A Moral History of the Evolution of a Caste of Workers

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Using a dialectic method of philosophic inquiry, the actual ethical, legal, and social situation associated with genetic testing of beryllium-exposed workers in Department of Energy nuclear weapons facilities for markers of chronic beryllium disease is described. The cultural evolution of a caste system in a similar situation, and its social and biological implications, among uranium miners in the Erz Gebirge of Central Europe and on the Colorado Plateau of the United States, marked by suicide and lung disease, including cancer, is also described. The historically persistent social disease resulting from these situations, the Masada Syndrome, named from an analogous situation in biblical times, is characterized. Cultural intervention, a necessary condition for the ethical progression of the Human Genome Project, is outlined. — Environ Health Perspect 104(Suppl 5):991–998 (1996)

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A History of Moral Betrayal

Moral judgments are never made in a vacuum. They are never value free. Those who make them can never be fully objective. Yet we can often make them with greater certainty than judgments made in the scientific world of "if." The ultimate test in either case lies not in the assumptions and distinctions from which the judgment emanated but in the fruitfulness of the judgment itself in salvaging life. Inherent in the fruitfulness of a judgment is its relevance in the mainstream of history but also in the currents of the society in which we live.

The judgments discussed here attempt to chart one such current, its interaction with others, how they may be harbingers for the future direction of the mainstream, and how human choice may affect that direction.

They were made during a prolonged but especially instructive controversy over the effects of toxic beryllium dust on workers in the workplace and the proposed role of genetic tests of "susceptibility" to such effects. Data from these tests were to be stored in what was to be the first industry-sponsored international bank of DNA, using samples of fluids taken from beryllium industry workers in the United States.

Located at the University of Modena, Italy, with the assistance of the U.S. Department of Energy (DOE), the scientist in charge of the bank stated, in workshops conducted by DOE in 1994, that the bank was intended to analyze DNA of workers in other industries in the future.

There are no known breaches of law or professional codes of ethics in the United States or Italy (where the laws and codes may be as protective as those in the United States). Nor are there any known differences in the protection of patients or research subjects by the American and Italian scientists involved. In fact, they hired a professional ethicist to insure conformity with existing recommended and mandated practices. It is these practices, the biomedical community that developed them, and the industries and agencies of government that use them, the status quo, that must be judged here.

The need for judgment arises from a long history of mistakes—moral mistakes—by those wearing a mantle of trust endowed by social expectation.

Recently I read that
For four hundred years since Galileo,
science has always proceeded as a free
and open inquiry into the workings
of nature. Scientists have always ignored
national boundaries, holding themselves
above the transitory concerns of politics
and even wars. Scientists have always
rebelled against secrecy in research, and
have even frowned on the idea of
parenting their discoveries, seeing them-
Themselves as working to the benefit of all
mankind. And for many generations,
the discoveries of scientists did indeed
have a peculiarly selfless quality.

This is an incredibly naive view. But
then we have to recognize that it appears in a
work of fiction, in <em>Jurassic Park</em> by
Michael Crichton (1). Of course, Crichton
goes on to make an exception for
molecular genetics. However, in the history of science,
molecular genetics is not an exception,
merely a discipline in focus at this time.

Without question, throughout history
there have been many scientists who sought,
but only some who lived, Crichton's ideal.
Only a few of us are immune to moral
mistakes. Codes of professional ethics are a
requirement of professional life. Still, the
magnificent few who have lived this ideal
project the widespread impression of
scientists as a saintly caste, whose values color
the understandings of the multitude about
the whole of the scientific establishment.
The consequence is trust embodied in the
appellation "scientist."

Warnings to the public have been
sounded before. For Socrates, it was the
sophists. For Galileo, it was not the Jesuits
but the professors he feared (2). Benda, in
France a generation ago, roared "La
Trahison des Clercs," "The Betrayal of the
Intellectual" (3). He whose sculpture honors
our National Academy of Science, Albert
Einstein, deeply distrusted organized science.

Yet, when a worker receives a request to
sign a consent form so that his body fluid,
his work history, his medical record, the most intimate details of his life are made available to the scientist, especially if the scientist is a physician, the trust embodied in the appellation "scientist" usually colors his perception, and he signs.

There are other forces at work: peer group and employer and union pressure, fear of alienating an attending physician or source of future help, altruism, and concerns for tomorrow. These factors, and too little or ineffectively transmitted information, resulting in both conscious and inadvertent deception about the risks of participation cause the pen to be put to paper.

