

# Natural Selection

A NEWSLETTER OF THE ROCKEFELLER UNIVERSITY COMMUNITY

## A PEOPLE'S HISTORY OF SCIENCE: An Interview with Clifford Conner

JOSÉ F. MORALES AND ALLAN COOP

In an ongoing series exploring the science/society relationship, we've noted that there is considerable evidence in the US for the development of a split between science and civil society<sup>1</sup>. Two leaders of science, Harold Varmus and Paul Nurse, have vigorously championed broader awareness of new threats to the scientific endeavor<sup>2</sup>. Chris Mooney, author of *The Republican War on Science*, has extended such arguments by documenting the unprecedented science abuse by modern conservatives. We have argued that these threats not only endanger science's benefits to society, but also the Enlightenment culture we enjoy<sup>3</sup>.

Such commentators suggest countermeasures to these threats that might be described as a multidimensional democratization of science. One level is the deepening of connections between science and the public. Dr. Nurse observed in his recent opinion piece, "Better dialog with the public about science and issues raised by science is fundamental for a good relationship between science and society"<sup>4</sup>. As a practical solution we have reported on another participatory mechanism, the European initiative of "Science Shops"<sup>5</sup>.

To better understand the current situation, we took Santayana's advice that "Those who cannot remember the past are condemned to repeat it"<sup>6</sup>. Thus, we interviewed Dr. Clifford Conner, the author of *A People's History of Science: Miners, Midwives, and "Low Mechanics"* ([www.PeoplesHistoryofScience.com](http://www.PeoplesHistoryofScience.com))<sup>7</sup>.

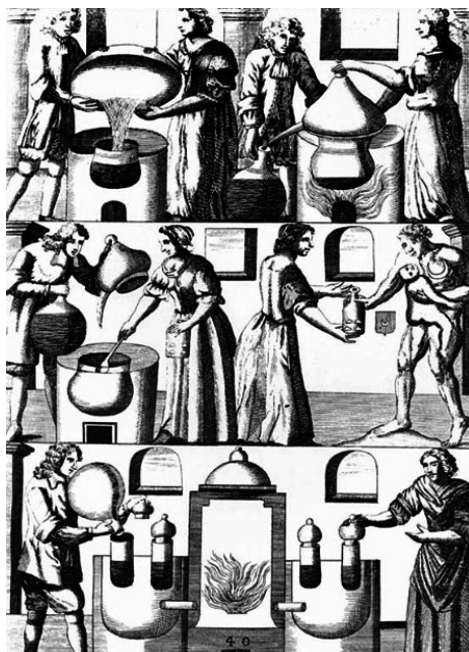
### NS: Why this book now?

Clifford Conner: I was motivated to do the book because I felt there was something missing in the way most people understand the history of science. I know from my graduate training that there is a lot of information out there about the history of science that doesn't get to the general reading public. The goal of writing the book was to take this information and try to make it

interesting for a general reading audience.

### NS: What is your definition of science and why do you use it?

CC: This is a controversial question. I use what I consider to be the simplest possible definition, also used by J.D. Bernal in his wonderful five-volume history of science: "knowledge of nature and the processes we have to go through to get that knowledge."



### NS: What is the relation between the "great man" in science and the people?

CC: One of the reviewers of my book said that I was replacing the "great man" theory with the "great mass" theory. Well, I'm not, really. The central focus of my book—although I tried to at least give an outline of how the knowledge of nature developed throughout the whole scope of tens of thousands of years of human history—is on what is called the Scientific Revolution. That occurred in Europe in the sixteenth and seventeenth centuries. What we call modern science today had its origins there. Most books in the past that have been written about the Scientific Revolution only focused on theoretical astronomy

and theoretical physics, and therefore only paid attention to Copernicus, Kepler, Galileo, and Newton, and how their ideas flowed into each other. But much more important at that time was the transformation of scientific method. For thousands of years, the people who claimed to be the arbiters of knowledge of nature were the elite scholars in the universities. If you went to them with a question, how would they try to answer it? Well, they'd go to the books of Aristotle or Avicenna or some other ancient authority and try to find the answer in the books, and if they couldn't find the answer, they would try to find some general principle that, through deductive Aristotelian logic, they could deduce the answer from. That was what science was until the Scientific Revolution brought about a new method—the empirical method, the experimental method. The important thing that I try to point out is that this did not come from scholars, but from the workshops of artisans. There were a few scholars who recognized this, especially Francis Bacon. There were others—William Gilbert, Robert Boyle, Galileo—who also noticed that things were happening in the workshops of the artisans, and they went there to learn. That's the most important thing about the Scientific Revolution, the thing that changed the way the whole world now looks at nature and investigates nature.

### NS: One might observe that there is a parallel between the elite appropriating and systematizing the knowledge of craftsmen and artisans back then and lab heads today appropriating and/or taking credit for the work of technicians, grad students, post-docs. Would you care to comment on that?

CC: Yes, I have a very interesting example of that in the book. Robert Boyle is considered one of the great heroes of science, but it's quite clear if you investigate it, that a lot of the things Boyle is credited with were done by people he hired to be his so-called assistants. Some of them have even gained recognition in the history of science them-

*continued on next page*

selves, like Robert Hooke. But in their time, they were subordinate to Boyle because he was an aristocrat and a very wealthy man. So, at the time, they didn't get the credit they deserved, and for the most part still don't. One of the things I mention is that there is a pretty good chance that even Boyle's Law was determined by experimentation by other people that he hired, and they even wrote it up, but we call it Boyle's Law. The question is, why? In those days, especially, you had to be of the class of gentlemen in order to publish something that other people would read and consider to be truth about science. You might have a similar thing happening today with lab heads, but maybe it's not done quite as consciously as in Boyle's day. Back then it went without saying that if Robert Boyle hired you, anything you discovered was his intellectual property. I don't think it would be quite the same today, yet sometimes it works out like that.

