FORMER SOVIET UNION

Estonian Researchers Lead The Way in Science Reform

TALLINN AND TARTU, ESTONIA—As the Soviet Union began to crumble in the late 1980s, reform-minded Estonian scientists wasted no time putting their house in order. Even before the Soviet Union's final collapse, researchers took the bold step of forcing out of power the president of the Estonian Academy of Sciences and creating a Western-style fund for handing out competitive grants. Estonia then invited Swedish scientists to assess every lab in the country to see whose work was up to international snuff and deserved federal support.

As a result, this small Baltic state has set the pace of reform in the former Soviet Union (FSU). It has won a disproportionate share of Western grant aid and, considering its small size, has made a noticeable impact in the world of science, particularly in dye and excimer laser research and environmental remediation technologies. But now, the reform crusaders are finally running into some spirited opposition—and it is coming from within their own ranks. A plan to shed the last trappings of the Soviet way of doing science, by ending the division between research institutes and the university system, has split the research community.

Until this setback, science reforms here have been so successful that other countries in Eastern Europe and the FSU are taking notice. "Among the Baltic states, I would say that Estonia is further along in the direction of moving to a peer-reviewed, merit-driven system and in integrating institutes into universities," says Norbert Bikales, head of the United States National Science Foundation's Europe office, who visited Baltic institutes this summer. Lithuania, he says, distributes virtually no merit-based funding. Latvia, meanwhile, may have moved too fast. In the early 1990s, it dramatically shifted much of its funding into individual grants, providing scant support for institutes to stay up and running. The move helped fuel a massive brain drain: By 1994, Latvia had lost an estimated 83% of its scientists.

Estonia took the middle path, and it appears to have worked. Although the country is the region's smallest, roughly twice the size of New Hampshire and home to only 1.5 million people, it wields an influence in the sciences out of all proportion to its size. Estonian scientists won 63 2-year grants from the International Science Foundation, a peer-reviewed fund backed by U.S. financier George Soros for sustaining top FSU researchers. This puts Estonia an impressive fourth in the league table of 15 former Soviet countries, but in per capita terms, it comes out on top, receiving 39.4 grants per million population; Russia placed a distant second, with 19.6 grants per million.

Much of Estonia's recent success can be attributed to reforms that began in 1988 when science funding from Moscow slowed to a trickle. With lab coffers dwindling fast, rank-and-file scientists in 1989 formed the Estonian Association of Scientists (EAS) to develop new science policies. "Reform was everywhere in Estonia, and we wanted to make sure science, too, was independent," says molecular biophysicist Toivo Raim, a science policy official in Tallinn.


MATI REINHOLD

Divisive merger. A plan to merge research institutes with Tartu University *(above)* is drawing fire.

This initiative riled powerful figures in the presidium of the Estonian Academy of Sciences, whose influence over its 20 institutes was dwindling fast. "The academy in the 1980s was very disliked," partly because its aged president, Karl Rebane, "refused to go along with reform," says EAS's first chair, Peeter Saari, a solid-state physicist at the Institute of Physics in Tartu. In an unprecedented action in 1989, Saari and other members of the academy presidium resigned. This brought to a standstill academy decision-making, forcing Rebane to resign as well. A reconstituted presidium in 1990 replaced Rebane with an academy vice president who was more sympathetic to their cause. To strip the presidium's last vestiges of influence, Estonia's Ministry of Education last year began funding institutes directly.

The reformers' next big step was to set aside a portion of Estonia's annual science budget for peer-reviewed grants—a move away from the Soviet tradition of allowing institute directors to decide who is funded and who is not. The EAS organized a council of top scientists and policy-makers to oversee the creation in 1990 of the Estonian Science Foundation (ESF). At first, the ESF did not have a lot of money to play with. Government spending on science since 1992 has hovered around 0.4% of the gross domestic product (in contrast, Spain spends about 0.8% and Sweden 1.2% of GDP on science), and the ESF that year received just 10% of that amount for competitive grants. By this year, ESF's share of the science budget has been ramped up to about 30%, or $5 million. The remaining money goes directly to institutes and university departments, although from next year even these funds will be awarded only to peer-reviewed projects proposed by scientific teams.

