Letter From Japan (9):
NOTES FROM THE PROVINCES

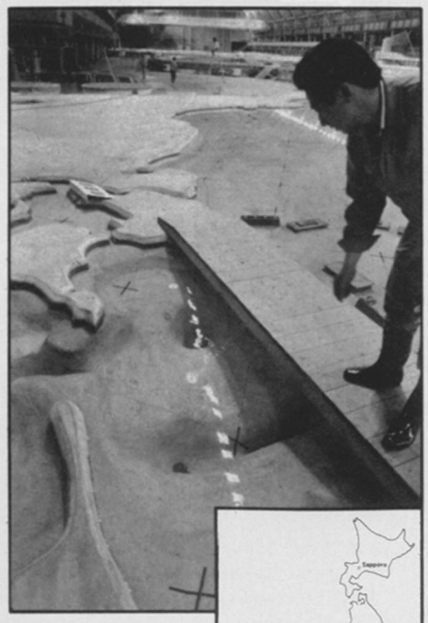
A visit to four regional Japanese laboratories reveals significant advances toward solving some important practical problems

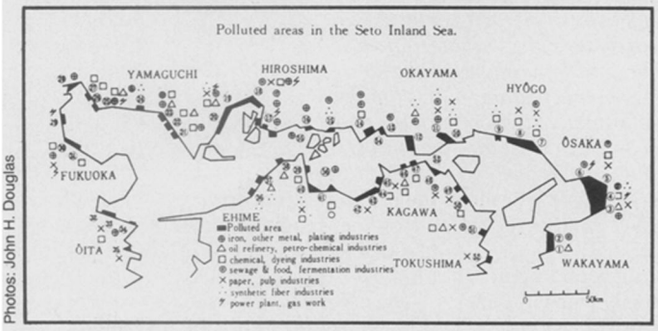
BY JOHN H. DOUGLAS

The great strength of Japanese science is applied research — the application of discoveries and techniques pioneered abroad to unique circumstances arising at home. These efforts, in turn, have sometimes proved so successful that the Japanese have already developed solutions to some problems that the rest of the world is only beginning to worry about. Although Tokyo remains the hub for most scientific, as well as commercial activity, regional Japanese laboratories are playing increasingly active roles in specific fields of applied research.

Take pollution of the sea. While most countries worry only vaguely about what pollution may eventually do to the ecology of the world's great oceans, the problem has already become acute in the Seto Inland Sea, enclosed by three main Japanese islands. This tranquil inlet of the Pacific, 240 miles long, was once known primarily for its bountiful harvest of seafood and its special blend of scenic beauty. But now a pall of smog from surrounding cities often blights the traveler's view in even remote reaches of the sea. And the yearly catch of some valuable fish species is steadily declining, due at least in part to increased water pollution.

To help prevent further deterioration, the Japanese government has established two important laboratories on the shore of the Inland Sea. The National Industrial Research Institute of Chugoku, in Kure, holds one of the world's largest indoor models — an elaborate hydraulic version of the Inland Sea. The model covers roughly the area of three football fields, yet its depth is accurate to within 2 millimeters in its shallower portions. Here the effect of pollution from a proposed industrial complex or from a sudden tanker collision can be forecast accurately in a few hours.





Photos: John H. Douglas

Pollution in the Seto Inland Sea is simulated by a huge hydraulic model in Kure.

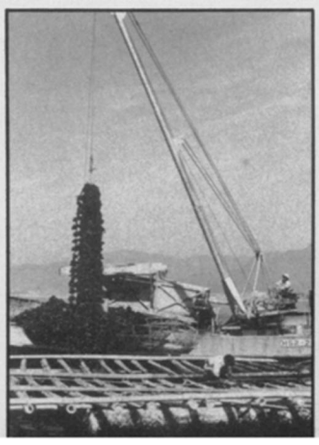
The model enables the spread of pollution to be visualized clearly and dramatically. A dye is injected through any of more than 70 river channels along the mortar coastline. Then giant pumps and a movable dam create the ebb and flow of tides, with periods varying from 3 to 10 minutes. Stop-action cameras suspended from gantries 45 feet above the model surface record the spread of the dye, and more precise measurements of dye concentration can be made using automatic water samplers. So faithful is the movement of water through the model that even the famous whirlpools of Naruto Straits are recreated.

