KOREA

Laid-Off Satellite Group Sets Up Shop

SEOUL—First Park Sung Dong got mad. Then he got even.

Park, an engineer at the Satellite Technology Research Center (SATREC) in Taejon, was furious when the Ministry of Science and Technology (MOST) decided that most of his university-based institute should be absorbed by a larger government contractor. But after threatening a mass resignation last month to protest the decision, Park and his 55 colleagues have vowed to show government bureaucrats just how valuable their work can be: They have started a company that will hire researchers as they are laid off from SATREC over the next 3 years and market their skills to developing countries.

SATREC was created in 1989 to develop Korean technical skills while doing exploratory research on microsatellites, those weighing about 100 kilograms. It is based at the prestigious Korean Advanced Institute of Science and Technology (KAIST), sometimes called Korea's MIT. But last summer MOST decided that much of SATREC's work overlapped with that of the Korean Aerospace Research Institute (KARI), which designs large commercial satellites costing several hundred million dollars, and that satellites should be developed at a government institute, not a university. Universities are places where professors teach students, officials explain, and the 20% that remains of SATREC will be better suited to filling a traditional educational role. "KAIST is not a research institute. It's a graduate school," says Choi Jong Bae, an assistant director at MOST.

Access to space is a priority for the Korean government, which last month announced a 5-year plan to build a rocket capable of launching small satellites. But SATREC workers feel that the government has a one-size-fits-all attitude toward satellites and is blindly consolidating two very different programs. "[KARI's] approach is to guarantee reliability and higher performance," says Choi Soong Dal, founder and director-general of SATREC. "We are doing small microsatellites for experimental purposes." Its third and most recent satellite, for example, cost just $10 million. It included experiments measuring Earth's magnetic field, solar particles, and the degradation of electric circuits from radiation in space.

Choi Soong Dal mounted a vigorous lobbying effort to fight off a similar attempt by MOST 5 years ago to eliminate his institute, but this time he says he's resigned to accept whatever happens. KARI officials declined to comment on the consolidation, which was proposed last summer after a new science minister took office. Given the frequent reshuffling of the Korean cabinet, sources speculate that opponents may be counting on the possibility that the plan may not outlive his tenure.

In the meantime, the first seven engineers to leave SATREC pooled $300,000 of their own money and on 11 January launched a venture company called Satrec Initiative. Their business plan targets developing countries with a limited budget and a hunger for technologies unavailable from advanced countries with laws that prevent certain tech transfers. They also hope to commercialize spin-off technology, says Park, noting that electro-optical systems for astronomy are similar to those used in semiconductor manufacturing and that materials shielding satellite circuits from radiation in space could benefit the nuclear power industry.

Park looks forward to cashing in on such technology. That incentive didn't exist for him as a fixed-salary employee at SATREC, which didn't pursue commercial applications. "I'd like all of our engineers to become millionaires," he says.

–MICHAEL BAKER

Michael Baker writes from Seoul.

MICROBIAL DISEASES

How Rotavirus Causes Diarrhea

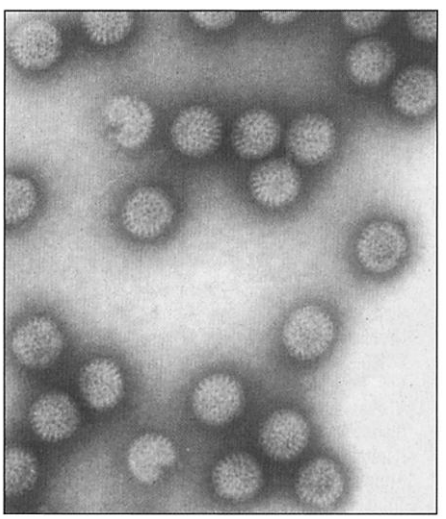
In a healthy adult, the diarrhea caused by common intestinal viruses such as rotavirus is largely an unpleasant nuisance. But to infants and toddlers, particularly those in the developing world where medical care may be scarce, rotavirus infections are a major cause of mortality, killing some 600,000 children worldwide. The virus is so deadly because it causes the intestine to secrete copious amounts of fluid, leading to death by dehydration in highly vulnerable infants. How rotavirus triggers the excess fluid secretion has long been mysterious, however. Now, on page 491, gastrointestinal physiologist Ove Lundgren at Göteborg University in Sweden and his colleagues provide a solution.