It is assumed that the worker knows what he is doing when he signs a consent form. Usually, the form is not even read, and when it is, the result verifies the response of Abelard: "I do not know what I do not understand."

The assumptions of free will and full understanding at the base of the process of seeking the informed consent of research subjects are not usually heuristic and, therefore, the process itself—as now ensconced in the widely imitated regulations of our National Institutes of Health—is morally invalid.

The Real World

The issues of genetic privacy and the assumptions of the process of informed consent were examined in the search to find a satisfactory biomarker for early stages of chronic beryllium disease (CBD). The disease currently is found most often among workers in the nuclear weapons industry, many of whom were exposed to excessive, unnecessary levels of beryllium dust. Labor unions cooperate to promote notification, early detection, and treatment of workers at high risk of environmental disease.

Typically, the first contact a worker had with the program was a consent form to be signed by beryllium-exposed workers prior to screening. At the DOE Rocky Flats, Colorado plant, workers asked to submit to lymphocyte transformation tests were asked to sign a form that read: "No future employer..., agency, group, organization or person will have access to the information provided by you, unless you authorize it in writing." No information on the ability of the researcher to keep that promise and the consequences of disclosure accompanied this request.

These and other beryllium-exposed workers at DOE facilities were to have been included in the proposed industry genetic testing program. After questions were raised by the workers' unions, non-DOE facility workers were substituted and samples of blood from those workers were drawn by industry-selected physicians and sent to Modena. There the DNA was tested for what has been described by industry spokesmen (not by the scientific investigators) as genetic "defects." These defects are hypothesized to be found among most workers with the disease.

The primary protection of privacy for these research subjects is the promise of confidentiality and the ethical codes of the physicians involved and their institutions, both in Italy and in the United States. Personal identifiers were not supplied to the Italian geneticists by the American physicians drawing blood samples and sending them to the DNA bank. The individual results of the analysis are not supposed to be available to the American physicians or anyone else without the research subject's consent. Privacy supposedly has been protected.

The exhaustive bibliography on ethical, legal, and social issues in human genome research published by DOE contains studies that establish the deceptions in the language of the consent form, the process of obtaining it, and the inadequacy of the supposedly blind laboratory procedures.

A court order can force public divulgence of the information the scientists say will not be accessed, with or without a signature attesting to consent. To apply for work or insurance, signing an access form is usually required. No signature, no work and no insurance. Current statutes provide little if any protection for genetic information. There is no effective protection of privacy even with the perfect enforcement of state and federal laws governing the confidentiality of patient or research subjects' personal and medical records.

Codes of professional ethics, a hypothetical condition of medical licensure in some countries and merely suggestive in most, effectively apply only to licensed professionals. Typically, those subject to the codes are asked to protect privacy but are not immunized from court orders and other legal requirements. The codes usually specify adherence to the existing "voluntary informed consent" process. The codes are silent on the kinds of information that should be provided on the risks of signing and the circumstances under which a signature should be solicited. When signed, the practice immunizes the scientist from legal responsibility for foreseeable events under his control, and significant events that are out of his control. The process protects the scientist, not the worker. Yet little is being done to revise or replace the informed consent process.

Americans for Disabilities Act provisions for ending discrimination for preexisting conditions may have little real-world effect on employment practices, which will continue to be guided by the perceived (real or imaginary) economic risks of hiring someone perceived (real or imaginary) to be at risk of a serious disease, compared to someone who is not.

The structure of our workers' compensation system, supposedly the guardian of self-regulation in occupational health, creates additional problems for rational health care. The system perpetuates Blackstone's two-centuries-old distortion of a cause: a single antecedent to a subsequent event.

Multifactoral causation—Darwin's "web of complex relations"—is a fundamental assumption of the prevailing population theories basic to modern medical etiology. But at least in their definition of causation, the laws of our states have not fundamentally changed since being copied from Blackstone's law dictionary when the United States were still British colonies.

A progressive definition of occupational disease under discussion for compensation law is "any disease or infection arising out of exposure to harmful conditions of employment, when those conditions are present in a peculiar or increased degree by comparison with employment generally..." This definition uses as a denominator the existing work environment, in which the conditions of "employment generally" result in most of the estimated 50-100-thousand annual deaths attributable to occupational disease. With this provision, state laws would enable the continued shift to workers of massive costs in lost wages and health care.

Hundreds of thousands of workers, faced with the irrelevance of the 56 separate workers' compensation systems, have sought the protection of third-party torts.