Already the model has been used to choose optimum locations for coastal factories and to predict the spread of oil from a burst tank at an oil refinery. Current work includes making more detailed surveys of the Inland Sea to help refine the model (the effect on current of a rough sea floor has proved hard to simulate) and computerizing the results of experiments into a purely mathematical model.

The Nansei Regional Fisheries Research Laboratory, near Hiroshima, must deal with effects of pollution in the Seto Inland Sea directly. Within its region lie some of the world's most advanced aquaculture projects, and its scientists provide the first line of defense between those who harvest the sea and those who pollute it.

Together with other government agencies, the Nansei Laboratory monitors pollution, warns oyster cultivators about hazards like the "red tide," forecasts the best time for collecting oyster larvae on strings of scallop shells and conducts basic research on the growth and mortality of a variety of commercially important marine animals. The "farming" of sea bream, for example, has become a particularly important topic for investigation because of steadily decreasing catches of this valuable species in open waters of the Inland Sea. The lab has succeeded in hybridizing red and black bream in an attempt to develop a strain with optimum characteristics for farming.

Although their main function is to assist local fishermen, scientists at the Nansei lab are concerned about the broader implications of their work. In discussions with SCIENCE NEWS, they talked of the possibility of adapting their aquaculture techniques to mass production of high-protein food for developing countries. The problem, they conclude, is principally economic: Intensive cultivation of oysters and sea bream is now practical in Japan only because of the high price that *sushi* (a raw seafood specialty) connoisseurs are willing to pay for these particular species. Fish raised in small pens must be fed spe-

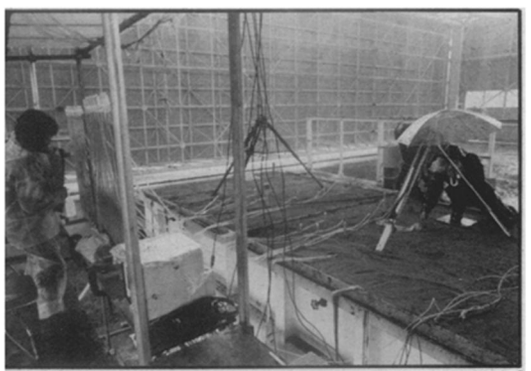


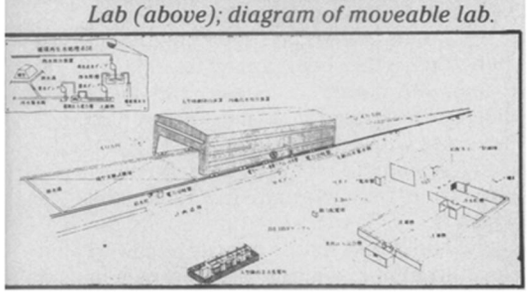
Strings of cultivated oysters are hauled from floating rafts in Hiroshima Bay (left) and shucked by hand. Government scientists help protect and improve the take.

cially prepared food, and cultivating strings of oysters is both expensive and time-consuming.

Another important function of regional laboratories is to develop methods of coping with the exceptional variety of natural disasters that plague the Japanese islands. In addition to preparing for earthquakes (SN: 4/29/78, p.282), special laboratories are needed to deal with flooding from heavy seasonal rains and with the wide range of problems facing Japan's "Snow Country." (Japan receives twice the annual rainfall of such a notoriously damp place as Great Britain, and snow plowed from city streets is piled in parks to be carved into elaborate monuments for winter festivals.)

The Rainfall Laboratory of the National Research Center for Disaster Prevention, in Tsukuba, is charged with finding means of preventing floods that traditionally have occurred in the rainy season. Full-





A wet business: Data collection in Rainfall Lab (above); diagram of moveable lab.

scale dikes and earthen slopes are subjected to artificial rainfall inside a building covering about 31,500 square feet, mounted on tracks so that one experimental object can be constructed outside while another is being tested. Nozzles mounted 50 feet above the ground can produce rainfall varying from a light drizzle to a torrential downpour of nearly 0.8 inches per hour.