They've shown that, in mice, the virus activates the enteric nervous system, the nerves that control the intestine's movements and its fluid absorption and secretion. The activated nerves apparently stimulate cells of the intestinal lining to boost their water secretion, resulting in diarrhea. The toxins released by some bacteria, including the one that leads to cholera and pathogenic strains of *Escherichia coli*, cause diarrhea this way. But, says gastroenterologist Don Powell of the University of Texas Medical Branch in Galveston, "nobody knew this mechanism was involved in rotavirus diarrhea. It's a nice piece of work." Understanding what causes the excess fluid secretion in rotavirus diarrhea, he adds, is an important first step in figuring out how to block it with drugs.

Currently, there's no way to prevent the infections. A vaccine against rotavirus had to be withdrawn last fall from the U.S. market, the only place it was sold, because it caused serious intestinal blockages that killed a small number of children. Children who become infected are treated with oral or intravenous salt and sugar solutions to prevent dehydration. But the treatment does not halt the diarrhea itself. So a drug that does, and could be added to the rehydration therapy, would be a big advance, Powell says.

Despite the evidence of the enteric nervous system's role in the diarrhea caused by the cholera and *E. coli* toxins, few researchers considered the idea that the same mechanism might underlie virus-induced diarrhea. Then in 1996, Lundgren, whose own lab helped prove the case for cholera toxin, read a paper indicating that little was known about how rotavirus might produce abnormal fluid secretion in the intestine. So he teamed up with microbiologist Lennart Svensson of the Swedish Institute for Infectious Disease Control in Solna and several other colleagues to determine whether intestinal neurons might be involved.

The researchers applied three types of compounds known to block neurotransmission in the gut to rotavirus-infected intestines from newborn mice that they maintained in solution. All three compounds greatly suppressed fluid secretion by the infected mouse intestines. The researchers found, for example, that fluids from infected intestines had a higher concentration of an unabsorbed radioactive compound after treatment than before, indicating that the intestines were secreting less fluid. But the inhibitors had little, if



CREDIT: LENNART SVENSSON/KAROLINSKA INSTITUTE

Nerve irritant. Rotavirus particles such as these cause diarrhea by activating the enteric nervous system.

any, effect on fluid transport in uninfected mouse intestines, indicating that the rotavirus was behind the excessive neural activity. The researchers confirmed these observations with studies in living mice. Whereas 14 of 15 rotavirus-infected mice developed diarrhea, only 6 of 14 did when the team treated the animals by injecting the anesthetic lidocaine into the abdomen.

By quantifying the effects of lidocaine and other nerve-suppressing agents on the isolated intestines, the researchers estimate that fully two-thirds of the intestine's secretory response to rotavirus is mediated by neurons. The "simplest" explanation for this, says Lundgren, is that rotavirus infection triggers the release of chemicals in the gut that activate nerve endings beneath the intestinal lining. The activated nerves then turn on secretory reflexes in cells of the intestinal lining that discharge chloride ions into the bore of the intestine. This action is thought to draw water into the bore by osmosis.

Researchers still need to fill out the details of this mechanism. In particular, they don't yet know the identity of the nerve-stimulating substance released during rotavirus infection—information that would be important to anyone trying to develop drugs that block the neural activity, says Helen Cooke, a gastrointestinal physiologist at Ohio State Medical School in Columbus.

Also unclear is whether pharmaceutical companies will take up the challenge of developing such drugs. They tend to shy away from investing in disorders such as rotavirus diarrhea that are important in developing nations but do not represent a big market elsewhere. Still, Lundgren says, his team's work suggests that many forms of diarrhea are caused by enteric nervous system stimulation. "If we are right," he adds, "we could use one drug for every type of diarrhea." And the drug companies might find that a far more attractive prospect. **–INGRID WICKELGREN**

