similar Atlantic and Pacific species. Although similar, these species have made fine adaptations to specific conditions, he says. Thus invaders from either side into the other would not be viable in the new habitats. He suggests both sides are saturated, with most ecological niches filled, whereas the Mediterranean was relatively unsaturated before the invasion from the Red Sea.

Dr. Sanders takes an in-between position, claiming that a variety of sometimes identical habitats exist on both sides and that species from one side would find hospitable habitats on the other. "But I would hesitate to say whether Atlantic or Pacific species would have the edge," he adds.

Scientists are immensely curious to find out which theory is correct, and this creates another kind of ambivalence. "To let the mingling take place would be the greatest biological experiment in the world," says Dr. Sanders. "But as a citizen, I have to recommend extreme caution. Anything could happen—from highly benign to utterly catastrophic." □

WEATHER MODIFICATION

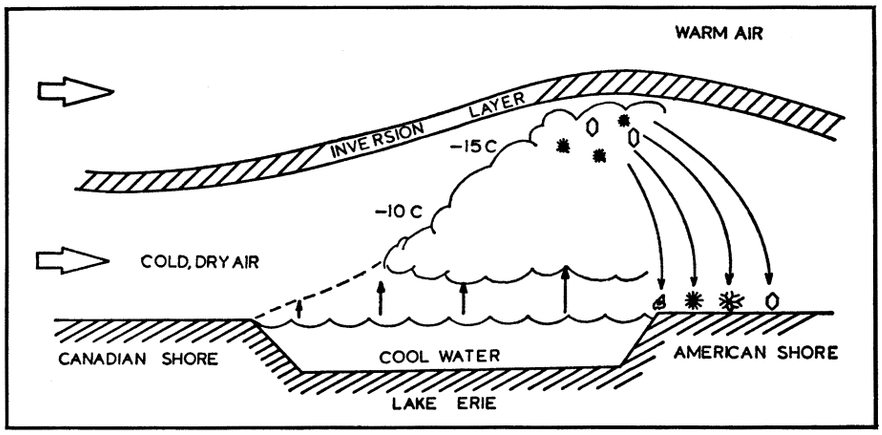
Becoming respectable

Weather modification has fought a nearly quarter-century-long uphill battle toward scientific respectability. The actions and claims of a few early private workers in the field, endowed with unrepressed overoptimism and a tendency to exaggerate evidence favorable to their commercial rainmaking operations, cast a stigma over the field that haunted it for years.

"Few fields have faced more painful birth or embattled infancy than weather modification," says Dr. W. Henry Lambright, a Syracuse University political scientist.

At the second National Conference on Weather Modification of the American Meteorological Society in Santa Barbara, Calif., this week (the first was in 1968) it was clear that scientists are now on firm ground when they say that cloud seeding influences precipitation in predictable ways.

The heritage of caution still remains. But Dr. Myron Tribus, assistant secretary of Commerce for Science and Technology and a long-time proponent of weather modification, took the occasion to review the status of the entire field. He concludes that the science is further advanced than is generally realized. And he proposes that the time has come to proceed to deliberate operational weather modification in two areas: the increase or decrease of snowpack in some mountains and the increase of rainfall in some tropical regions.



ESSA

Weather modification in Great Lakes project: A basically feasible concept.

Responsible for much of the new optimism is a series of snowpack augmentation projects carried out in the Colorado Rockies. Dr. Lewis O. Grant and his colleagues at Colorado State University have been conducting what is regarded as an admirably sophisticated scientific project in 400-square-mile area high in the mountains near Climax, Colo. The project involved first the development of a physical model of how air flows, how clouds form and how precipitation develops in the area.

Using this physical understanding they described how seeding should affect winter clouds under various conditions. Then they performed randomized seeding experiments. The results have been exactly in accord with the theoretical predictions.

On days when the temperature of cloud tops was minus 26 degrees C. or warmer, seeding has increased snowfall by 100 to 200 percent. The results are rated highly significant. The probability that the increase in the two independent samples at Climax could be due to chance is less than 1 in 100.

On days when cloud-top temperatures were colder than minus 26 degrees C. seeding has caused decreases in snowfall of about 30 percent. This too is in accord with theory, which implies a temperature-dependence of the ideal concentration of ice nuclei for precipitation. The colder the temperature, the lower the optimum ice crystal concentration. Seeding under these conditions produces an over-seeded cloud whose nuclei are so small the ice crystals don't fall; they evaporate. In the warmer clouds seeding produces the perfect concentration of ice nuclei to enhance snowfall.

Dr. Grant says he has also very recently obtained data indicating a statistically significant increase in stream flow attributable to the seeding in the basin where the project was conducted.

Dr. J. Owen Rhea and L. G. Davis of EG&G Inc. in Boulder, Colo., have produced similar results near Steamboat Springs, Colo. Seeding of warmer clouds has produced greater than 100 percent increases in snowfall at Rabbit Ears Pass. Seeding of colder clouds has decreased snowfall by about 24 percent.

The crucial importance of cloud temperature in seeding effects brings up the matter of statistical analyses of the results of seeding projects.

Mention of the name of Dr. Jerzy Neyman, the University of California at Berkeley statistician, still raises the hackles of modification enthusiasts. Many try to dismiss him; other say he is a highly regarded scientist and his arguments carry some weight. He and his associates have been saying for some time that the Whitetop experiment from 1960 to 1964 produced a net decrease of rainfall (SN: 2/14, p. 173).

But his statistical method lumps all seedings together, ignoring physical conditions. The point that Dr. Grant and others make is that the new understanding of physical mechanisms allows them to select, if they wish, only favorable warmer clouds for treatment.