The reformers knew that a switch to a competitive grant system would draw fire from unproductive scientists who managed to get by under the Soviet system. So Richard Villems, director of the Estonia Biocentre in Tartu, and other reformers decided to seek outside support: In 1991, they invited the Royal Swedish Academy of Sciences to send teams of experts to review every Estonian lab. The year-long review rated labs and judged which were up to international standards. The results "put everyone in their proper place and were actively rejected by everyone who didn't come out well," says Endel Lippmaa, director of the Institute of Chemical and Biological Physics. Reformers claim that the review has had an impact on funding decisions. According to Saari, "We could take [a lab's rating] into account in deciding distribution of grants."

Until recently, there had been general agreement among the reformers, who include many of Estonia's top scientists, about what direction the changes should take. But they are now divided over the fate of the academy's institutes. In a small country like Estonia, Western-style integration of research into the university system makes especially good sense, but both sides believe they have something to lose: Institute scientists may have to sacrifice time in the lab for time at the chalkboard, and professors may face competition for teaching assignments and perhaps their jobs.

The battle lines are not being drawn in the labs, however, but in the Estonian government's offices in Tallinn, the capital. The minister of education, laser physicist Jaak Aaviksoo, wants to merge research institutes with Tartu University, Estonia's main university. "Integrating academic [institute] research into the university system is my number one priority," Aaviksoo told *Science*. Opposing him is Lippmaa, who, in addition to his scientific post, is a member of parliament and is expected to sit on the powerful financial committee. He wants institutes to develop closer university ties but remain independent. Lippmaa says his camp "wants to renovate Soviet-constructed science without destroying the science."

A handful of institutes are already integrated. For instance, the Estonian Biocentre and the Institute of Molecular and Cell Biology, which share a building, already have close ties with Tartu University, and they plan to break ground later this month on an adjoining 1000-square-meter lab, including a transgenic animal facility, funded by a Swiss private charity. For Aaviksoo, the time has come to have other institutes, including those a couple hours' drive away in Tallinn, answer to the university.

"Research institutes are cut off from young, ambitious people," says Mart Ustav, a molecular virologist at the Institute of Molecular and Cell Biology. Moreover, says Aaviksoo, placing the institutes under university administration would help integrate the institutes' 750 scientists and the university's 200 full-time researchers. Without administrative changes, he argues, "we can never achieve integration of functioning research teams."

Lippmaa says that he does not want to perpetuate the Soviet-style system in which many scientists "spent their creative years shuffling for positions" as lab chiefs or directors. Rather, he says, the institutes and the university must strive for "an association on equal terms." He compares Estonia's institutes to U.S. national laboratories such as Lawrence Berkeley, which are affiliated with universities but retain independence to plan their research. Lippmaa says, however, that his proposal has been rejected by the education ministry.

So far, Lippmaa's close ties to Estonian's Prime Minister Tiit Vahi have forestalled any government action on Aaviksoo's proposal. Top Estonian scientists and policymakers are working hard to find a compromise, but in the meantime this bitter dispute has sapped the momentum of Estonia's reform process. But that may not be all bad. Villems says that many Estonian scientists, dizzy from the pace of reforms, "just want to stop and catch their breath for a while."

–Richard Stone

PLANT GENETICS

First Global Sequencing Effort Begins

The list of organisms whose DNA is being cranked wholesale through U.S. genome sequencing labs includes a worm, bacteria, fruit flies, and humans. Notably absent are plants—until now. Last week the U.S. government ended the omission by putting up $12.7 million to begin large-scale sequencing of *Arabidopsis thaliana*, a small, flowering member of the mustard family. The awards will allow the United States to join other countries already sequencing *Arabidopsis* in an international collaboration to decipher the plant's entire genome by 2004.