**NS: We sign a contract which says that The Rockefeller University owns any intellectual property we create while employed by the university [as is now required for federally funded research in US universities]. So things haven't changed that much.**

CC: That's right. Maybe we think about it differently, but it works out the same in the end.

**NS: What would your ideal high school science textbook look like?**

CC: I think the main thing I would stress is that there is more to science than theory. The other thing I would stress in a high school textbook is that the relationship between science and technology is not what we have been led to believe by our modern experience. Our modern experience teaches us that science comes before technology. Today scientists in laboratories theorize and come up with theories that are then applied to create new technologies. But that's a fairly new thing in history. For tens of thousands of years, the relationship was exactly the opposite. Historically, the relationship has always been technology first and then science. The classic example is the steam engine. One might think that it was created by theorists who developed the laws of thermodynamics and then applied those laws to create the steam engine. But it was quite the opposite. The steam engine was created by artisans, tinkerers, and inventors... "lower-class" people. Scientists began to study the steam engine, because it was such an important part of the economy, to find out how it worked. By studying and analyzing it, eventually the laws of thermodynamics were formulated. So that is the true relationship historically, almost al-

ways, between science and technology. First the technology was created by artisans and people working with their hands, and experimenting, and so forth. Then the scientists, by analyzing the products of the artisans—the technology—developed the theories and laws. You can't speak of the history of science as being only theory because you have to start with where it all comes from: technology and the contributions of the artisans.

**NS: So you are suggesting that now things have changed in that regard?**

CC: Oh, yes. Let's take the biggest example of all, the Manhattan Project, where a practical result was developed from abstract scientific theories about nuclear physics. Those theories resulted in atomic and hydrogen bombs in the mid-twentieth century. You can actually go back to the late nineteenth century, when the first real examples of technologies created on the basis of theories were probably the ones developed from the theories of electricity. From the modern experience, people falsely generalize that that is the essential relationship between science and technology; that scientific theories come first and technology follows. But historically, at least until the late nineteenth century, it has been the other way around. A good example even in the early twentieth century is the airplane. The airplane wasn't developed from theories of aerodynamics. A couple of bicycle mechanics from North Carolina did what the theoreticians said was impossible and created an airplane. And keep in mind that even though those theoreticians were physicists in the era of quantum theory and relativity theory, aerodynamics developed on the basis of an artisanal contribution, the practical technology of the airplane.

**NS: How would you respond to this critique of your position? Artisans are like technicians; they really don't understand what they are doing and they need the scientist to get at what is really going on. They're just hands and they produce useful things, but they don't have a full understanding of what they're doing.**

CC: Again, there's a difference between today and most of history. Today there might be some justification for someone saying that. Although I suspect that if they did, what's really going on in their mind is, "I'm smart, I'm superior, I'm better than these people that work with their hands." But historically it has usually been the other way around. At the time of the Scientific Revolution, the artisans knew what they were doing, knew what they wanted to do. The uni-

## Natural Selections

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versity-trained intellectuals—calling them "scientists" is a bit anachronistic—were like butterflies, dilettantes. They called themselves the "virtuosi," and they would go into the artisans' workshops and try to exhibit their knowledge, but they rarely knew what they were talking about. In the nineteenth century and earlier it was typically the case that the artisans were the people who knew things, and the "virtuosi" who were trying to develop theories were just there to pick their brains.

**NS: You talk about how social elites have appropriated science as a source of authority and have commodified it. It's these same forces that Chris Mooney identifies in his book *The Republican War on Science* as anti-science and for whom new knowledge may be a threat. How do you reconcile this apparent contradiction?**

CC: Well, the corporate elite needs the new knowledge. They need it because their economic system depends on it. It's like the man on the bicycle: if he stops, he falls over. They have to keep growing and growing and growing. They need new products, new science, new technology, but at the same time they fear some of the science as damaging to their profit interests. The best example is global warming. So it's more than an apparent contradiction; it's a real contradiction. But it's their contradiction.

**NS: You contend that the undermining of science's authority stems from "whoever pays the piper, calls the tune," and you point out that a lot of science is conducted**

**by corporations. However, the vast majority of basic research in biomedicine, for example, is in fact funded by the social wealth represented by taxes. So would you say that tax-funded research is people's science?**

CC: No, but I certainly agree that that's the way it should be. Unfortunately, the government has defaulted on its responsibilities in this regard, and tax-funded research has become just another facet of the "scientific-industrial complex." In most biomedical research, "Big Pharma" calls the tune, directly or indirectly, and that's the piper that has to be paid.

**NS: Do you think that ordinary people can still make discoveries in an era of heavily funded science? If not, what prevents them?**

CC: Well I think there's a lot that tends to prevent that—the great rise of specialization, the immense amount of money it takes to do research these days—but the answer to your first question is, yes, I think it's still possible for scientific outsiders to make momentous contributions to science. It's not likely, and it's not going to happen often, but it can happen and we shouldn't be shocked when it does. The best example I can think of is the personal computer revolution. "Big Science" had developed the electronic digital computer, but at first they were huge machines used by the military-industrial complex to crunch numbers. But then some kids got interested in it and formed computer clubs all around the country. It was a social movement, and these high-school kids and college dropouts developed an alternative that democratized computer science. This is one of the greatest scientific innovations that's happened in our lifetime. It just goes to show that "Big Science" is very dominant and very powerful, which makes it very unlikely that many scientific advances will come from the outside, but...you can't write-off the possibility.