Once protected by the government from effective regulation, one industry—the asbestos industry—already is bankrupt. With this example before it, the beryllium industry (which has enjoyed even more government protection) is understandably looking for ways to prevent potentially huge awards to sick workers and their families.

The hypothesis that CBD is caused by a defective worker, rather than a defective workplace, is an economically appealing defense for a threatened industry in our
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A single cause--single effect legal system. The recent confirmation by the International Agency for Research on Cancer (IARC) of the 16-year-old finding of carcinogenicity of beryllium dust by the National Institute for Occupational Safety and Health (NIOSH), coupled with beryllium-specific community protection provisions of the Clean Air Act, is viewed apprehensively by an industry that must cope with the effects of environmental sensitivity in our society. Attributing beryllium-associated cancer to a genetic cause, not an environmental cause, may be necessary if the industry is to continue production of products as varied as the gold color in pen clips, electronic circuit boards, and key elements of the atomic bomb.

In the face of these pressures, the interest of the beryllium industry in molecular biological research is understandable. Given the additional pressure for social protection in other nations where genetic testing is being contemplated, the search for havens of industrially sponsored DNA banks can be expected and, as we have seen, has already occurred.

**Absence of International Standards**

A determined multinational industry, such as the beryllium industry, can generate banks of data, even of DNA, outside the effective reach of any nation's protection. The procedures for litigating the disposition of body fluids and medical records in the courts of another country—seeking enforcement of court orders issued in another country—may be navigable for practitioners of international law in the employ of multinational corporations. They would be an endless nightmare for the ordinary worker.

In this case, there is no evidence that the workers being tested understood that they were permitting their body fluids to be sent to another country for tests or what difficulties might be encountered if they chose to restrict the use of information derived from those tests.

In 1993 I asked the program officers in the DOE, the investigating scientists, and leading officials of the industry for a 6-month moratorium on their proposal to create a DNA bank until an interim, enhanced informed consent procedure could be put in place for the relatively small number of beryllium-exposed workers to be studied.

They refused, while fully aware of the absence of effective national or international protections for the privacy of medical records and body fluids drawn from research subjects and patients whose consent cannot be fully informed or voluntary. The "voluntary, informed consent" process protected the industry and its collaborators in academe and government, not the research subjects.

The industry's program of molecular biological research appears to be designed to defend what the Beryllium Industry Scientific Advisory Committee has already proclaimed as the discovery of the first "occupational genetic disease." As stated publicly, the purpose of the research is to make a case for the exclusion of purportedly "defective" workers from employment on the basis of an alleged genetic difference found among 30% of our total population.

The program is a persuasive argument for a new body of law to deal with an unjust threat to the well-being of millions of workers and their families perpetuated by courts whose jurisdictions may not extend beyond state, let alone international borders, and whose rules governing causation have not changed essentially in two centuries, in a system of law that accepts a signature as evidence of informed consent, guided by judges often unable—and sometimes unwilling—to digest the results of modern scientific investigation.

Can we lean on quaint but antiquated and rotted reeds of law to cope with the double helix unraveled? Should we not conclude that there are no judicial impediments to the evolution of a new caste of workers? There is only the question of mechanism, and this has already been established.

**Origins of Caste Evolution**

Some of our moral mistakes are semantic in origin. We often fail to distinguish among genetic defects, genetic disease, and genetic differences, or between inherited genotypes and the environmentally evoked phenotypes. Failures in expression, however, are less important than our failure to recognize a basic mechanism of human evolution at work: social selection.

We are not facing a totally new experience. With insensitive handling of medical testing in the early days of implementing the standard for vinyl chloride established by the Occupational Safety and Health Administration, in one plant I witnessed the creation of what the workers themselves called a "leper colony." Workers who "failed" a bilirubin test were exiled to a pallet shop. Nearly everyone in the plant, and many in the plant community, knew that everyone in that shop failed the test. They were seen to be sick, albeit most were not, and subjected to shunning.

There is a rich literature on the effects of the shunning of the sick. As devastating as those effects can be, they are relatively short term and minor compared to long-term social selection against those stigmatized by genetic disorders (real or not), including the intergenerational effects of changes in family and community relationships and disturbed mating behavior.

The intergenerational effects of selection through mating-pool restriction and other demographic changes, expressed biologically, might not be expected to be significant for many, perhaps hundreds, of generations. That calculus of events results in little urgency. But that is not the case for the cultural expression of social selection.

This is an aspect of evolution that Darwin understood well. His notes on genocide, especially the murder of young Indian women in South America, were not only expressions of his horror. He wanted to document a method of rapid cultural selection deleterious to our species (4).

