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Radiation, Once Free, Can Follow Tricky Path

By ELISABETH ROSENTHAL

Ten days after an earthquake and tsunami crippled a nuclear plant in Japan, officials are detecting abnormal levels of radiation in what may seem like a scattershot assortment of foods: milk from Fukushima Prefecture, where the reactors sit; spinach from Ibaraki Prefecture to the south; canola from Gunma Prefecture to the west; and chrysanthemum greens from Chiba to the south. Shipments of the milk and spinach have been banned.

Experts hesitate to predict where the radiation will go. Once radioactive elements that can harm health are released into the outdoors, their travel patterns are as mercurial as the weather and as complicated as the food chains and biochemical pathways along which they move.

When and where radioactive contamination becomes a problem depends on a vast array of factors: the specific element released, which way the wind is blowing, whether rain will bring suspended radioactivity to earth, and what types of crops and animals are in an exposed area.

Research related to the 1986 Chernobyl accident makes clear that for decades, scientists will be able to detect the presence of radioactive particles released by the crippled Japanese reactors thousands of miles away. Scientists and doctors in Japan and abroad will be monitoring the results to see if those measurements reach dangerous levels. So far there is no indication that anyone has been harmed by eating contaminated food.

"It's natural that people worldwide will be monitoring for this — just in case it is far worse than we now expect," said F. Ward Whicker, a professor emeritus at Colorado State University who developed a leading model for following radiation through the food chain.

When radiation is released with gas, as it was at the Japanese reactors, the particles are carried by prevailing winds, and some will settle on the earth. Rain will knock more of the suspended particles to the ground. "There is an extremely complex interaction between the

type of radionuclide and the weather and the type of vegetation," Dr. Whicker said. "There can be hot spots far away from an accident, and places in between that are fine."

The principal elements that have been released from reactors at the Fukushima Daiichi plant are iodine 131 and cesium 137. Cesium is dangerous because it is long-lived and travels easily through the food chain, continuing to emit particles for centuries once it is released.

More than 15 years after the Chernobyl accident in what is now Ukraine, studies found that cesium 137 was still detectable in wild boar in Croatia and reindeer in Norway, with the levels high enough in some areas to pose a potential danger to people who consume a great deal of the meat.

While iodine 131 is much shorter lived — its radioactive potency is halved every eight days — it is dangerous because it concentrates in the thyroid gland, resulting in high radiation doses to that vulnerable organ. The thyroid is such an iodine magnet that Dr. Whicker recounts that a week after a nuclear weapons test in China, iodine 131 could be detected in the thyroid glands of deer in Colorado, although it could not be detected in the air or in nearby vegetation.

Initially, some plants will collect more radiation than others: those with big leaves like lettuce, spinach and other greens will naturally collect more radiation than apples, oranges or potatoes, he said. Foods like rice and corn whose edible portion is protected by husks or leaves are relatively safe in this early stage.

But over a period of weeks, the radioactivity particles enter the food chain when they are ingested by animals or settle into dirt where they can be absorbed by the roots of growing plants. Soils with high clay content tend to bind radioactive elements and hinder their travel, while sandy soils allow more of the radiation to pass into growing food.

Long-lasting particles of cesium 137 can cycle through an ecosystem for decades, entering plants when they are taken up by root systems and returning to the earth when the plant dies.

For the first time on Monday, Japanese nuclear officials said that some of the water used to douse and cool the damaged reactors had reached the ocean, raising the possibility that seafood might eventually be at risk, too. The officials said they would monitor the situation. Scientists generally measure radioactivity of local mussels and seaweed to assess the level of contamination.

Experts suggest that levels would have to be watched closely because cesium 137 concentrates in fish muscle much as mercury does when it moves up the food chain from plankton to small fish to big fish. "I would definitely be monitoring fish populations in the area, since there may be certain items that should be avoided," said Nicholas Fisher, a professor of marine sciences at the State University of New York at Stony Brook.

In a worst-case scenario, said Paul Falkowski, a professor of marine sciences and geology at Rutgers University, a major ocean current that travels up the coast of Japan, across the Pacific and into the Gulf of Alaska could carry radiation to Alaska fisheries months from now. He said the International Atomic Energy Agency should monitor such movements, although he and other experts considered it highly unlikely that the current would take the radiation to Alaska unless the leak became far worse.

Many fish and the oceans already contain radiation, both naturally occurring and as a result of prior nuclear testing, said Dr. Fisher, who said that added current levels from the damaged reactors were not likely to be significant in terms of human health.

But he and other experts say that vigilance is crucial because problematic levels of radiation can turn up unexpectedly.

After the Chernobyl accident, some relatively distant villages were contaminated with fallout of iodine 131, and local cows ate grass that contained the radiation. Children who drank milk from those cows ended up with high rates of thyroid cancer.