

Letters

Water: Can Cloud-Seeding Help?

Desalination is now believed to be the most promising way to forestall drought disasters. Practical methods for increasing the water supply are so vital that present research and development programs for desalination, and more, are well justified. But while this may be the best approach to increasing the water supply of coastal regions, the delivery of desalinated water to the interior and to localities high above sea level is likely to be prohibitively costly. What are the prospects for such areas?

A short decade ago there was much enthusiasm about artificial cloud nucleation (ACN) as a means of augmenting natural precipitation. Now much less is heard about it. Its possibilities are given relatively little consideration at high levels of authority and planning for the world's water supplies. But it is possible that ACN could be the best means of augmenting water in certain interior regions, especially mountainous parts.

Theoretically, the seeding of supercooled cloud droplets associated with up-slope winds which provide moisture for condensation more or less continuously should yield more precipitation than has in general been obtained in field experiments on mountainous coasts. The reasons for the difference between theoretical and actual yields are not fully known. Research meteorologists have not neglected this field. Its importance is too great and its identity with basic phenomena which must be understood for the advancement of weather prediction are too obvious for meteorologists to overlook. Since 1946 many excellent and productive studies have been pursued in cloud physics and related problems of condensation and precipitation in the free air. Thousands of field tests have been made. But the possibilities and results of ACN in its several techniques are still unknown quantitatively. While much knowledge has been ac-

quired of many of the individual features of precipitation processes, comparatively little is known about the yield from the seeding of clouds in particular cases. Clearly this question would soon be answered if a practical method were found for identifying rainfall or snowfall caused by artificially introduced nuclei and distinguishing it from the precipitation due to natural causes operating at the same time. It would then be relatively simple to run field tests in various favorable regions and obtain a basis for estimating how much ACN might contribute to the world's water supply. But of course the problem is *not* "simple"; quite the contrary.

Much time has been lost and many efforts misdirected. As long ago as 1950 competent research scientists showed the need for basic research in the physics of condensation and precipitation of water vapor in the atmosphere and demonstrated beyond doubt the careful design and conduct of experiments necessary if invalid conclusions were to be avoided in "rain-making" tests. [See *Amer. Meteorol. Bull.* **29**, 266 (1948); **30**, 289 (1949), and other sources for reviews of the classic work by Gunn *et al.* in cloud-seeding tests.] But commercial rain-making operators and others claimed great successes. Scientists who advocated basic research to resolve the many unknowns before releasing the techniques of cloud-seeding for practical applications were put off with the argument, "We can't wait for fundamental studies—we need rain now!" But we *have* waited, in a sense, and now the basic researches are generally recognized as prerequisite to sound practical use of ACN.

There has been progress. Extremists on both sides are less extreme. The public is less credulous when exaggerated claims of having "made rain" are published. The universities and other research institutions, including government agencies, have conducted research which has contributed much to scien-

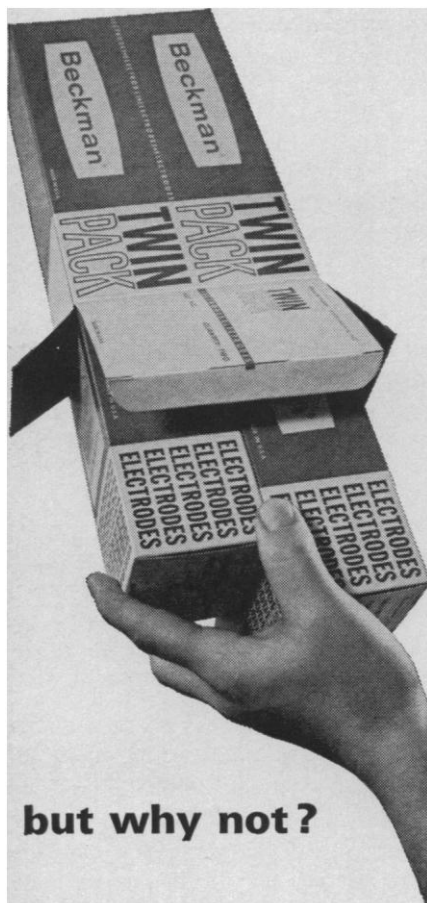
tific knowledge of particular features of the precipitation cycle. But a comprehensive and concerted program is needed to fill the wide gaps in knowledge. Several such programs have been proposed, among the earliest those of Hall and Kline of the U.S. Weather Bureau, in 1950–55. The National Academy of Sciences, the World Meteorological Organization, and the International Council of Scientific Unions (International Union of Geodesy and Geophysics) are among the organizations that have sponsored committees to review the possibilities and problems of the atmospheric sciences and to include in their recommendations related plans for research in weather modification. The probability that advanced ACN techniques will yield worthwhile increments of precipitation from orographic clouds over certain mountain ranges, and the possibility of increasing yields from cumulo-nimbus clouds and in other favorable situations, should be thoroughly explored. Perhaps, as was suggested many years ago, the complexity of the phenomena may necessitate an examination or "diagnosis" for each individual synoptic situation or cloud system to make sure of maximum yields of precipitation and to settle uncertainties about overseeding and unintentional reduction in coalescence of droplets; but the benefits not only to the understanding of the possibilities of weather modification but also to the advancement of weather prediction and the solution of other atmospheric problems are ample justification for giving very high priority to such research.