Given the computer, records linkage, and the ease of widespread testing, a cultural expression of negative social selection (without germline intervention) could occur worldwide in one or two generations, as it did in South America. The selection could be less bloody, but no less efficient. No one need be murdered. But in the path of the scythe of social selection stand hundreds of thousands of workers who could be placed in a caste whose members can be tagged for life, and their offspring tagged, as poor insurance, employment, education, and mating risks.

Gilbert Omenn (5) has calculated that for some two dozen biomarkers established at the time—blood types, red blood-cell enzymes, blood plasma proteins, and leukocyte histocompatibility types—except for identical twins any two persons have only a one-in-three-billion chance of the same profile of genetic differences. The spectrum of profile differences biologically is massive.

The process of positive natural selection based on genetic differences that might be deleterious, would be very slow. (One anonymous EHP reviewer noted "the probability [particularly in terms of the immunological basis of CBD] that a worker with an inherited susceptibility to beryllium will not, on the basis of possessing that allele, be susceptible to other chemical or physical agents in the work-
place." Another such reviewer believes that
the word "possible," not "probable," fits
the data.) For most common diseases, "the
susceptible genotype... is (a) neither neces-
sary... nor sufficient (cause)," The pene-
trance of the genotype depends upon other
vectors as well, such as environmental fac-
tors. Because of adaptive mechanisms,
including environmental controls, negative
natural selection need not occur at all (6).

Alpha-1 antitrypsin deficiency is a
genetic disease that occurs in 7 to 12% of
American workers. Associated with emphy-
sema evoked by airborne irritants, the
deficiency provides an example of an inher-
ited characteristic that may never be
expressed in a controlled environment (7).
In a study of blood donors in the St. Louis
area, only about 2% of the cases of chronic
airflow obstruction exhibited alpha-1 anti-
trypsin deficiency (8).

In some cases, as for the sickle cell trait,
there is in fact an environmentally induced
selective advantage.

Saltini’s (9) estimate that 30% of the
population is sensitive enough to beryllium
dust to evoke disease should not surprise
us. Burton (10) noted that ambient gas-
aerosols, which typically include beryllium,
even in low concentrations evoke hyper-
reactions from 10 to 20% of a young,
healthy adult population. How much of
this reaction would be inherited?

What would be the effects on society
and these 10 to 20% of all young, healthy
adults and those no longer young or
healthy if we exclude from worksites all
workers hyperreactive to even low concen-
trations of gas aerosols? Only some would
have inherited susceptibility and, of
these, few or none would have a phenotypic
expression in the absence of the dust.

Beryllium is ubiquitous in fossil fuel; as
a consequence its ambient levels are accu-
mulating primarily where it is the source
of energy. Even with stringent environmental
controls, workers in almost all agriculture,
food processing, mining, fabrication, distri-
bution, energy generation, construction,
communications, disposal, and in every
university library are subject to low con-
centrations of beryllium as a gas-aerosol.

Should 20 or 30% of these workers be
placed in a real or merely perceived geneti-
cally based caste that would exclude them
from their jobs? What would be the effects
of such castes on the species, and on those
in the caste?

Before we can understand what can
happen to humans within a caste, it is nec-
essary to understand castes as persistent
biosocial phenomena. Social selection
through an evolving caste mechanism fits
an ecological paradigm well documented in
human history. Class structure is an essen-
tially unstable economic dynamic that cuts
across communities (which are relatively
stable organic units). Evolving hereditary
caste structures are relatively closed, socially
static, organlike systems that can be grafted
onto a natural community by other than
economic vectors.

The ancient Indian word for caste is
varna, or color, a biological concept. When,
more than a century ago, the British began
their census of Indian castes, they found two
categories of pariah communities. They
found ritually distinct tribal and occupa-
tional communities with encapsulated gene
pools endogamous due to marriage restric-
tions, physically side-by-side but culturally
with vertical status relative to one another,
within which class structures existed. The
Census of India in 1901 found two to
three thousand subcastes (depending upon
how they were counted).

The members of each caste inherited, as
Weber (11) put it, a "charisma that origi-
nally had nothing to do with heredity."

Dobzhansky noted that of about 2000
Indian subcastes, the most genetically signif-
ificant groups, 200 or more may be sympa-
thetic in the same district, leading to a genetic
convergence of most castes in at least their
physical traits. But divergence also took
place. "At least some sympatric caste popu-
lations remain nevertheless genetically
distinguishable (e.g., in blood group fre-
cuencies) and, to some extent, also physi-
cally..." (12). They can be identified by
physical appearances that are a consequence,
at least in part, of the caste system itself,
which reinforces the rigidity of the caste.