**NS: You have mentioned a variety of instances in history where social elites in fact inhibited the development of science (e.g., the introduction of Arabic numerals in Europe). Is the current corporate integration into science, with prohibitively expensive technologies, a parallel to the elite inhibition of access to tools that could advance science?**

CC: Yes, that's one of the reasons that I focus on this so much in the book, because I think there's an important lesson in it for today. When people set themselves up as authorities and say, "I speak in the name of science," it's worth remembering that historically a lot of scientific authorities actually retarded the development of science. The two biggest

examples I cite in the book—and there are thousands, big and little—are, first, the retardation of science by the scientific elite of ancient Greece as institutionalized in Plato's Academy and Aristotle's Lyceum. The kind of science they started became solidified and ossified, and led science into a blind alley for two thousand years, until the Scientific Revolution. And the other example I cite is the intellectual elite of China, the mandarins who were the administrators of the imperial bureaucracy. They did everything they could to prevent the development of science and most technology, which is why science was slow to develop in China. I give some cogent examples of that, especially in maritime technology and the navigational sciences. China's naval superiority in the fourteenth century put it in a position to rule the world, but the Emperor arbitrarily drew back, because the mandarins decided that it was a threat to their social stability and put the kibosh on it.

**NS: Do you think that the process of democratization of science is going on or is it actually being retarded at the moment by the attack on science?**

CC: To use a Hegelian phrase, it's a dialectic. It is going on and at the same time it's being pushed back. A good example is the rise of the Internet in China. I read in today's paper that there are now something like 110 million people on the Internet in China, doing all kinds of things. Meanwhile, the Chinese government is trying its best to keep what's called "the Great Firewall of China" in place, to try to keep dissidents from linking up with each other, you know, in a democratic way. So there's this great surge of democratization through the Internet and at the same time there's a tremendous police power pushing back against them. Right now it seems the government is still a step ahead of the dissidents in China.

The central theme of Conner's book is that "scientific knowledge production is a collective social activity, that essential contributions have been made by working people ... and that elite theoreticians are often unjustly awarded all the credit for knowledge produced by many hands and brains" (Conner's emphasis). Early in the book Conner states, "In a nutshell, the birth of modern science occurred when gentlemen began to appropriate artisans' knowledge and to systematize it." In a detailed example, he describes how Francis Bacon advocated a reinvigorated science based on craftsmen's knowledge of nature, calling for assembling a compendium of craft

knowledge. However, "Bacon, sensing the potential power of the artisanal knowledge collected by Plat<sup>8</sup> and others like him, was concerned that it not be unleashed without regard to its political consequences but controlled to forward the interests of the governing class he represented." In short, "Bacon sought to rein in the power of the new knowledge by bringing it under the command of elite intellectuals". Although "The knowledge and methods of craftspeople put them in the vanguard of the Scientific Revolution in its initial stages... in the end it was not they who emerged as the masters or beneficiaries of the new science... The big winners were the captains of commerce and industry...[who ushered]...in the Industrial Revolution and its mechanized factory system...Other prime beneficiaries were the self-styled *virtuosi*, the gentlemen natural philosophers whom the Scientific Revolution raised to the status of a new scientific elite". This gives new meaning to the famous Newtonian quotation "If I have seen further it is by standing on the shoulders of giants"<sup>9</sup>. ☉

#### References:

1. José F. Morales & Allan Coop (2005) Shopping for Science: Paths to Science for Everyone, *Natural Selections*, issue 13, March.  
———The Republican War on Science: An Interview with Chris Mooney, *Natural Selections*, issue 21, November.
2. Harold Varmus (2005) Is Science Under Siege? American Academy of Arts & Sciences, 1895th Stated Meeting, New York, NY, Wednesday, November 16.
3. Paul Nurse (2006) *The Scientific Endeavor: Keeping the Global Public Engaged*. The Rockefeller University, January 19.
4. Paul Nurse (2006) US Biomedical Research Under Siege, *Cell* 124: 9-12.
5. José F. Morales & Allan Coop (2005) Shopping for Science: Paths to Science for Everyone, *Natural Selections*, issue 13, March.  
———(2006) In Pursuit of Better: Science Shops 201, *Natural Selections*, issue 24, March.
6. George Santayana (1905) *Life of Reason: Introduction and Reason in Common Sense*. Charles Scribner's Sons, New York, 4th Ed., p. 284.
7. Clifford D. Conner (2005) *A People's History of Science: Miners, Midwives and "Low Mechanics"*. Nation Books, New York. (<http://www.peopleshistoryofscience.com>)
8. From (7). Hugh Plat published "10 books based on the knowledge he had gleaned from artisans and his own experimental practice."
9. Isaac Newton, *Letter to Robert Hooke*, February 5, 1675. [http://www.quotationspage.com/quotes/Isaac\\_Newton/](http://www.quotationspage.com/quotes/Isaac_Newton/)



# Trains “R” Us

SRI RAM

When I first proposed to write an article on railfanning, the editorial board of *Natural Selections* reacted in a manner that was half-way between hilarity and incredulity. After my desperate attempts to enlighten the board members that railfanning was more romantic than standing at a subway platform and watching trains zip by, I began to wonder if an open confession of my love for trains was a good idea. Fortunately, this happens to be the April issue—a majority of the readers may just assume that this is an April fools’ joke.

