# On the Success of the First New York City Urban Barcode Project

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On behalf of my Sloan Foundation colleagues, President Paul Joskow and Program Director Paula Olsiewski, thanks for the opportunity to join you, celebrating the Inaugural Urban Barcode Project Symposium and its awardees. A renaissance of science is underway in New York, as it was in the late 19th century when our intellectual forebears established this Museum, the New York Botanical Garden, and Cold Spring Harbor Laboratory.

The ripples of barcoding began spreading during a dark and stormy winter night ten years ago, along the rocky coast of Nova Scotia, Canada, about 600 miles northeast of New York. There I first heard about DNA barcoding.

For the Sloan Foundation I was in Nova Scotia meeting with Canadian experts to advance a program to count all the fish in the sea, the Census of Marine Life. The Census would count not only the abundance of fish but also the kinds or diversity of fish, and not only fish but shrimp and jellies and snails and seaweeds.

A captain netting fish in a region like ours, the Northwest Atlantic, would probably know the common names of most of the fish caught: striped bass, bluefish, herring, mackerel, sardine, eel, redfish or flounder. Well, the captain might not know exactly which kind of redfish or flounder. And the captain might not know some rare fish caught among the frequent ones. The captain might not have a name for some by-catch in the nets such as shrimp, or creeping snails that look alike, superficially. Different species may resemble one another.

If some animals in the net were damaged, leaving only a tentacle or a fin behind, then the captain could offer a description only as generic as jelly or fish. He might wonder whether the half-eaten minnow in the mouth of a striped bass was an Atlantic silverside.

Making the captain's task yet harder, many species metamorphose into different forms as they cycle through stages in their lives. Although fish eggs may become fry, and fry become easily recognized as some kind of salmon, distinguishing species is hard in their early life stages. Animals can also be too small for the captain's eyes to see.

And for sure the captain would know only a very few of the formal scientific or Latin names for the species in the net. He would not hold the key to unlock international biology.

In the Gulf of Maine, where a harbor would offer the homeport for our captain's vessel, the number of named species exceeds 4,000. No one remembers 4,000 names. Even a baseball fanatic struggles to know the names of just the 750 players on the 30 Major League teams. A 1995 study estimated the vocabulary size of first-year college students at about 12,000.[i] Would you want to fill fully one-third of your entire inventory of words just to name marine life around New York?

But, these scientific names, like *Morone saxatilis* for striped bass, are crucial. Because the scientific binomials for species are the currency of biology, their identification is no academic diversion, and getting them wrong corrupts science. Biologists and governments count the rise and fall of animals by their names, and they count biodiversity by the number of species. Inspectors define quarantines in identified species. Consumers judge the value of a purchase based on the accuracy of the name of the product. When we search the Internet, the name is the link connecting each specimen to all the rest of biological knowledge amassed over hundreds of years.

Biologists of all ages risk the weight of these consequences as they pick one name from almost two million known species. Species identification matters. Names matter. Each time we use the word "specific," we hint at the importance of species and the qualities and characteristics particular to a form of life. Mistaken identity can bring tragedy, in a murder trial, or from a food allergy.

So, on that dark and stormy night in Nova Scotia, a Canadian authority in polar biology, Paul Hebert, enthralled me with his acclaim that a uniform locality on genomes, a DNA barcode of life, would provide a "digital" identifying feature for almost all animals, supplementing the analog gradations of shapes, colors, and behaviors that our fishing captain and even experienced taxonomists had to depend on. A library of digital barcodes would provide references as unambiguous as

Social Security numbers and email addresses to identify species invading and retreating across the globe, entering harbors and airports, sold in markets and displayed in museums, and living in forests and gardens.

When I returned from Nova Scotia to New York City, I consulted colleagues at The Rockefeller University expert in genetics, Joshua Lederberg and Norton Zinder. I asked if they thought the DNA barcode could work. When they said yes, I invited Professor Hebert to present a seminar at the Sloan Foundation.

The engineer and businessman Alfred P. Sloan had established the Foundation in 1934 with a mission to help enterprising people with novel ideas in science and technology. The possibility of successful DNA barcoding impressed my colleagues. But how would we stimulate the assembly of a reference library of DNA barcodes comprehensive enough to be useful? Like a library of books, it would need hundreds of thousands and eventually millions of reference sequences against which to compare the DNA of new specimens. Its accumulation would require a worldwide movement, spanning polar and tropical species, marine and terrestrial, and plants and fungi as well as animals.