Dobzhansky’s observation of Indian
castes is predictable given their relatively
small size in any one district. This is likely
the case of a caste defined by a single
genetic difference in any one American
industrial area. It has been apparent for at
least half a century that population size is a
critical genetic factor. Alfred Emerson
(13), looking at social insects, saw the
community in which evolution takes place
as a superorganism in which natural selec-
tion operates on a structure of whole popu-
lation units. Within these communities,
Sewall Wright (14) observed a population
structure subdivided into small semi-isolated
demes, also subject to selection, within
which, because of their small size, random
drift has a greater effect on changes in gene
frequency than in larger populations.

Thus, while genetic differences concen-
trate within a caste, albeit relatively less
important biologically in Indian society,
they parallel the concentration of relatively
very important cultural traits, the inherited
charisma of belonging to a caste. Negative
social selection based on even one such
difference draws a discomforting picture.

Gunnar Myrdal (15) described the per-
sistent caste defined by skin color in which
African-Americans find themselves. The
closed and rigid caste, distinct from the
open and mobile classes found within each
of the black and white castes, restricts free-
dom of movement between the demes. The
synthetic evolution of this caste mimics the
development of occupational castes.

Hereditary occupational castes are ritu-
ally differentiated in many ways, but for
our purposes we need only focus on the
differential tolerance levels of occupational
disease and injury. In America, through the
loss of social esteem for physical labor
(noted with dismay and last resisted seri-
ously by the Jefforansions), rituals for these
castes evolved in adaptation to risks rele-
gated or imposed on the caste by the
greater society. We see these rituals today
in the industry and government policies of
"acceptable risk": two-tier environmental
protection (risks of one death in a million
established as acceptable in ambien
t environments versus one in 10,000 in the work
environment). We see it in segregated
occupational health care (replete with seg-
regation of professional education, ethical
codes, and facilities extended even to work-
site health promotion).

Flight from an occupational caste is
possible by a change in the color of a col-
lar, a remedy not available within castes
defined by skin color, the most obvious
case, or any other genetically based
caste. Although they are now few, the
number of identified environmental agents
that provoke genotypically based reactions
is increasing. There are also increasing
numbers of diseases for which both a
 genetic disposition and an environmental
factor have been found. Even when suscep-
tibility to even one environmental agent is
still hypothesis, as is the case for beryllium
dust, the charisma attaches to the individ-
ual and the shunning process in the com-
munity and at work can occur. The
worker will be perceived as defective. Even
though the genetic difference from other
workers may be narrow and the allele may
have no known effect on sensitivity to
any other known agent, the worker will be
stigmatized and placed in a caste with
others also stigmatized for the same or even different sensitivities.

Employers will often have a choice, legal or not, between eliminating what they perceive as defective workers or cleaning up the environment of the workplace, and increased opportunities for identifying those defective workers will be. How will such workers escape a caste so defined and inscribed on the hard drives of thousands of computers that already link employment and insurance applications?

Genotypically defined castes deny equal opportunity to reach the human potential, aptly described by Dobzhansky "as the wastage of the genetic potential of our species" (12). The despair that arises from this denial is very often described in economic terms, less often in terms of life and death.

When escape does not happen, at least one cultural–biological effect is well documented. The inability to escape has been measured historically by a surrogate measure of a sick society: suicide.

Erz Gebirge Legacy

The social misapplication of technology and research from which human despair stems is difficult to contain within a capsule of time or within a caste of a few workers denied generic human needs and, therefore, generic human rights. The almost infinite range of possible genetic differences is easily used repetitively in the creation of genotypic human castes in a computer-driven society. The beryllium case, and others on the horizon, if the industries succeed in pressing their claim, will be a step back into a history we need not repeat.

Comparing the human ecology of the uranium industry in the American West and in the Erz Gebirge (Ore Mountains) of Germany and the Czech Republic, we encounter the latent, endemic, sentinel social malignancy identified by Thomas Masaryk in the last decade of the last century.

Masaryk's work (16) was completed prior to his becoming the first president of Czechoslovakia, where in Bohemia (among the Saxon miners of Joachimstal, now called Jachymov) uranium disease and pollution were described centuries before (in 1556) by Agricola, who was town physician there and in Chemnitz (the capital of the region), in De Re Metallica: "...Miners are sometimes killed by pestilential air which they breathe; sometimes their lungs rot away; devastation of beasts...fish...fields...woods...rivers" (17).