The Indian Railways (IR) cast a spell on me at a very young age and I have been a railfan ever since. Even today, a train ride always brings back fond memories of childhood trips between Delhi and Chennai. The 32-hour, ~1350 mile long journey between these two metropolises was an annual family ritual. On these trips, the window seat was my perennial haunt as the train proceeded from the northern plains through the Vindhya mountain range and the Deccan plateau to the eastern coast and finally to its destination in the South. I was especially fond of the mountainous sections, with the train disappearing into tunnels and emerging amidst verdant surroundings. In fact, I was perfectly happy with the train running behind schedule as was often the case. To put it simply, IR rocked, both in the literal and colloquial sense of the word.

The Indian Railways, along with the English language and the game of cricket, is one of the biggest legacies of the British rule in India. Apart from being one of the largest railway networks under a single management, it is also famous for being the largest commercial employer in the world, with an estimated 1.6 million employees and many more living off of it. It would not be an overstatement to call the railways the lifeline of India. The railways also provide a rich metaphor for life in India in general. The cultural diversity, the disparity between the privileged and the less-privileged, the petty corruption, and the sheer fortitude and enterprise of the people: all of these can be witnessed in a typical train journey. For the uninitiated, a train journey may prove to be the quintessential Indian experience: colorful, crowded, chaotic. Long train jour-

neys in India are rarely dull: strangers become friends as passengers strike conversations with one another, food and drink (non-alcoholic beverages only) are aplenty with a relentless stream of vendors moving along the aisles, and perhaps most importantly, there is never a shortage of opinion on the reasons for the train being late.

The study of trains, or more precisely, locomotives, is referred to by the rather glorious name of Ferroequinology. Ferroequinologists are a rare lot, which explains why Ferroequinology has not yet made

dience. Amongst the ranks of IRFCA, there are timetable buffs, signaling aficionados (many would profess an affection for the quaint semaphore signals), diehard fans of diesel locos, equally ardent fans of electric traction, and people with other distinctive preferences. The older members invariably harbor a nostalgic feeling for the good old steam days (IR has essentially phased out steam locomotives).

This enthusiasm and affection for IR led to the organization of the first IRFCA conference on February 26, 2006 in the city of

Pune (about 100 miles east of Mumbai). While I could not attend the conference, I did participate in a get-together of IRFCans in the New York area. The get-together was generously hosted by one of the long-time members to coincide with the monumental occasion of the first conference. For the first time in my life, I was in a social event where I could talk about trains without being apologetic or being dismissed as crazy. In fact, I felt overwhelmed as I found myself in the company of people who had traveled more ex-

tensively on IR and were more knowledgeable about train operations. Nevertheless, I had a great time as we talked about trains and reminisced about great travel experiences on IR. We all concurred that while IR may not have the fastest or the most comfortable trains, there is still something charming about a train ride in India that makes it unique.

It would not be appropriate to conclude this article without some sobering facts lest it be surmised that railfans are hopeless romantics. The threat posed by decreasing airline fares and improving road infrastructure to passenger and freight traffic on IR is evident both to the IR management and to IR fans. IR also needs to improve its safety record and take care of some aging infrastructure including some bridges which were built in the colonial era. For the moment, though, IR is enjoying a golden period with a responsive management and a booming Indian economy resulting in record profits. An India without IR is still inconceivable. ☉



Photo courtesy of John Lacey, IRFCA

it into the English dictionary. Yet there is enough enthusiasm for trains to support dedicated railfanning communities and websites. There is an active Indian railfan community which goes by the name of IRFCA (Indian Railway Fan Club Association, [www.irfca.org](http://www.irfca.org)). IRFCA was formed in 1989 after what may be succinctly described as a fortuitous meeting of minds in a newsgroup discussion back in the days when the Internet was largely restricted to academic institutions. Over the years, the group has expanded by leaps and bounds and now has over 3,000 members.

IRFCA is a motley group of people passionate about trains. What all IRFCans share is a limitless appetite for idiosyncrasies in the procedures and day-to-day operations of IR. With the bureaucratic way of management it inherited from the British, a mixture of antiquated and modern equipment, and with the necessity of dealing with the vagaries of Indian climate (torrential rains, foggy winters, hot summers), IR is full of operational quirks. Little wonder that it invites the adulation of a diverse au-



This month, *Natural Selections* features **Konstantin Goulianos**, Professor and Head of Laboratory  
Country of Origin: Greece

## New York State of Mind

**1. How long have you been living in New York?** A total of 41 years, six years in the '60s, when I was a graduate student and then a research associate at Columbia, and 35 years since I came to Rockefeller in 1971 after spending seven years in exile at Princeton. Well, Princeton was nice, at least at that time, but it was not New York! I felt like Napoleon in the island of Elba—minus the wonderful Adriatic Sea!

**2. Where do you live?** In the center of the world (!), on 69th Street, right off Central Park West.

**3. Which is your favorite neighborhood?** Definitely my own! When I came to Rockefeller I headed west by bus to escape the crowded East Side, I got off after crossing the park ... and stayed there! On the West Side you have the playgrounds of Central and Riverside Parks, the Hudson River (don't swim, but enjoy the open air views, the breeze, and the sunsets), Columbus Avenue and Broadway filled with life, and immediate train/bus access to everywhere else in NY—and in the world! I lived through the transformation of this area from a quaint old-fashioned European style neighborhood with all kinds of small shops in the '70s to a period of fancy (good-for-what?) boutiques crowded with yuppies in the early '80s, and fortunately back to a great neighborhood again after the 1987 stock market crash that sent the yuppies back to the caves—something good did come out of the market crash, after all!