"Even when I ignore physical mechanisms and mix up all my results, the pluses and minuses balance and I don't get any net effect," points out Dr. Grant. "But you wouldn't do actual operational seeding that way. As long as you understand the situation physically, you can select only the clouds that will give you more precipitation."

As a result of the striking successes of the snowpack experiments, the Bureau of Reclamation of the Department of the Interior plans to begin this fall an upper Colorado River pilot project to operationally increase the snowpack over a 3,300-square-mile area west of Wolf Creek Pass in southwestern Colorado by seeding the warmer winter clouds.

By 1976, Dr. Archie Kahan of the bureau's Atmospheric Water Research Program Office in Denver says, he intends to know how many additional

acre-feet of runoff are produced by operational seeding, with what measure of statistical significance and at what cost per acre-foot.

Dr. Kahan says the hope is to increase the snowpack accumulation by 50 percent over the long-term average for each location within the project area. Once the level has been reached seeding there will be cut off to avoid any danger of causing a flood threat. Much of the seeding will be conducted by automated ground-based generators placed at very high and remote locations. They will release silver iodide on radio command and report back on their performance.

A Great Lakes experimental snowfall modification project currently underway has an objective different from the Colorado projects. Here the goal is to reduce the massive recurrent snowfalls along the south edge of Lake Erie in the Buffalo area by spreading the snow farther to the south. Detailed data are not yet in, but early work tends to demonstrate the basic feasibility of the concept. □

CRYSTALLOGRAPHY

Deciphering proteins

In biology, form and function go hand in hand. The architecture of a molecule, governing its ability to interact with other molecules with compatible structures, determines how it functions in the body. Hence molecular biologists—seeking precise knowledge of biochemical events—are becoming molecular architects, focusing their attention on drawing blueprints of living molecules.

Proteins are among the primary targets of this research. Though the chemical and crystallographic tools are essentially in hand, determining protein structure remains a complex and time-consuming process (SN: 9/21/68, p. 298). While scientists hope that by the end of the decade atlases will contain maps of hundreds of proteins, complete structures are available now for only about a dozen, and partial blueprints have been drawn of only a few more.

The protein that most recently joined the ranks of those to be partially deciphered is the enzyme lactate dehydrogenase (LDH), which occurs in most muscle tissue and is essential to the chemical conversion of glucose into energy for muscular activity. LDH is the first enzyme that functions within cells to be unraveled. Its three-dimensional structure was reported last week in London by a team of Purdue University scientists speaking at a symposium marking the 80th birthday of Nobel laureate Sir Lawrence Bragg, a pioneer in the techniques of X-ray crystallography that makes these architectural studies possible.

Drs. Michael G. Rossmann, Margaret Adams and their colleagues at Purdue grew crystals of LDH to fix its internal molecules into a regular three-dimensional array and then bombarded them with X-ray beams that reflect off those molecules in readable scatter patterns. After collecting more than 100,000 pieces of data from X-ray diffraction, the investigators turned them over to a computer for analysis and generation of maps pinpointing the positions of the amino acid molecules that constitute the total protein.

The enzyme, they found after about six years of work, contains approximately 310 amino acid molecules, and, structurally, is composed of four subunits. Instead of being a long, single chain of amino acids folded into a three-dimensional configuration, LDH is built of four separate polypeptide or short amino acid chains.

Knowing the three-dimensional or tertiary structure of LDH, scientists are now halfway in their attempt to decipher it completely. The remaining unknown is its primary structure, the sequence of specific amino acid molecules in the four chains. X-ray crystallography pinpointed the spatial positions of those amino acids but told nothing about which molecules they are. That is a problem of chemical analysis, which is being conducted in other laboratories and should be completed soon.

In an effort to hasten the rate at which protein structures become available, the Massachusetts Institute of Technology is establishing a center for the New England area. MIT's Dean Robert A. Alberty of the School of Science points out that although techniques of structure analysis are reasonably well developed, the equipment and trained workers in the field remain clustered at a few large institutions and are not generally available to individual biologists and chemists. Says Dr. Alberty, "The net effect (of the Center for Macromolecular Structure) will be to hasten the development of understanding of fundamental molecular interactions which are the basis of living systems." □

Purdue Univ.

From crystallographic data, Dr. Michael Rossmann built a 3-D model of LDH.

METHADONE

Cracks in the panacea

The treatment of heroin addiction with the use of methadone, a synthetic narcotic, is becoming popular at a rapid rate. Ten years ago methadone was used mainly as an aid in detoxifying addicts and was little known by the general public. Now there are methadone-maintenance programs in more than a dozen cities, including large-scale programs in New York and Washington, D.C.

The programs have mostly received favorable publicity. But a number of scientists are beginning to object to the notion that methadone-maintenance should be the preferred mode of treatment for heroin addicts.

The new programs are based upon the demonstrated success of an experimental methadone-maintenance program begun six years ago by Drs. Vincent Dole and Marie Nyswander at Beth Israel Medical Center in New York.

The traditional detoxification procedure with methadone consisted merely of substituting methadone for heroin and then gradually decreasing the dosage until the addict is off drugs altogether. Given the opportunity, such a patient often reverts to heroin use. Drs. Dole and Nyswander therefore increased, rather than decreased, the dosage of methadone being given as a heroin substitute. At high dosage levels, methadone blocks the effects of heroin, so that a patient maintained on methadone cannot get high from heroin or other opiates even if he tries.

Two years ago a Columbia University evaluation team endorsed the Beth