On the north slopes of the Erz Gebirge, Jachymov lung disease was called Schneeberg lung disease. It was diagnosed as lung cancer by the German scientists Harting and Hesse (18) first in 1879, and again by the Czech scientists Pirchan and Slik in 1932 (19).

The medical literature focuses on describing cancer and other diseases of the lung among miners, not on conditions in the mines and the mining communities associated with the disease. It is tempting to blame other etiological factors found among this relatively encapsulated caste. Richard Doll (20) reported that Schneeberg lung disease "was commonly ascribed to a secondary effect of silicosis in an inbred population predisposed by hereditary susceptibility."

The natural history of the region and its people supports Masaryk's account of suicide as a social malignancy found among miners and their communities. This disease measures the despair associated with the impact of mining conditions not only on the miners, but on the families and communities of miners, over long periods.

Agricola described landslides that in a single day "robbed 400 women of their husbands," and subsidence that swallowed up a hut and the woman and child within.

Masaryk was inspired by a childhood encounter with suicide and the Faust legend of his culture. He read Goethe's accounts, written two centuries after Agricola, which allude to conditions in the mining industry of the region. They depict adaptation to centuries of disease, ecological devastation, and other historical and social factors: centuries of communal resignation, entsangung, pervading the social life of the encapsulated mining communities of Saxony.

Goethe was no stranger to life in these communities. He was Minister of Mines in nearby Saxe-Weimar, where he supervised the miners of Ilmenau. The resignation he observed in the morés of the miners is the despair which, unbot-tled, becomes the suicide ritual of that region.

The fiction of Goethe imitates reality echoed in the numbers, in another imitation of reality, found in the statistical analysis that enabled Masaryk a century later to predict multiplying pools of human despair within the caste of workers, within which caste suicide takes place in ever widening dimensions.

Masaryk found that the growing rates of suicide in Europe were at the time highest on the north slopes of the Erz Gebirge in Saxony (where the uranium mines are concentrated). He found that the etiology of suicide—urban environment, poverty, occupation and other factors associated with technological "progress"—explained "the great increase in suicide among children" as well as among adults.

The pattern of growth and concentration of suicide predicted by Masaryk persists in the region today. What he described is a worldwide pattern.

In America, only a quarter-century ago, suicide was a minor cause of death. Today, suicide is the eighth leading cause of death for populations of all ages in the United States. Among minors and young people just entering the workforce, ages 15 to 24, suicide rates have undergone a dramatic change in a single generation. In 1960 the rate for this population was half that of the nation as a whole. By 1979, the rate for minors and young people exceeded that for the general population. By 1986, in this age group, suicide became the third leading cause of death. In 1990, it became the second leading cause of death for white males in this age group. (One EHP anonymous reviewer notes that "suicide rates have been much higher at least twice in the 20th century in the United States than in the present decade." Two excursions do not necessarily weaken the case for the increasing significance of suicide. In any case, the intractability of rates of suicide rising relative to those of other diseases plus rising or higher rates documented in pockets of despair among workers, supports the argument made here.)

Suicide is only the sentinel event. Parasuicidal behavior—suicidal behavior short of death—may occur at 20 and 40 times the suicide rate, especially during the critical early years of the afflicted. This explains much of the self-destructive behavior reflected in soaring drug abuse and in homicide rates, which exceed the increased rate of suicide itself, among youth in urban black caste communities.

Suicide statistics are not always recorded. The former Democratic Republic of Germany did not report suicides, but the conditions in which they took place are well documented. In the spring and fall of 1991, after the reunification of Germany, and again in the summer of 1993, a group of researchers witnessed and heard firsthand accounts of these conditions and the consequent disease and ecological devastation. (During the first visit, Dr. Hans-Joachim Woitowitz of Giessen and I were accompanied by Dr. Cesare Maltoni of Bologna. Dr. Woitowitz and I made the second visit as part of a joint study being conducted by the Ramazzini Institute for Occupational and Environmental Health Research.) Through an examination of
medical and exposure records, in interviews with uranium miners, community physicians, representatives of the labor-management Berufsgenossenschaften, and mining officials, and in visits to miners' clinics and to the mines themselves, we observed the same kind of the pestilence found by Agricola among miners and mining communities impacted by massive piles of mine tailings from deep and open pit mines feeding large-scale milling operations.