**4. What do you think is the most overrated thing in the city? And underrated?** Overrated? I can't think of anything, except for the standard museum-dinner-theater combo, which is popular with visitors from the 'burbs. OK, this is great, but is rated high relative to other things that are also great but unknown to those who don't live in the city. For example, once I went to a classical song recital at the YMCA given by a friend of ours, attended by about 30 people, all of them her friends. About two months later, our friend performed as a soloist in Handel's *Messiah* at Carnegie Hall in front of several thousand people—if those people only knew what they missed at the YMCA! Underrated? The peace and quiet one can get in a big city. I really mean it! Where we live, it is very quiet at night, and so is the park late at night—try it!

**5. What do you miss most when you are out of town?** The freedom I enjoy in NY going by bicycle anywhere I want to: to work, to shop, to play. As soon as I come back from a trip I get on the bike and go...go...go!

**6. If you could change one thing about NYC, what would that be?** This is personal, but it bugs me! In the park, there are signs ordering "no bike riding on pathways." All bike accidents occur on the park drive—believe me, I have seen many in 35 years, and yet the signs tell you to ride only on the drive! So, Mr. Parks Commissioner, please

change the signs to "ride your bike with caution" and let the people enjoy strolling about on wheels—any wheels, or walk "barefoot in the park!"

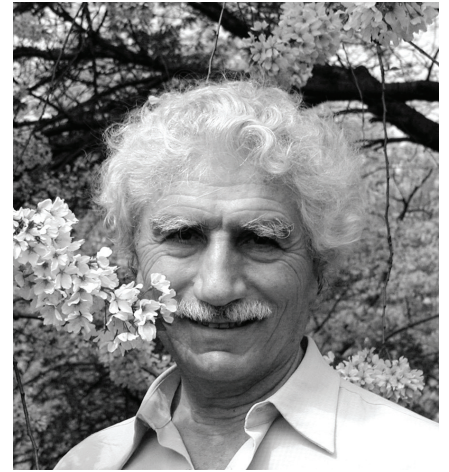
**7. Describe a perfect weekend in NYC.** Saturday morning in June, take a run in an almost empty park or maybe run a race and celebrate life! In the late afternoon, pack dinner and ride bikes to Battery Park.

Have dinner sitting on the grass, watching the Statue of Liberty, the boats, and the sunset in NJ—there are some good things about Jersey! On Sunday, drive to Robert Moses State Park in LI and experience the wonders of a several mile long sandy beach, then back to town for dinner next door on Columbus Avenue. Simple and great!

**8. What is the most memorable experience you have had in NYC?** Sometimes, while running, I try to play a game: recall a NY experience for every 10 steps I take—and I can keep it going for a long time! But I guess, there is one experience that stands out: the first date with my wife. Easter time, the cherry trees in the park in full bloom, lunch with Karen under a beautiful tree—which has since become our "marriage tree," and then a stroll through the park for the rest of the day, with her singing arias (she is a classical singer) and me responding with Greek songs. She didn't speak Greek then, so I could compete! The lyrics of one of my songs went like this "She shook the blooming almond tree...and her shoulders, arms, and hair were covered with flower petals..." We tried it with the blooming cherry trees and it worked—we got married!

**9. If you could live anywhere else, where would that be?** I don't even want to think about another place, but if I HAD to I guess I could live in Thessaloniki, Greece, where I was born and raised—provided I could press a button and make it revert to the way it was back then, made up of single homes with flower gardens spread out on a plateau wedged between the sea and the mountains.

**10. Do you think of yourself as a New Yorker? Why?** Yes, definitely, can't you see why? ☺



## Spring is Springing—In the Bronx

FELICE KELLY

As the weather improves, you may have a more and more difficult time focusing on your work in the lab. Here's a bit of advice for dealing with the yearning to be outside, in the sunshine, among trees and flowers: give in! And I recommend a field trip this month to the New York Botanical Garden in the Bronx.

I visited the garden recently to see the annual orchid show, which is spectacular. Unfortunately, this winter show closes on April 2, just after this issue of *Natural Selections* comes out in print. Keep it in mind for next year. As I walked through the bizarre and gorgeous orchid forms I was reminded of the spectacular variety of organisms that

sparked my interest in biology. Orchids are insect pollinated, and the great variety of their blooms stems from co-evolution with their pollinators. The flowers employ all sorts of tricks to lure specific pollinators into their blossoms. We learned many of these strategies in our plant biology courses, but to see

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the variations in bloom is to understand the amazing power of selective pressure.

Luckily, the botanical garden is more than the orchid show, and in mid-March many of the spring flowers were in bud, though not yet in bloom. By early April, the magnolia and cherry trees will be spectacular. There are areas dedicated to both of these flowering trees, as well as daffodils, tulips, and azaleas. The botanical garden's grounds are extensive—250 acres—including an interactive children's garden, and a beautiful glass-enclosed conservatory for tropical and desert plants.

The New York Botanical Garden is also an active research institution with 25 staff scientists and a graduate program. In the library, there is a small exhibition about biology research that is quite different from what we do at Rockefeller, with the possible exception of the Chua Lab. Many of the gardens' labs do field collection in exotic locations, and the gardens' work centers around conservation. Because so many molecular biologists started out as child naturalists, learning about the research at the botanical garden gives a glimpse of an intellectual path not taken.