ASTROPHYSICS

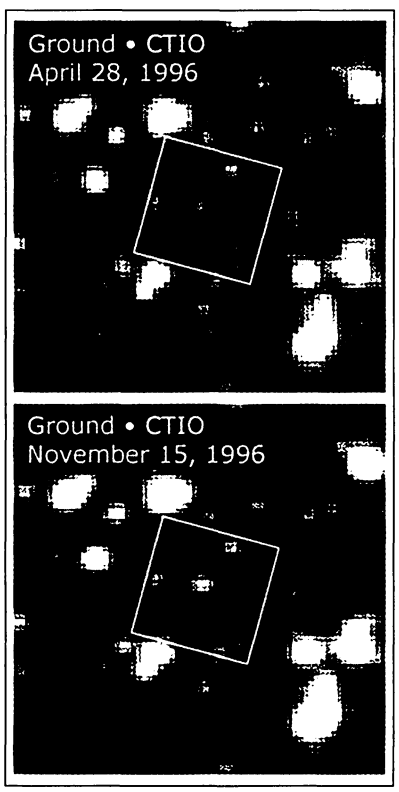
Black Holes Begin to Lose Their Mystery

ATLANTA—From the fringes of the universe to nearby reaches of our own galaxy, black holes are becoming more than obscure figures on the cosmic stage. Several findings released here last week at a meeting of the American Astronomical Society offer insights into the many forms that black holes can assume. Those guises, it appears, are determined largely by the ages of the black holes and their dietary habits.

Astronomers have long suspected that most, if not all, large galaxies harbor black holes, including our own Milky Way (*Science*, 7 January, p. 65). In the distant universe, the most powerful black holes shine as quasars—highly energetic cores of galaxies fed by streams of hot gas spiraling into the holes. NASA's Chandra X-ray Observatory now may have unveiled the precursors to those voracious black holes—remote objects that emit torrents of x-rays but whose visible light may be shrouded by thick veils of dust. Tens of millions of the objects would dot the sky, although Chandra thus far has scanned for them only within a patch one-fifth the size of the full moon.

Chandra identified these remote blips as some of the main sources of a previously mysterious glow of x-rays, first seen during a rocket flight in 1962, that fills the sky. The objects may have dominated the centers of galaxies that formed within a billion years of the big bang, speculate astronomers Amy Barger of the University of Hawaii, Honolulu, and Richard Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Maryland. If so, they would easily rank as the most distant black holes yet detected.

In our galactic neighborhood, the identification of black holes has become almost routine. The Hubble Space Telescope has fingered 20 such objects at the cores of nearby galaxies, including three new ones described at the meeting by astronomer Douglas Richstone of the University of Michigan, Ann Arbor. Powerful gravitational fields around these holes, which carry perhaps 50 million to 100 million times more mass than our sun, pull stars into tight whirling orbits that Hubble easily resolves.



The hole story? This distant star brightened and then dimmed over a period of 800 days beginning in 1996, its light possibly altered by an isolated black hole between us and the star.

CREDIT: NOAO, CERRO TOLOLO INTER-AMERICAN OBSERVATORY

But these black holes are dim shadows of the quasars that blazed billions of years ago, according to research by astronomers Neil Nagar and Andrew Wilson of the University of Maryland, College Park, and their colleagues. The team studied about 100 nearby galaxies with the Very Large Array, a set of 27 radio telescopes near Socorro, New Mexico. About 30% of the galaxies emitted weak levels of radio signals similar in detail to the emissions from quasars, Wilson says. Further analysis by the Very Long Baseline Array, a chain of radio telescopes stretching from Hawaii to the U.S. Virgin Islands, showed that the sources of those emissions were extremely compact. "The only known way to do that is with an accreting black hole," Wilson says.

Wilson regards such black holes as "dying quasars," because they consume perhaps 1000 to 100,000 times less matter than their bright ancestors in the distant universe. Indeed, the key difference may be that most galaxies around us today are mature and stable, says astronomer Virginia Trimble of the University of California, Irvine. Black holes in the centers of these galaxies apparently go hungry, she says, because stars and gas no longer travel on the perturbed orbits that typically push matter toward the core of younger and more vigorously churning galaxies.

Even closer to home, another team of astronomers may have spotted the first known black holes in the Milky Way that eat nothing at all. Two of these wanderers apparently revealed themselves when their gravity acted as lenses in space, temporarily warping and amplifying light from more distant stars (*Science*, 7 January, p. 67). Astronomer David Bennett of the University of Notre Dame in South Bend, Indiana, and other astronomers in the Massive Compact Halo Object (MACHO) collaboration estimate that each invisible object is a few thousand light-years away and about six times more massive than our sun, fingering them as likely black holes.

The work by the MACHO team "looks very plausible," says astrophysicist John Bahcall of the Institute for Advanced Study in Princeton, New Jersey, although he awaits more such lensing events for confirmation. Because black holes of this mass probably emerge naturally from the violent deaths of many giant stars, the Milky Way may brim with them. Bahcall says that these tiny brethren of the monster at our galaxy's heart could supply a sizable chunk of the elusive "dark matter" that makes the Milky Way far more hefty than it appears. **–ROBERT IRION**