At this point, Sloan turned to the Cold Spring Harbor Laboratory on Long Island, famous for incubating important movements in biology. Happily, the Cold Spring Harbor Lab convened a pair of meetings during 2003 at its Banbury Conference Center to evaluate thoroughly the technical promise of barcoding and, if appropriate, to develop a strategy to create the reference library. As at this Urban Barcode Symposium today, among the most engaged participants at the initial meetings were scientists from the American Museum of Natural History and the New York Botanical Garden. The achievement of 150,000 species with DNA barcodes so far testifies that something clicked back in 2003.

But I would be omitting crucial history if it seemed the movement, which operates under the auspices of the Consortium for the Barcode of Life (CBOL), consisted only of famous institutions and professors.

Perhaps what inspires most about the emergence of DNA barcoding are the roles played by young people. In 2007 two seniors at the Trinity School barcoded the identity of raw fish sold in Manhattan. Mentored by my Rockefeller colleague Mark Stoeckle, they found mislabeled items sold in 6 of 10 grocery stores and fish markets and 2 of 3 restaurants.  A couple of months after they published their findings in *Pacific Fishing* magazine, the front page of the *New York Times* broke the Sushigate scandal.

The floodgate of student participation opened.  Since then New York City high school students have uncovered cow's milk cheese sold as sheep's milk cheese and frequent incomplete labeling of herbal teas.  Students may even have discovered, not just another, but an entirely new species of cockroach in a Westside apartment building only a few blocks from where we meet today.

I hesitate to call these young scientists *students*, except in the sense that all of us are students throughout our lives.  These young people are scientists, doing science: contributing new observations, adding to the catalog of DNA barcodes and broadening knowledge, globally.

Alfred P. Sloan grew up in Brooklyn.  The opportunities for learning and citizen science created by the Urban Barcode Project implemented by the Cold Spring Harbor Lab, its DNA Learning Center and Harlem DNA Lab, led by David Miklos and Oscar Piñeda-Catalan, and by my Sloan colleague Paula Olsiewski would thrill Alfred P. Sloan of Brooklyn.  I congratulate your spread  of participation of associated organizations in New York: Public and private and home schools, agencies of the City government, City University of New York, GenSpace, the Metropolitan Museum of Art, Staten Island Zoo, Customs and Border Protection at Newark Airport, and of course, the New York Botanical Garden and American Museum of  Natural History.  The totality of the Urban Barcode Project truly forms a unique scientific collaboration and makes an extraordinary contribution to CBOL and the international barcode of life initiative.

Last Thursday and Friday, the reports of the 70 or so teams inspired me and all the other judges: projects about moss and lichens and birches and Christmas trees; about biblical citrons and Mexican melons and Chinese pears; about fungal diversity of Central Park and mushrooms for sale in Chinatown and about the absence of *Gingko* DNA in *Gingko* products; about cod and catfish and crab and small killifish whose common name goes back to the Dutch word for creek, kill; about salamanders and mosquitoes and nematodes and bedbugs; about Jamaica Bay and about weeds in tree boxes and about ants of the South Bronx; about content of pet food and animal and plant origins of adhesives and glues in artworks.

We are entering, indeed creating together, another golden age of science in New York City.  During last week many of you will have enjoyed the World Science Festival, sponsored by the Sloan Foundation together with the Simons and Templeton foundations and other public-spirited organizations.  Science and technology are in the air again in the Big Apple, as they were in the late $19^{th}$ century when Thomas Edison and Alexander Graham Bell and electricity and telephones made New York the commercial and cultural center of the world, and this Museum, the Botanical Garden, and Cold Spring Harbor lab were founded.  To all the young scientists and their mentors who have carried out the Urban Barcode Project, I say on behalf of the Alfred P. Sloan Foundation, you are the fast-rising yeast of $21^{st}$ century New York science.  Thank you.

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[i] E.B. Zechmeister, A.M. Chronis, W.L. Cull, C.A. D'Anna and N.A. Healy, Growth of a functionally important lexicon, *Journal of Reading Behavior*, 1995, **27**(2), 201-212.