## Bombs of Knowledge

MAURIZIO PELLEGRINO AND RUDY BELLANI

*"Remember your humanity, and forget the rest."*

In 1955, Albert Einstein and Bertrand Russell published a manifesto, signed by eleven prominent thinkers, including nine Nobel laureates, in which they argued that nuclear warfare must be renounced by all humanity because of its destructiveness, and that scientists need to convene and converse on the topic of nuclear war. Bertrand Russell wrote previously, "The prospect for the human race is somber beyond all precedent. Mankind is faced with a clear-cut alternative: either we shall all perish, or we shall have to acquire some slight degree of common sense. A great deal of new political thinking will be necessary if utter disaster is to be averted."

The Einstein and Russell proposal led to a meeting of 22 prominent scientists in the Canadian fishing village of Pugwash. From those early beginnings, Pugwash has become an internationally renowned group (winning the Nobel Peace Prize in 1995) which advocates nuclear disarmament and conversations on the intersection of science and policy and the responsibilities of sci-

If your outer borough travels take you south, the trees of the Brooklyn Botanic Garden also put on quite a show in the spring. There is a Cherry Blossom Festival on April 29 and 30 celebrating the beautiful blooms and Japanese culture. If you're interested in viewing the cherry blossoms at their peak, you can track their progress on the blossom status map at the Brooklyn Botanic Garden website (<http://www.bbg.org/exp/cherries/map.html>)—useful, as the cherry trees can be unpredictable. The garden also has an area dedicated to magnolias and, in Brooklyn style, a how-to section on home composting. The Brooklyn garden is about one-fifth the size of the New York Botanical Garden, but is a well-laid-out peaceful spot.

It is certainly worth taking a day to enjoy the warming weather among the flowers of either of these gardens. The delicate, fleeting days of spring are calling for you to put down your pipetman, pack a picnic lunch, and get outside! ☉

### Logistical Details:

#### **New York Botanical Garden (Bronx)**

Directions: Take the D or 4 train out to the Bedford Park Boulevard stop. Follow

the signs east to the garden, approximately eight long blocks from the D, slightly further from the 4. Or take a Metro North train from Grand Central Station, 22 minutes to the Botanical Garden station. These trains run once an hour on the weekends—check the MTA website for the schedule.

**Admission:** Admission to the grounds costs \$6 for adults, \$2 for students, and \$1 for children. Tickets to special exhibits, including the interactive children's garden, are sold separately, or as a more expensive combination ticket. The MTA sells "one-day getaway" tickets with combined rail travel and admission.

**Hours:** From April to October the gardens are open from 10 a.m. to 6 p.m.

**Website:** [www.nybg.org](http://www.nybg.org)

#### **Brooklyn Botanic Garden**

**Directions:** Take the Q train to the Prospect Park Station or the 2 or 3 train to Eastern Parkway Station. The garden is on the northeast corner of Prospect Park.

**Admission:** \$5 for adults, \$3 for students; children under 16 are admitted free.

**Hours:** From April to October the garden is open from 10 a.m. to 5:30 p.m.

**Website:** [www.bbg.org](http://www.bbg.org)

entists towards society. Pugwash covers a broad spectrum of topics, including health, energy, chemical warfare, ethics, policy, and many other emerging discussions that involve the interface of science and society. Centrally, Pugwash has offices in London, Rome, Geneva, and Washington DC, which have assisted in the organization of over 275 conferences, symposia, and workshops. Furthermore, there are hundreds of Student Pugwash groups throughout the world, including one at The Rockefeller University. Formally, Student Pugwash USA (SPUSA) was started in 1997 by Jeffery Leifer who, after attending an International Pugwash conference, believed that younger scientists should also be exposed to the topics championed by the Einstein-Russell Manifesto. Here at RU, a SPUSA chapter was started in 2003 with tremendous faculty support, in order to invite discussions on the Iraqi war and the use of chemical weapons. Since then, Pugwash has widely expanded its membership and topical interests to cover such things as poverty, neuroeconomics, policy, and the role of scientists in society.

In his memoir, *Surely You're Joking, Mr.*

*Feynman!*, Richard Feynman recalled a moment after the successful test of a nuclear bomb which purports the need for groups such as Pugwash:

After the thing went off, there was tremendous excitement at Los Alamos. Everybody had parties, we all ran around. I sat on the end of a jeep and beat drums and so on. But one man, I remember, Bob Wilson, was just sitting there moping. I said, "What are you moping about?" He said, "It's a terrible thing that we made." I said, "But you started it. You got us into it." You see, what happened to me—what happened to the rest of us—is we started for a good reason, then you're working very hard to accomplish something and it's pleasurable, it's excitement. And you stop thinking, you know; you just stop. Bob Wilson was the only one who was still thinking about it, at that moment.

Becoming conscious of the role and responsibility of science in modern society is not an easy step to take; this act involves shaping the way one learns, thinks, and approaches problems, and being exposed

*continued on page 8*



# Art in the Post-Genomic Era

BORKO AMULIC

Visitors to last month's Scope Art Fair (the smaller, more avant-garde version of the well-known Armory Show) had the opportunity to see the latest work by Brazilian artist Eduardo Kac, famous for his 'glowing bunny.' Created in 2000, this transgenic rabbit contains the GFP gene from the Pacific jellyfish *Aequoria victoria*, giving it the ability to glow under ultraviolet light. Alba the glowing bunny was not itself a part of the exhibit. It couldn't attend, having never left the lab in France where it was created.

