic pride" among disenfranchised minorities in Southeast Asia by offering them a glimpse of their history through genetic science. The sample collection of native DNA has been so successful in Southeast Asia that there were plans in Australia to undertake research on the genomics of indigenous populations.

In this genome discourse, the SNP project brings Asian populations who have historically been overlooked by modern medicine into the orbit of cutting-edge science. By the intervention of Asian scientists, Liu claimed, minority groups are made scientifically visible and proud of their genetic heritage as distinctive peoples valuable to science. This inclusion in a holistic genomic map of Asian peoples is celebrated as an antiracist gesture that combats the disenfranchisement of indigenous groups from modern biological sciences. Through scientific study, diverse minority populations are also enfolded into their respective nation-states. This inter-Asian narrative of genetic discovery makes DNA legitimate, explorable, and sexy, that is, a biological asset that embodies ethical values. Instead of victimizing the powerless, the collection of genetic data endows aboriginal groups with pride in their biological and cultural ancestries.

For majority populations in Asia, the conversion of genetic databases into affective identities involves making an urgent connection between ethnicity and potential therapies. A pharmaceutical narrative is disseminated by newspapers, especially the *Straits Times*, that tend to dwell on the common goal of capitalizing on diseases that are differently expressed in flawed Asian bodies. The most compelling stories are focused on "Asian-specific cancers," especially different forms of cancers (breast, lung, stomach, liver) that disproportionately affect ethnic Chinese and, more broadly, East Asian populations. A cancer institute in Singapore identifies its research as focused on "cancers endemic to Asian populations such as gastric, liver, and lung cancers."[9] An American cancer scientist notes that "Singapore is exactly the kind of place where a scheme like this would work.... A national database, along with a detailed chart of genetic mutations among cancer sufferers, could only serve as a hugely effective new weapon in fighting cancer" (qtd. in Gilfeather 2010). Oncologists in Singapore hope to generate a molecular taxonomy so that researchers can track differences between different groups of patients. For instance, by tracking different oncogenic pathways in Asian patients, further studies can identify subgroups in stomach cancer and thus refine steps toward personalized treatments. Ethnic-specific cancer databases can become a condensed representation of correspondences among ethnicities, mutations, and forms of the disease that tend to disproportionately afflict Asian peoples. There is therefore the perception that cancer biology in Singapore contributes to research in Japan and China, which have the highest rates of gastric cancer in the world.

The search for biomarkers in "Asian cancers," however, has to be communicated to the public outside laboratories and clinics. For instance, at the Duke-NUS medical

[9] Cancer Science Institute of Singapore website (http://www.nuhs.edu.sg/research/programmatic-research/major-research-programs/singapore-gastric-cancer-consortium.html, accessed 18 January 2011).

school, there is a poster that proclaims, "Our objective is to be a center of excellence in CSCB (Cancer and Stem Cell Biology), basic and clinical translation studies, with emphasis on molecular interventions and cancers that affect Asians." A clinical physician explains that the poster was from the opening ceremony in 2009: "It is directed at the general public, emphasizing the study of diseases relevant to Asians."[10]

In public discourses, there is an oscillation between "Asian" and "Chinese" when it comes to expounding on the benefits of finding biomarkers for targeted cancer research. Ethnic Chinese are the majority population in Singapore and in much of East Asia and thus presumably a critical mass of the public and potential patients. Liver cancer is an "Asia-Pacific disease" because of the prevalence of chronic hepatitis B and C, and 80 percent of liver cancer worldwide occurs in the region, especially among people originating from Southern China. A professor at the medical school spells out "the philosophy" behind forming an inter-Asian network: "The heterogeneous ethnicity of the Asia-Pacific reflects the clinical reality of HCC [liver cancer] on the ground." Such a transborder trials group was needed, he stressed, in order to overcome the "cultural resistance of Chinese people to be experimental subjects," as well as to recruit patients who would otherwise have no access to new therapies (Chow 2010). A concrete goal is to obtain liver cancer patients to participate in clinical trials for major drug companies. But the public presentation of trans-Asian activities surrounding liver cancer stirs feelings of ethnic vulnerability as well as hope of special treatment for ethnic Chinese patients.

Another example of the ethnic-inflected idiom on biomarkers concerns research on lung cancer, which tends to take a different form among patients of Chinese ancestry. In a public talk, another oncologist declares that the identification of "Asian biomarkers" can guide the testing of new molecular therapeutic treatments. "The bench has never been closer to the bedside.... New anticancer drugs are being tested at a frantic pace." He then mentions that a new lung cancer drug, Irressa, has as its biomarker "a young Asian female nonsmoker." The molecular fingerprint found to be common among "Asian patients" (especially ethnic Chinese from multiple sites in Asia) seems to be a good match for Irressa. Such medical correspondence between biomarker and ethnicity seems to stir feelings that modern medicine is going beyond the one-drug-fits-all approach when it comes to treating a fatal disease that is common among Asian/Chinese peoples. The cascade of ethnic vital signs—fatal disease, mutation, biomarker—can only transmit a sense of shared corporeal vulnerability and optimism for cancer patients in Asia.