The sign of the miner's guild is still the symbol of the region, but it marks abandoned guild halls that with the near closure of the mines seems to have ended 500 years of caste evolved from working relationships described by Agricola. The folkways, work practices, and life rituals of mining communities are found now in carvings and exhibits made by miners themselves for the museum of Schneeberg; funerals, marriage, guild ceremonies, the school, the town hall, the square, the mine galleries beneath it all, and the church that was their voice in the world beyond the caste.

Scarce in the museum are reminders of those who live outside the caste, reminders of the physicians, engineers, and scientists—from Agricola's time to Goethe's time to reunification in 1991—who witnessed the disease and repression, and did little. For some it may have been because the caste of miners was not their own. For some it was because they could do little. Yet, while action was thwarted, emotion was not. It is not possible to read the history of the region, speak to contemporary government leaders, read the medical reports, speak to community physicians, and visit the clinics without feeling the compassion among physicians and officials outside the caste. Entsagung prevailed until unification provided opportunities to move their government to organize a successful, massive effort of medical, social, and financial assistance.

About 300,000 former uranium miners in Germany, many of whom were KGB prisoners of war or politics, experienced about 15,000 cases of silicosis. More than 6800 cases of lung cancer were recorded, of which 5131 cases were compensated by the East German government. The same conditions prevailed on the Czech side, in Jachymov, where in 1953 there were 11,816 KGB prisoners in the mines.

These prisoners, mostly Germans, had a monument to their suffering, a collection of more than 200 autopsied silicotic lungs neatly marked with laundry tags and stored in the basement of a miners' hospital in barrels of formaldehyde, with simple wooden covers, along with thousands of paraffin blocks of cancerous tissue.

With two colleagues, I met with a group of miners from this population during a visit in spring 1991. It was the first meeting in a union office of freely elected miner representatives with representatives of the Wismut Corporation (created by the Soviets and East Germans to operate the mines) and government officials since the pre-Nazi era. It may have been the first time the international community had ever demonstrated an interest in their welfare (other than as research subjects) and had shown support for the humane initiatives of physicians in both East and West Germany who tried to alleviate the misery of their patients. Half a century of silence imposed by fear was broken in a human storm. These workers did not need statistics to understand their experience. The torrent of emotion in that meeting documented a continuity of heart-rending despair reflected in a continuity of the pre-World War II rates for suicide in the region reported by the new government of Germany.

In America, as the studies by Archer and his colleagues (21) in the U.S. Public Health Service document, a pattern of excess death due to suicide was found among uranium miners on the Colorado Plateau engaged in the same Cold War, albeit under a different flag.

This excess was found in the four corners mining region: New Mexico, Arizona, Colorado, and Utah. This region already experiences four of the five highest rates of suicide found in the United States. The neighboring state of Nevada has the highest rate.

One of the earliest mines was in a carnotite deposit at Uravan overlooking the Unaweep Canyon on the western slopes of the Rocky Mountains. It was opened in 1881, only two years after Harting and Hesse published their paper identifying what had been called "Schneeberg lung disease" as lymphosarcoma. The mine supplied much of the ore from which the Curies isolated radium. The Uravan mine once supported a community of 800, with another 200 in surrounding communities. I visited the mine in April 1994 (the third visit over a 25-year span), found it closed, the community dismantled, and the tailings successfully "remediated". Some of the families remain in the area and are still engaged in small-scale mining. The miners have not been remediated.

Most of the miners on the plateau worked in what they themselves called "dog holes." They were relatively few in number and dispersed in small units: about 4000 miners in 900 small mines typically operated by families but owned by major corporations under contract to our government (the U.S. Atomic Energy Commission and the Bureau of Mines).

This decentralized pattern was devised to escape unionization and regulation. (Small enterprises have traditionally been exempt de facto from regulation in the United States.) The miners were prisoners of a system that varied from that of the KGB only in its social graces and magnitude. Fewer American miners were required than in the Erz Gebirge.

Our government, unlike the German government, never organized a timely or adequate effort to notify the miners of their risk, provide adequate health care, or pay timely compensation for their families despite known high rates of tuberculosis and silicosis in the early years of mining and, in later years after the normal long period of latency, a cancer rate nearly five times more than expected.

Among the white miners, the rates of suicide exceed the rates generally found. The suicide rates among the Native American miners, perhaps attributable to differences in culture, were not in excess. Their lung cancer rate was essentially the same as that experienced by the white miners. Many were recruited to replace the white miners in mines and mills outside tribal territories because they tended not to be smokers, a defect of white miners alleged by the uranium cartel (when opposing a more stringent radon standard in 1972) as the reason for their high lung cancer rates. This finding was nearly a century after the findings of Harting and Hesse. The Native Americans, selected for membership in the miners' caste on the basis of an alleged resistance to lung cancer, a genotypic selection, did not need to commit suicide to suffer the same (uncompensated) fate.