Kac's work is exemplary of a new direction artists are taking: one that combines various techniques of molecular biology, gene transfer, and tissue culture technology in a highly conceptual discipline that explores notions of life, as well as the ethical issues raised by biotechnology. Labeled bioart, it has been greeted with controversy, with responses ranging from "brilliant" and "thought provoking" to "silly." Oftentimes, people just find it frightening and upsetting.

Some of the work does indeed require a strong stomach. This is literally the case in a recent performance piece by Tissue Culture and Art Project, entitled "Disembodied Cuisine." It consisted of growing biopsied frog skeletal muscle *in vitro* and culminated with a dinner at which artists ate their creation. The work deals with "victimless" meat consumption and the creation of a "new class of object/being" which they refer to as "Semi-Living". The same group also makes "soft sculpture," such as wing-like objects made of pig tissue (a play on "when pigs fly"). This is done by seeding cells on a polymer scaffold and growing them in a bioreactor, a procedure also used by another group to make "designer hymens". These are described as "not intended for human application at this time".

The move of art to this new medium of biological materials and live organisms is perhaps not surprising. In fact, it has been called "a logical next step in contemporary art", which has historically made use of new technologies such as photography, video, and computer technology. Bioart uses life itself in its attempt to generate discourse, which makes it a pretty powerful medium if one considers the common perception of art mimicking life.

This form of artistic production requires an intimate collaboration between artists and scientists. For instance, Joe Davis, one of the first people to envision the possibilities of bioart, has a research associate position

in the lab of Alexander Rich at MIT. In close collaboration with students and postdocs, Davis mastered the techniques of molecular biology and started encoding messages in the genome of *E. coli* and other organisms. In his Microvenus project he used a binary code to represent a graphic symbol in a short piece of DNA that was stably replicated in bacteria. The symbol was an ancient Germanic rune that was used to represent life and the female earth (the symbol also mimics female genitalia)<sup>3</sup>. Davis has also encoded a 60-character piece of text by the Greek philosopher Heraclitus into a fruit fly gene. Incidentally, since they are made of propagating organisms, Davis's works have been replicated more times than all the other works of art put together. This is an interesting echo of the mechanical reproduction mode of artistic production practiced by artists such as Andy Warhol.

While many scientists question the decision of Alex Rich to hand over valuable lab space to Davis, whose work arguably has no scientific merit, Rich values "his unconventional imagination" and considers it "fun to have somebody like that around". As many bioartists will attest to, it is only very senior and well-established lab heads that will take on an artist in their lab.

What is the artistic merit of bioart? It provides a new form of artistic inquiry, one that can be used to comment on the possibilities and limitations of the scientific method and the emergent biotech culture. It also provides a deconstruction of novel, hybrid products of genetic engineering. Kac's GFP bunny is neither natural nor completely unnatural, just like victimless steaks occupy an uncertain position on the life-death continuum. Not everyone finds great value in this new movement. San Diego-based artist Veronika Bauer sees "only limited potential to express metaphor" with an artwork such as the GFP Bunny. She also brings up the important question of when something is considered a creative act. Says Bauer: "How does one differentiate between a non-creative and creative gesture? What degree of commentary or deviation from the already said, sensed must exist?"

But not all the work is this esoteric in nature. Some of it is more immediately engaging and more accessible. The Whitney Biennial (ongoing through May 28) includes three videos from Critical Art Ensemble (CAE), a group that attempts to "provide information about government

and corporate co-optation of global industries, therefore empowering the masses to reflect and react". Their videos document different performances, such as "Genterra", which is basically 'participatory theater'—an interactive space posing as a biotech company that manufactures genetically modified organisms that are supposed to be socially beneficent. Visitors are encouraged to discuss the dangers and advantages of the organisms and then to actively participate in determining the risk by choosing to release (and thereby expose themselves) to either wild bacteria (collected locally) or a transgenic "crippled lab-strain." These are released via a mechanical arm that lifts the lid of a Petri dish for five seconds.

It is projects such as this one that have repeatedly led to CAE's confrontation with the authorities, most prominent of which was the arrest of Steve Kurtz, a founding member of the collective and respected professor at SUNY Buffalo. The tragedy started when Kurtz made a 911 call because his wife was having a heart attack. The police discovered a biological lab at his house—complete with incubator, centrifuge, and bacteria growing in Petri dishes. Even though the bacteria turned out to be benign (the type sold to high school teachers), Kurtz was indicted in the summer of 2004 on charges of mail and wire fraud. The problem was that the bacteria were sold to a lab at the University of Pittsburgh and then sent to Kurtz. The case will likely go to trial in the next few months and the maximum sentence Kurtz can receive is 20 years in prison. One of the videos showing at the Whitney Biennial documents the invasion of the artist's house by the FBI. While the episode is mainly the result of bioterror hysteria (the statute in question was expanded by the Patriot Act), it also points to the murky legal, ethical, and practical issues raised by the convergence of art and biology. ©

