ENVIRONMENTAL RADIOACTIVITY

Radioecology's Coming of Age—Or Its Last Gasp?

A group of rebel scientists contends that efforts to protect humans from radioactive contamination have short-changed the environment. But some experts are balking at their calls for a radical new approach

MONTE CARLO, MONACO—The devastating atomic bombs dropped on Japan at the end of World War II created a new branch of science almost overnight for charting radiation's effects on the human body. At about the same time, scientists also began probing how radioactive contamination filters up the food chain to people. Compared to studies of human health, however, the field of radioecology has struggled to make an impact. Its second-class status is even enshrined in a decade-old statement from the influential International Commission on Radiological Protection (ICRP): "The standards of environmental control needed to protect man to the degree currently thought desirable will ensure that other species are not put at risk." Now, some radioecologists are beating the drums for a better deal for the rest of the living world.

The ICRP stance, says radioecologist Jan Pentreath of the University of Reading, U.K., "sounds like a religious statement": There's no explicit scientific evidence to back it up, he says. In most environments, including obvious places such as the ocean floors, "humans are likely to be the least exposed" to radioactivity, says Pentreath. Adds Per Strand, the newly elected president of the International Union of Radioecology (IUR), "It's very strange that we don't protect the environment from radioactivity like we do for other contaminants."

This heretical new view had its coming-out party here last week at a gathering of 300 radioecologists from around the world. "This is the first time we've brought this issue to a broader audience," says Strand, who chaired the conference and is one of the movement's leaders. Their campaign might soon score its first victory. Following months of often fractious debate, ICRP last month put out an updated statement for public comment, this time declaring that nonhuman species should be protected in their own right from the harmful effects of radionuclides spawned by nuclear power generation, atomic weapons production, and other human activities. The rebel radioecologists see this as just the first step. They also want to put the field on a more systematic and quantitative footing, perhaps laying the groundwork for tighter regulations on radionuclide release in areas such as coastal waters. "There is a general feeling that the current system of radiation protection we have is inadequate," says Carl-Magnus Larsson of the Swedish Radiation Protection Authority.

Some experts, however, think this expansionist push is an attempt to prop up a discipline that has little new to say. "Responsible scientists should not try to manufacture a crisis before there is scientific evidence that such a crisis exists," argues physical chemist Pier Roberto Danesi, who recently retired from the directorship of the International Atomic Energy Agency's (IAEA's) laboratory in Siebersdorf, Austria. "Lack of knowledge about the effects of radioactivity on many species doesn't necessarily mean there's a problem." Indeed, many presentations at the meeting here highlighted the environment's resilience to radionuclides. Others say that focusing too much effort on marginal impacts on some species could sap efforts to tackle more important issues, such as disposing of the vast accumulations of radioactive waste. "To me that's the biggest problem to solve," says radioecologist Graeme (George) Shaw of Imperial College in London.

Red forest. Some scientists argue that the field of radioecology has been focused for far too long on Chornobyl studies.

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A dying breed?

This is not the first time that radioecology has reached a crossroads. Following the boom years of the 1950s and 1960s, during which it traced the effects of fallout from nuclear weapons tests, the discipline suffered a slow decline. By the mid-1980s, when it was clear that global fallout posed minimal risk to ecosystems, radioecology was searching for an identity.

Then on 26 April 1986, reactor number 4 at the Chornobyl Nuclear Power Plant exploded. The blast and subsequent fires released a radioactive plume that settled over large swaths of Europe, triggering scores of cases of childhood thyroid cancer, despoiling cropland, and gouging a deep psychological wound that has not yet fully healed. The Chornobyl disaster breathed life into radioecology. "It really renewed the field," says Shaw, an associate editor of the *Journal of Environmental Radioactivity*.

Radioecologists have been at the forefront of studies to determine the contamination's consequences, particularly from the most prevalent radioisotope left on the land, cesium-137. But experts disagree about whether many of the effects they're seeing in wildlife around Chornobyl—for example, higher levels of genetic variation in yellow-necked mice and other denizens of radiocesium-ridden land—pose a threat to the animal populations or whether the animals are taking the radiation in stride.

The difficulty in deriving meaning from such data has contributed to radioecology's identity crisis. "We've lost our sense of direction in the last few years," says Shaw. "Chornobyl and radiocesium have been our main focus for too long." There are plenty of exceptions: Highlights from the Monaco meeting included presentations on the risks posed by depleted uranium munitions used in the Balkans and the Gulf region (see sidebar) and studies showing that no radioactivity was released from the *Kursk*, the Russian nuclear submarine, either as a result of the explosion that sank it or the effort to raise the vessel from the seabed.

But although Chornobyl may have been the lifeblood of the field in recent years, it may also pose its greatest threat. The accident crippled the world's nuclear industry, and some prominent radioecologists have argued that if nuclear energy disappears from the world's energy programs, "there will no longer be a justifiable role for radioecologists," Shaw says.

A raison d'être?

