NORTH KOREA

Joint Projects Allow a Peek Into an Impoverished System

A new wave of collaborations could give North Korean scientists a chance to end their historic isolation and to bolster a civilian research sector long starved for resources

SEOUL, SOUTH KOREA—In a laboratory somewhere in North Korea, a prototype high-tech machine is under construction. The lab is plagued with power cuts and all the equipment is outdated, but the researchers forge ahead, assembling the frame with welders and metal files instead of precision-controlled machine tools. As they put the prototype through its paces, the engineers monitor such variables as pressure, voltage, and temperature—in other countries, a simple task for a desktop computer. Here it takes three workers: One watches the needle of an analog meter, another holds a stopwatch, and a third records the results on a pad of paper.

That scene, described by recent visitors to North Korea, who withheld details about the project to protect team members from possible recrimination, seems bleak. Indeed, North Korea is one of the most difficult places in the world to do science. Like many communist countries, it has a large pool of scientists and technicians. But the end of the Cold War snapped years of active ties with East Bloc countries and triggered a decade-long recession that has been worsened by a 3-year-old famine. The combination has brought this country of 22 million near collapse. While defense research is well funded, the rest of the scientific community goes without equipment and basic necessities. Although most still report to work each day, says one foreign scientist who requested anonymity, "they have lost conviction and will."

The country's dire straits haven't reduced respect for scholarship. Proclamations by "Dear Leader" Kim Jong Il encourage the young to pursue science, and a calligraphy brush accompanies a hammer and sickle in the country's communist emblem. A constitutional revision in 1998 noted the importance of research to national development, and high-ranking scientists can still expect to earn a decent living, with a house and car.

But most North Korean scientists have little opportunity to earn the respect of their peers abroad. "Twenty years ago, North Korean scientists and professors were excellent because they studied in the USSR, Hungary, East Germany, and Romania," says a foreign scientist familiar with North Korea. Those countries also top the list of scientific collaborators, according to a database of articles in international journals maintained by the Institute for Scientific Information in Philadelphia, although the numbers are small—36 papers with North Korean authors since 1981, and only 16 this decade, with none in the last 18 months. Now only the children of diplomats have the privilege of studying abroad. College graduates are educated at the level of Chinese high school students, he says, and the equipment in many universities is 30 or more years old. In addition, for the past 4 years scientists and other white-collar workers have been required to spend 2 months a year doing physical labor in the countryside.

Lacking Internet access, most journals, and links to colleagues around the world, North Korean scientists often tackle questions that have been solved elsewhere years earlier. "They end up doing everything from scratch … trying to reinvent well-understood technologies," says another foreign scientist.

Although it would take a major political upheaval to fully open up the country to outsiders, there are some channels of communication. Sympathizers in Japan and elsewhere occasionally send information, and the Pyongyang Informatics Center in the nation's capital even has a branch in Singapore that supplies journals from The Institute of Electrical and Electric Engineers. Some North Koreans are still allowed to travel, and a few experimental joint projects are under way, particularly with the country's southern neighbor. They involve areas closely linked to the country's survival—notably agriculture and energy—where the official animosity toward the South takes a back seat to economic necessity.

Kim Soon-Kwon, an agricultural scientist from Kyongpook National University in Taegu, South Korea, has teamed up with the North Korean Academy of Agricultural Sciences to set up 17 research stations across North Korea to breed varieties of high-yield corn and disseminate improved farming methods that might eventually help to end the famine. Kim provides the stations with everything from pollination bags to computers using funds raised by his International Corn Foundation, which this year expects to donate $1 million. He says he's impressed with the quality of the younger scientists and rewards their hard work with bicycles.

The results are already noticeable. In the past 18 months, various teams have introduced intercropping techniques to improve soil fertility, taken antierosion measures, applied thousands of tons of imported fertilizer, and grown high-yield seeds bred in South Korea for similar ecological niches. "The sustainability of North Korean food production has really been improving, especially in the uplands," says Kim.

Such positive results are the key to continued collaboration, he adds. Pyongyang is unlikely to back a project "without a special target," he says. Kim's success should also help an effort begun in June to improve potato production led by Chung Hyuk, a South Korean potato specialist at the Korean Research Institute of Bioscience and Biotechnology in Taejon.

The next North-South project may involve a computer scientist who says that North Korean programmers represent a large untapped pool of talent. They have produced impressive programs for medical diagnosis, accounting, and "edutainment," says Park Chan Mo, a professor at Pohang University of Science and Technology. Park, who says most programmers have only recently learned C++ after working for years in BASIC, COBOL, and Fortran, wants to set up training courses to convert North Korean math teachers into computer science teachers and to develop the North's software industry. The idea is to make use of the two countries' common language and the huge

A hunger for help. South Korea's Kim Soon-Kwon, second from right with colleagues in North Korea, imports new hybrids and advanced technology to improve corn production.

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supply of cheap, well-trained labor.

U.S. environmental activists have also begun building ties. A Berkeley, California–based nonprofit called the Nautilus Institute believes that one major cause of the famine is an energy shortage triggered when China and Russia began cutting back on fuel subsidies. Nautilus, which tracks Asian security issues, first made contact with North Korean leaders in 1991, and last fall, after 4 years of up-and-down negotiations with its Korean counterpart, a team installed seven advanced wind generators in a small village. In addition to their goal of supplying power for a clinic, irrigation pumps, and other vital functions, project leaders hope their North Korean counterparts, who are maintaining the generators, will adapt and disseminate the new technology throughout the country. "The engineers and technicians we met were well-educated, nimble-minded, and eager learners," wrote Jim Williams in the May/June issue of *The Bulletin of the Atomic Scientists*.