The miners generally were represented by unions only in a few larger mines and mills. But unionization does not mean the absence of a caste of workers within which torment and despair are neatly contained. Among DOE's highly organized nuclear bomb production workers, it was not until 1987 that their historically silent despair finally ended in a petition to the Industrial Union Department of the AFL-CIO for intervention. The despair has not ended, only the silence: the most recent death among these workers was a suicide associated with CBD.
Masada Syndrome

Masaryk’s description of the causes of suicide is very close to describing the social implications of the impending abuse of genetic information. But it eludes a crystallized picture of despair, and hence suicide, in a “closed and rigid” human caste system.

Josephus, an historian of the biblical era, helps us find a precise description of the social disease we face (22).

About a 1-hr drive south of Jericho, but in Israel overlooking the Dead Sea, there is a mountain called Masada. Nearly 2000 years ago, on the flat top of Masada, lived nearly 1000 men, women, and children—Jews who had not accepted Roman rule. The Romans built a wall around this community to prevent escape, and built an earthen ramp over which their army could enter Masada.

When Eleazar, the leader of this community, saw the desperation of his people, who faced torture, slavery, and rape, he reasoned that “life could be a calamity, not death.” He called his people together, and they agreed to choose by lot ten men to slay all the rest, and then one of the ten to slay the remaining nine and then himself. The Romans found 960 bodies.

Josephus described a social disease in which by lot we destroy ourselves, not just those in the caste, but as a society guided by reverence for life and freedom: The Masada Syndrome.

The Masada Syndrome takes its name from a microcosm of the negative mechanism of social selection recognized by the great students of our evolution as the brutal substitute for positive natural or environmental selection.

The Masada Syndrome has been manifest many times in the human past. Within a caste we have selected by lot humans for physical or spiritual suicide. In the absence of effective intervention, predictably we will in the future create more castes of humans deprived of basic human rights, even the generic right to life, and select by lot still others for the same fate.

Western society, as we idealize it, could self-destruct if we permit a precedent the computer can replicate in multiple anomic progeny. Drawing lots with molecular biological markers of genetic difference or variation could impose despair of an intensity that, as history has witnessed, leads to mass suicide.

This precise effect would not always occur. Caste systems persist in many societies for centuries with less bloody effects on their members, as they do in India, but with effects that are just as destructive, since they are the death of moral values at the heart of our civilization.

Not just the momentum of history coupled with the undirected impact of advances in molecular biological technology make a new caste of workers predictable. We must also cope with demographic changes that accelerate its development. The loss of 30 million middle-income jobs over the past 20 years has created an increasingly rigid two-tier society with radical changes in demography that impact the essential character of the entire population. The mobility factor, social and geographic, is especially important.

The loss of social mobility means indigenous cannibalism: child labor, transgenerational poverty, worklessness, alcohol and drug dependency, socially bifurcated safety and education, institutionalized illegitimacy, no recognizable nuclear families, endemic violence, and decreased communication through radical changes in language, art forms, and leisure time use. It means suicide, of an individual and of a society: the Masada Syndrome.

Emerging Patterns

The impact of molecular biological technologies used to select workers based on genotype is difficult to see from the stage on which it may occur. Unfortunately, that is the only place on which we can stand. There, the dynamic of social change is like causation in the physiological milieu. The tendency toward equilibrium obscures relationships we must isolate to understand the multifactorial reality. Nevertheless, some patterns have emerged.

Fundamental biological change may be primarily Darwinian in nature and natural selection may result in undirected variation, but fundamental cultural change is primarily Lamarckian in nature.

New characteristics of culture, even molecular biological technology itself, pass from one generation to another by communication, communication in a community. Cultural variation is directed in the universe of discourse in structured communities. It is a myth to believe that this variation will occur by blind forces of human selection or by chance. New multinational institutions, driven by new needs, must direct cultural variation that reflects our beliefs on how mankind should evolve, what we should become.

The process of cultural evolution need not mimic the tooth-and-claw misconception of natural evolution that rationalized the negative, often well-meaning but often socially disastrous, eugenic planning made notorious in the first half of this century. There is another evolutionary route, a positive process accelerated by the gradual expansion and inclusiveness of an open society that protects life.

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