Ethnic-inflected biomarkers are thus in excess of the concept of "biovalue" that has been defined by Catherine Waldby and Robert Mitchell in purely commodifying terms, that is, to increase their biological productivity as "biovalue" (Waldby and Mitchell 2006: 32). By contrast, in the Biopolis milieu, the value of biomarkers is enhanced by their moral value. Biomarkers become affective categories when they are in excess of mere biochemical indicators of disease processes; they enroll ethnic associations that provide vital clues for drug testing and customized medicine. By combining molecular *and* ethnic indicators of an at-risk medical condition, Singapore researchers endow their work with powerful affective value. Especially in cancer

[10] Interview with VMD, 7 May 2010.

research, biomarkers can pinpoint condensed nodes of attributions not limited to mere genetic symptomatology. At the broadest level, ethnic biomarkers are diagnostic tools that give scientific and symbolic value to genetic diversity and refine thinking about biopolitical interventions that can be tailored to cultural and ethnic communities in Asia.

5 Conclusion

Anthropological inquiry into biomedicine has been dominated by anxieties surrounding the formidable powers of contemporary biosciences to exploit poor peoples and extract resources from their environments. But the life sciences, when properly managed, have been vital tools for securing "the flourishing life"[11] in modern times and today, hopefully in the developing world. Growing competence in biomedical sciences is part of contemporary problematizing activities in Asia that investigate causes and raise complex hopes for improving human existence.

The contemporary "biopolitics of security" revels in the pluripotency of life and its capacities for regeneration at multiple scales (Dillon and Lobos-Guerrero 2008: 286). In other words, genetic science cannot be understood only as a story of the global spread of biomedical effects or predatory biocapitalism; it is also a global form that anticipates emergent politics of security. Biomedical knowledge and practices are a crucial part of what Foucault calls the "apparatuses (*dispositifs*) of security" for governing life (Foucault 2007 [1988]: 11). Techniques of security are manifold and include scientific mechanisms for shaping spaces of security as well as the accumulation, analysis, and profiling of individuals and populations, that is, the molecurization and digitalization of knowledge in a biopolitics of emergence. The politics of biosecurity also includes strategic interventions into a series of possible and ultimately unpredictable events that threaten life and living standards (Collier 2008).

My research in Singapore tracks how a particular assemblage of biomedical practices, scientific objects, and ethics is shaping a distinctive style, prioritizing certain kinds of inquiry and bodies of data. Singapore's scientific entrepreneurialism—in assembling collaborations, amassing data, drawing sustainable support, and generating affects of pride and hope—is productive of a set of economic, knowledge, and social values that seek to improve living conditions for millions of people.

Researchers in the elastic Biopolis laboratory promote the "making more of life," that is, a strategy to convert pluripotency in biology and diseases into novel knowledge and practices for the better management of health in Asia. In a continent long haunted by biological excess and failures (Ong 2010), geneticists, biostatisticians, and oncologists are mining the diversity of human bodies, tissues, mutations, and diseases and making them into fungible assets that can benefit the common good. Monsoon Asia is a region long stigmatized by the perception having too many people and too many diseases that threaten to derail economic development. The political significance of

[11] This borrows from the Greek concept of "flourishing life," or *eudaimonia*, which corresponds to the idea of having objective moral and intellectual conditions of well-being. In contemporary Asian contexts, "a flourishing life" may be interpreted differently, perhaps as more about material and social conditions of a good life ensured by a morally responsible mode of governance.

biomedical science is magnified in an era when, even as standards of living are rising for many in Asia, the specter of SARS and yet-unknown disease threats are an ever-present reminder of biological frailties that can quickly turn new affluence into ashes. The expansion of genetic research into human and nonhuman life forms is helping to give the Asian pandemic "hot spots" a new significance as a space of transnational bioscience. This milieu of mutations configures not only geography but also the genetic composition of heretofore neglected populations, thus conditioning feelings of being corporeal, at risk, and cared for.

This kind of scientific entrepreneurialism is not entirely about the search for bio-profits. Indeed, the difficult, time-consuming, and uncertain nature of experimental medicine focuses scientific minds more on sustaining financial support for their research projects. It seems appropriate to view science researchers as, among other things, risk-taking artists who are building novel biological entities that may prove useful for the development of an Asia-oriented pharmacogenomics. Biomedical calculations of how life is distributed, at risk, and valued are defining a shifting terrain of contingent formation of power.

In other words, the accumulation, analysis, and circulation of Asia's rich array of vital signs transmit affects surrounding bodies and identities in the region. Biomedical research has invested being "Asian" or being "ethnic" with contradictory affects of vulnerability and hope. A constant stream of science talks and articles is shaping public imagination about past migrations, DNA associated with fatal diseases, and expectations of special biomedicine. Discourses on "Asian" mutations, biomarkers, and diseases index tax dollars at work and transmit a sense of biological and social security among populations brought under new biomedical surveillance (a both benign and troubling aspect of contemporary governance). By shaping a milieu of mutations in an Asian ecosystem, Singapore-based science researchers are anticipating a new biopolitics of security in emergent Asian nations today.

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