*The author is a graduate student at Weill Cornell University.*

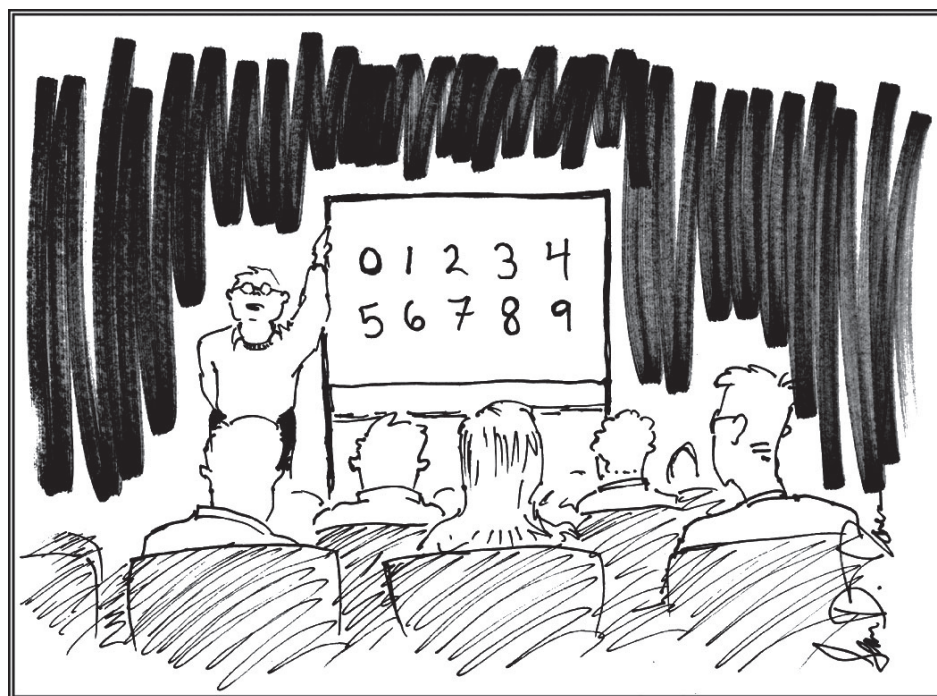
## References:

1. <http://www.tca.uwa.edu.au/>
2. The Artists in Hazmat Suits, Randy Kennedy. *The New York Times*. July 3rd, 2005.
3. Microvenus - art form using genetic sequences and binary code. Joe Davis. *Art Journal*, Spring 1996.
4. Science for art's sake. Steve Nadis. *Nature*, Vol. 407, October 12, 2000.
5. <http://www.critical-art.net/>
6. <http://www.vivolabs.org>

to issues that are not commonly part of our scientific life. A big picture is difficult to catch, but acknowledging the existence of problems is the first big step toward their resolution. This is the reason why Pugwash aims to cross-educate scientists with multidisciplinary conferences and workshops, thus fostering effective collaborations that concentrate on equitable solutions. Pugwash has developed a unique mode of action, with individuals participating in conversations or conferences representing only themselves and not their institutions or governments. There is no formal membership, minimal bureaucratic structure, no official political stance, and the organization is maintained privately and independently. Pugwash was constructed in the academic tradition, with freedom of expression emphasized and minimal boundaries enforced.

For more information, or if you'd like to get involved here on campus, please e-mail the Rockefeller Pugwash group at [pugwash@rockefeller.edu](mailto:pugwash@rockefeller.edu). If you'd like to find out more information, please visit [www.spusa.org](http://www.spusa.org) or [www.pugwash.org](http://www.pugwash.org). ©

## ACADEMIA NUTS



cartoon by Sean Taverna

*"Your answer may include one or more of these digits"*

## International Literature Festival

New York City will host the second PEN America Festival of International Literature during April 25-30. The number of incredibly gifted writers who are taking part and the depth and diversity of what is on offer is absolutely amazing.

Some highlights include: Tuesday April 25, A conversation with the Turkish writer Orhan Pamuk, hosted by Margaret Atwood and Salman Rushdie; Wednesday April 26, A panel discussion on the theme Faith and Reason with 15 writers including Nadine Gordimer and Zadie Smith; Thursday April 27, A discussion by writers on the impact of the AIDS epidemic (just around the corner at Hunter College); and on Sunday April 30, a discussion with the Nobel laureate economist Amartya Sen. There are many other noteworthy events with subjects as wide-ranging as Revolution, Multiculturalism, Insults and Freedom of Expression, Exile, Translation, and Faith and Politics.

Events are free or require tickets at \$10 or \$15. The most popular events sold out last year, so buy your tickets sooner rather than later.

For program details see <http://pen.org/page.php/prmID/1096>



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## The Rockefeller Film Series

LUKASZ KOWALIK

On Monday April 17 at 8 p.m., the Rockefeller University Film Series will be pleased to screen *Moolaadé*, the latest feature film by acclaimed Senegalese director and writer Ousmane Sembène. Sembène, sometimes hailed as the "father of African cinema," sees himself both as an artist and a social critic. Understandably then, his books and films take on subjects such as colonialism, rule of corrupt elites, and hardships of the continent's women. *Moolaadé*, a story about a group of young girls trying to escape circumcision, is the second installment of a trilogy focused on the changing role of women in Africa. The subject is of utmost

seriousness as female genital mutilation is practiced in most of the countries of the African Union. Sembène manages to avoid being a preachy modernist, instead building a conflict based on two powerful, ancient traditions: the practice of circumcision as a passage to womanhood, and the individual's right to protection or "moolaadé." The girls turn to Collé, a villager that did not have her daughter circumcised, who grants them sanctuary, protected by her spell. The tension between Collé and the red-robed priestesses who perform the ritual proceeds to engulf the whole village, pitching family members against one another. Dra-

matic turns take place when two outsiders, a peddler and the chieftain's son who has just returned from France, take sides in the conflict giving way to an emotional finale. Aside from the plot, the portrait of village life in Djerisso, with its inhabitants obeying many Islamic and animist traditions yet accommodating modernity, is enough to keep the viewer captivated. The sights are also impressive as the village boasts one of the oldest 'porcupine' mosques in West Africa, and, yes, there is singing and dancing. *Moolaadé* won the 2004 Prix Un Certain Regard at Cannes and it is certainly worth our special attention. ©