The initiative is being hailed by scientists who use *Arabidopsis* as a model organism. "I've been hoping for this," says one grantee, Steve Rounsley of The Institute for Genomic Research (TIGR) in Rockville, Maryland, who studies the plant's flowering genes to understand the molecular basis of flower development. "There's a huge number of *Arabidopsis* researchers out there who will get a head start by identifying many genes." The information should provide insights into basic cell processes and plant development and help researchers bioengineer more desirable crops and foods. For plant biologists, who have lagged behind biomedical researchers in using model organisms, "this will make it much clearer how a model system will help," says Oklahoma State University plant scientist David Meinke.

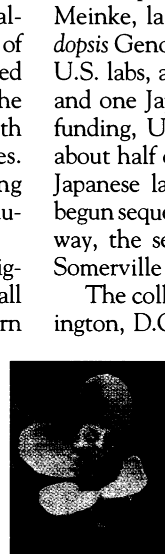
The 3-year awards are being funded with $9.5 million from the National Science Foundation (NSF), $2.1 million from the Department of Energy (DOE), and $1.1 million from the Department of Agriculture (USDA). The winners (see table) include some groups already using the fastest automated methods to do human genome sequencing. "We are thrilled," says Meinke, who helped organize the competition. "We were concerned that some of the major sequencing labs would have their hands full and wouldn't want to expand."

Arabidopsis has several features that make sequencing its genome a worthwhile challenge. At 120 million base pairs (only 3% of the length of the human genome) distributed over five chromosomes, it is thought to be the smallest genome of any flowering plant, with the least amount of noncoding sequences. What's more, the plant's rapid growing cycle—6 weeks—and large number of mutants make it a good experimental model.

Sequencing *Arabidopsis* should have a significant impact on plant science because all 250,000 species of flowering plants, from corn to tulips to cherry trees, are genetically very similar. A gene transferred from one plant into another usually continues to operate in the same way, explains plant scientist Chris Somerville of the Carnegie Institution in Stanford, California, a co-investigator on one award. DOE hopes that similarity will aid its search for plants bioengineered to clean polluted soil by absorbing toxins, and to provide biomass that can replace fossil fuels.

The *Arabidopsis* community began preparing for the sequencing effort 6 years ago when, with NSF support, it started a multinational project to begin analyzing cDNA clones and to set up stock centers and a World Wide Web database (http://genome-www.stanford.edu/Arabidopsis/). This project, now chaired by Meinke, laid the groundwork for the *Arabidopsis* Genome Initiative, which involves the U.S. labs, a consortium of 17 European labs, and one Japanese lab. Armed with the new funding, U.S. scientists expect to sequence about half of the genome; the European and Japanese labs, some of which have already begun sequencing, will do the other half. "In a way, the sequencing is just the final step," Somerville says.

The collaborators met in August in Washington, D.C., where they pledged to coordinate their efforts to avoid duplication and to post their data on the Internet as quickly as possible in a form easily used by all plant scientists. An international project isn't "necessary," says Satoshi Tabata of the Kazusa DNA Research Institute in Chiba, Japan, but "by doing it that way, the data obtained become more 'common' to all the researchers in the world. I think that is very important."



M. YANAFSKY/UC SAN DIEGO

SEQUENCING THE *ARABIDOPSIS* GENOME

Lead Scientist	Laboratories	Estimated Funding	Chromosome	Rate (kb/mo)
Richard McCombie (Cold Spring Harbor)	Cold Spring Harbor Lab; Washington U.; Applied Biosystems, CA	$4.2 million/ 3 years	4, 5	150
Ron Davis (Stanford)	Stanford U.; USDA/ UC Berkeley; U. Penn.	$3.8 million/ 3 years	1	150
Craig Venter (TIGR)	The Institute for Genomic Research, Md.	$4.7 million/ 3 years	2	220
Satoshi Tabata (Kazusa Institute)	Kazusa DNA Research Institute, Chiba	$4.5 million/ year	3, 5	500
Mike Bevan (John Innes Center)	17-lab consortium of European Union	$7.5 million/ 2 years	4, 5	200

SOURCE: MULTINATIONAL *ARABIDOPSIS* STEERING COMMITTEE

The group expects to cover about 40% of the genome, with 99.99% accuracy, in the first 3 years of the effort. They will need additional funding to finish the project.

–Jocelyn Kaiser