Laboratory surveys have shown that the characteristics of dangerous flooding in Japan have slowly been changing. In former times, floods usually appeared only after long periods of rainfall over a wide area. Now, however, damage is mainly caused by flash floods, created by runoff from urban areas. Collapse of embankments has been a particular interest of the laboratory, where experiments have established the relationship between runoff and ground saturation for a variety of soils.

Investigation of the problems arising from severe winter weather is the principal function of the Institute of Low Temperature Science at Hokkaido University in Sapporo. The laboratory began modestly in 1935 with a small cold room used to study artificial snow crystals, but for more than a decade scientists from the institute have been working at the forefront of international research, through cooperative ventures in Alaska, the Antarctic, northern Canada and Siberia.

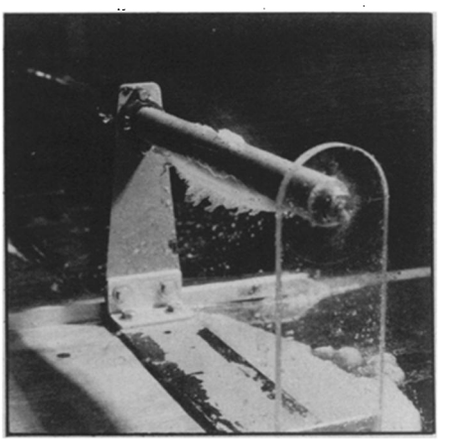
Perhaps the most ambitious of the institute's own installations is a radar network for tracking sea ice in the Sea of Okhotsk, off the northern coast of Hokkaido. How sea ice forms remains largely a mystery, and the speed at which it sometimes builds presents a severe hazard to vessels in northern waters. A dramatic film prepared with the help of the laboratory shows how, in a single day, the sea surface will suddenly turn viscous, develop "pancakes" of slush and then freeze into a jumbled terrain of meter-thick ice. Computer analysis of the radar data promises to reveal some of the complex forces of wind and current that affect sea ice build-up, perhaps making it possible one day to accurately warn vessels of impending ice conditions.

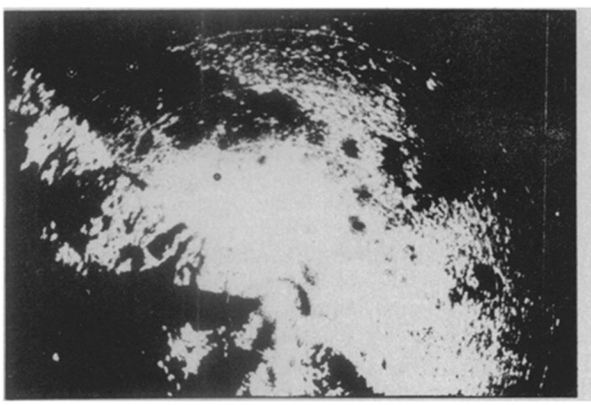
Already, experiments conducted in the institute's wind tunnel have produced a surprisingly simple solution to a long-standing problem in areas that experience severe winter storms — the accumulation of ice on power lines. The studies showed that wet snow blown by a strong wind would first build up along the side of a wire, then rotate downward, allowing more accumulation along the side. Eventually a complete cylinder of ice, several inches in diameter, could form around the wire, causing it to break.

The solution proposed was simply to stop the rotation of the accumulating snow, either with a flange along the side of a single-stranded wire, molded into the insulation, or with small collars placed along helically wound cables. Under both circumstances, snow continues to accumulate along the side facing the wind until it falls off under its own weight, rather than rotating.

Other work at the institute has produced new designs for trenches along hill tops to prevent avalanches and a method to store red blood cells at low temperature without freezing. (The method was discovered through studies of an insect that uses glycerin in its blood to prevent freezing.)

Despite what is going on at these laboratories, Japanese science is sometimes criticized for its lack of originality and for an exceptionally tight bureaucratic structure. Talks with scientists at these and other regional laboratories only tend to reinforce this impression. Particularly those who have worked abroad complain about the relative lack of freedom in institutions with antiquated administrative practices. Nevertheless, the researchers take pride in the realization that in a growing number of specific, important fields of applied research, Japan is becoming *sekai-ichi* — number one in the world. □





Snow accumulates on cylindrical bar in the wind tunnel of Low Temperature Institute (above right). The Institute's radar network (left) shows the build up of sea ice north of Hokkaido.