The most active area of science and technology in North Korea—military research—is also the most secretive. The country has developed and tested long-range missiles that could reach Japan, and it may be working on one that could threaten parts of the United States. It is also believed to have shared weapons technology with other countries. In June, Indian customs officials intercepted a North Korean ship carrying crates of blueprints, parts, and tools for making Scud missiles that was presumably headed to Pakistan. That country's Ghauri missile is thought to be an exact copy of North Korea's Rodong missile, which is based on the Russian Scud.

Ironically, the best hope for the country's neglected civilian sector may be outside pressure to curb its military activities, combined with its desperate food situation. In April North Korea allowed U.S. inspectors to visit an underground site suspected of being used to make nuclear bombs in exchange for technical help in growing potatoes. Such assistance could pave the way for stronger scientific ties with the outside world for this closed and secretive country. **–MICHAEL BAKER**

Michael Baker writes from Seoul.

ASTRONOMY

The First Step to Heaven

Every effort to survey cosmic distances relies on a common yardstick, found in our own neighborhood. But astronomers can't agree on its length

In the old Led Zeppelin song, there's a lady who is buying a stairway to heaven. Astronomers who measure distances across the glittering heavens must wish it were that easy to get what they're looking for. They have a staircase of sorts: Distance indicators that work within our galaxy and its immediate environs measure the first step, which sets the size of every subsequent step out into the cosmos. But while astronomers have gotten better at counting the distant steps, and thus getting relative distances in the distant universe, they have been unable to beg, borrow, or steal a final answer for the size of the very first step.

The almost absurd tininess of that step, cosmically speaking, is galling all by itself: The distance is the short hop between us and the Large Magellanic Cloud (LMC). One of two dwarf galaxies hovering on the outskirts of the Milky Way, it's plainly visible as a twinkling wisp in the sky of the Southern Hemisphere. In the favored units of astronomy, the LMC is somewhere between 40 kiloparsecs (or 40 kpc, about 130,000 light-years) and 60 kpc away. But because the LMC is where astronomers prepare for their next step out into the cosmos by calibrating a set of cosmic surveyors' beacons known as Cepheid variable stars, that 40% uncertainty propagates outward as far as the cosmic distance ladder can reach.

Because cosmic distances are critical to calculating the age and expansion rate of the entire universe, "the consequences of that uncertainty are enormous," says Barry Madore of the California Institute of Technology in Pasadena, a member of the Hubble Key Project, which aims to measure the cosmic expansion rate, or Hubble constant. Madore and his colleagues can now find relative distances far beyond our galaxy with such precision that their latest Hubble constant results claim a formal uncertainty of only ±10%, for a 20% spread (*Science*, 28 May, p. 1438). But the doubts about that first step in the ladder mean that the central value could change by more than that. As Alistair Walker, an astronomer at the Cerro Tololo Inter-American Observatory in La Serena, Chile, writes in a forthcoming review, "If we cannot agree upon the distance to two galaxies that are only a few tens of kpc from us, how can we be sure of the distances to more remote galaxies?"

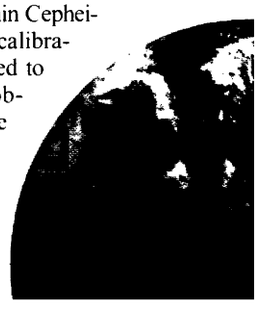
The lack of a resolution "is not for lack of trying," says Wendy Freedman, an astronomer at the Carnegie Observatories in Pasadena, California, and a leader of the Key Project. At least 10 different indicators have been applied to the problem. They include "standard candle" stars thought to have a known intrinsic brightness, so that their faintness as seen from Earth gives a distance measure, as well as clever geometric techniques that derive distance from the apparent size of objects with known dimensions—in effect, cosmic yardsticks. The results are all over the map, a situation that only worsened 2 years ago, when results came in from a European spacecraft called Hipparcos. Designed to settle the issue of galactic distances, Hipparcos instead "produced a lot of confusion," says Princeton University's Bohdan Paczyński.

A cloudy view

For most of this century, the two dwarf galaxies named for the Portuguese navigator Ferdinand Magellan, one of the first Europeans to see them, have played a crucial role in astronomy. Around 1910, while studying photographic plates of the Small Magellanic Cloud, Harvard's Henrietta Leavitt discovered the period-luminosity relation for Cepheids: Those that flicker more slowly are brighter. Since then, Cepheids have become the linchpin of cosmologists' efforts to survey the universe. By using the period of a Cepheid as a proxy for its actual brightness, then measuring its apparent brightness, astronomers can infer how far away it is. They can thus arrive at a distance to the galaxy containing the Cepheid, which allows them to calibrate standard candles that can be seen at even greater distances, such as the exploding stars called supernovae.

But Cepheids themselves have to be calibrated. Astronomers have to determine the absolute brightness of Cepheids with different periods—the so-called zero point of the Cepheid distance scale.

They've traditionally done so by measuring the distance to a handful of Cepheids in our own galaxy. Few Cepheids are close enough for observers to apply the only truly direct technique for determining astronomical distances, called parallax—measuring how much the stars seem to move back and forth in the sky as Earth orbits the sun. So observers made parallax measurements of nearby "main-sequence" stars, garden-variety stars like our sun, which have a characteristic relationship between color and brightness. Using stars at various points of the main sequence as rough standard candles, they estimated the distance to star clusters within our galaxy that also contain Cepheids. This rough galactic calibration could then be applied to the numerous, easily observed Cepheids in the LMC to find its distance and determine the zero point for the entire



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