Amid the angst, a few individuals have begun to sketch out a new direction for the

New Findings Allay Concerns Over Depleted Uranium

When several NATO peacekeepers in Kosovo contracted leukemia after their tour of duty, some people pointed the finger at depleted uranium (DU). Because uranium is roughly 70% denser than lead, it makes an effective armor-piercing weapon. NATO aircraft had fired several tons of ballpoint pen–sized DU projectiles at Serb military targets in Kosovo in 1999; much of the ordnance would have fractured and disintegrated on impact, dispersing uranium particles into the air and soil. Fears were heightened after DU penetrators collected in Kosovo were found to contain traces of plutonium and highly radioactive uranium-236, indicating that at least some of the uranium had been irradiated and reprocessed and thus would be more radioactive than typical DU. To assess the danger, if any, to soldiers and local people, the United Nations Environment Programme (UNEP) dispatched teams of researchers to Kosovo in November 2000.

At a radioecology conference last week in Monaco (see main text), one of those teams presented results that should calm the nerves of peacekeepers and Kosovars. The team, led by physical chemist Pier Roberto Danesi, former director of the International Atomic Energy Agency's (IAEA's) laboratory in Siebersdorf, Austria, confirmed that some patches of soil from known impact sites in Kosovo are tainted with DU. But the amounts, the team maintains, are so tiny that the radioactivity poses virtually no cancer risk. Moreover, Danesi's group found no evidence of elevated plutonium levels in the soil. Their findings jibe with those of other bodies, including the U.K.'s Royal Society and the European Union, that have surveyed the DU literature. "There is a consensus now that DU does not represent a health threat," says Danesi. The latest findings, asserts radiochemist Corrado Testa of the University of Urbino in Italy, "confirm that there is no risk from DU."

Depleted uranium is what's left of natural uranium after the fissile isotope U-235 is extracted for nuclear weapons or fuel. According to NATO, its aircraft shelled 112 locations in Kosovo in 1999 with 30,000 rounds of DU munitions totaling about 9 tons. Newspaper reports linking the munitions to cancer cases, particularly leukemia, soon followed.

Danesi's group collected 16 soil samples near DU penetrator holes and underneath penetrators found on the soil surface at five sites. Minefields prevented the team from visiting other areas hit by DU penetrators. Back at the IAEA lab, the researchers threw everything at the samples: instruments ranging from a secondary ion mass spectrometer to a scanning electron microscope equipped with an energy dispersive x-ray fluorescence detector. They found that in the most contaminated places, a few milligrams of soil could contain hundreds of thousands of DU particles—but still not a high enough concentration to elevate cancer risk, Danesi says.

Plutonium levels in the Kosovo soil—about 1 becquerel per kilogram—accorded with global levels of fallout from atmospheric nuclear tests. For comparison, soil levels in the Alps, near Salzburg, are nine times as high, thanks to Chornobyl. "As far as the plutonium is concerned, you could feed this soil to someone and he'd be fine," Danesi says. His team will elaborate on its findings in companion articles in the December issue of the *Journal of Environmental Radioactivity*. Other field investigations in Kosovo have yielded even more comforting results. "We found it very difficult to distinguish between DU and natural uranium," says Testa, whose lab performed analyses for UNEP.

Bringing in the big guns. Soldiers measure radiation levels on a Yugoslav army tank in western Kosovo in January 2001.

The findings might be reassuring, but the DU issue will not be laid to rest. UNEP is organizing a sampling mission in Sarajevo next month, where 3 tons of DU was dropped during the Balkans war, and Iraqi officials have called for investigations into DU on their territory. Nevertheless, maintains Testa, "for me this is a false problem. We could be spending money on more urgent problems"—toxic solvents, heavy metals, and organic pollutants, to name a few, he says. **–R.S.**

field. One of the pioneers is Pentreath, who in 1999 proposed a framework for charting the effects of radioactivity on sentinel species that could serve as "reference flora and fauna" for whole ecosystems and encourage a more systematic approach to estimating radiation exposure and dosimetry across species. "We need a common lexicon," Pentreath says, that would replace today's piecemeal approach.

IUR adopted Pentreath's ideas as a proposed strategy for the field in 2000, and the approach is gaining favor among funding agencies. A project sponsored in part by the European Union called Environmental Protection for Ionising Contaminants in the Arctic has put together a list of reference organisms, ranging from lichens and soil invertebrates to mammals, including lemmings, voles, and reindeer. A second European project called FASSET is attempting to build a framework for assessing radiation effects—in particular, death, illness, reproductive impairment, and cellular damage—across species. "It is a dramatic change that has occurred over the last few years," says Larsson, "and a welcome change."

More contentious, however, are the potential implications of the approach for regulations. Such work could, for example, influence regulations on radionuclide releases into the environment. Although dumping radioactive waste on the high seas is now prohibited, most countries allow waste to be discharged from pipelines into coastal waters. "We have a rather weak international regime for the control of discharges, although there are moves to strengthen it in some regions of the world," notes IAEA's Gordon Linsley.

Critics point out that much of the driving force for the new approach to radioecology is coming from scientists in Scandinavia, which has long tended to take an aggressive stance on nuclear issues. "The IUR was heavily criticized; they called us Greens," recalls Strand, who rejects that characterization. "The IUR simply said, 'Let us be open-minded and look [at] how we can assess the consequences of radioactivity.' "

In the meantime, Strand was invited to join a task group crafting the ICRP's new statement (now on the Web at www.icrp.org) reflecting that view. ICRP will take comments through the end of the year and expects to finalize the statement in April 2003. "It really has to be sold around to the radiation-protection community," says Strand. For some observers, it will be a tough sell.

–RICHARD STONE