F. W. REICHELDERFER
3031 Sedgwick Street, NW,
Washington, D.C.

That Seventh Veil

J. K. Mackenzie (Letters, 1 Oct., p. 7) observes that scientists have no aptitude for designing television "science programs" for the general public, and proposes that the education in science of "the tens of millions who are not responding to our present efforts" be entrusted to quite different hands. His criticism and proposal are impressive, but in his preoccupation with the cure he may not have fully analyzed the disease. One symptom can be found, appropriately enough, in Galen, in the often quoted close of the Hippocratic Law:

**You
don't
have
to buy
two...**



Beckman pH Electrodes now come in a Twin Pack. When you order one electrode, why not order two? It saves ordering so often. It avoids delays during important determinations. You've always got a spare.

Most Beckman Electrodes can be ordered in Twin Packs that protect them better than ever. Twin Pack's protective, expanded polystyrene insert does double duty around the lab, too. It conveniently holds electrodes, test tubes, pencils, and other small items. For your electrode needs contact your local Beckman Sales Engineer, or write for Electrode Catalog 86.

Beckman® INSTRUMENTS, INC.

**SCIENTIFIC AND PROCESS
INSTRUMENTS DIVISION**
FULLERTON, CALIFORNIA • 92634

INTERNATIONAL SUBSIDIARIES: GENEVA, SWITZERLAND;
MUNICH, GERMANY; GLENROTHES, SCOTLAND; PARIS,
FRANCE; TOKYO, JAPAN; CAPE TOWN, SOUTH AFRICA

... Secret things are revealed only to initiates. It is forbidden to reveal them to profane persons before they are initiated into the mysteries of knowledge. ...

In commenting on this passage, the classical scholar Werner Wilhelm Jaeger goes on to observe:

Here we have mankind divided, as if by a religious rite, into two classes, one of which is severely debarred from an arcane knowledge ... [*Paidea*, (Oxford Univ. Press, New York, 1944), vol. 3, p. 10].

No modern scientist consciously withholds knowledge as suggested in the passages quoted, yet we are all impelled, in one way or another, to retain the seventh veil around those matters that are closest to our professional lives.

I am far from proposing this as the root cause of scientists' notorious failure to communicate to a lay public. I only suggest that the reasons for this failure may lie deeper than mere indifference, a technical vocabulary, or lack of dramatic flair.

J. S. ROBOTOM

*Graduate Research Center for
the Southwest, Dallas, Texas 75230*

Education and Support of Scientists

An article by Adolf Butenandt, president of the Max-Planck-Gesellschaft, in *Bulletin No. 111 of the West German Press and Information Office* (Bonn, 1965), deals with the sponsoring of research in the Federal Republic, but many points made in it are universally applicable and should be of interest to American scientists. Following are a few translated excerpts:

The building of immense institutes whose dimensions reach beyond the available intellectual capacity may quite conceivably be the reverse of meaningful research support. ...

Investment in research is economically as sound as any other logical investment. The meaning of research here is rather broad and without a borderline between basic and applied, for "research is a unit." ...

Basic research should and must be supported without planned partiality and to an extent determined by the number of available productive minds and facilities. ...

Careful evaluation of the literature gives the impression that publication of industrial research findings is much more restrained in Germany than in the United States or Switzerland. ...

I would like to comment as follows on

the natural sciences, especially the field of chemistry: I am definitely convinced through my experiences that a young scientist will reap the most profit in his later professional career if the fundamentals of his initial training are widely extended and if all early specialization is avoided. Of course, a dissertation will always be specific, but the nature of this detailed topic is of no importance at all. Its major purpose must be to supply the aspiring researcher with an opportunity for observation, critical thought, orderly experimentation, and an understanding of casual reasoning. These processes can be learned on any chemical problem and can be effectively applied in the solving of any problematical situation. ...

With regard to training and course work for our students, I consider as best promoting our research effort that education which is general in scope and which does not aim at a future professional specialty. ...

A professional education which is formally ended when the student is 30 years of age cannot be any good; it should be reduced by at least three or four years. ...

The 1963 Student Guide of the Technische Universität Berlin contains the following words of Professor Kniehahn: "A preferably brief university education is not to fill a vessel, but to kindle a fire. The world should not be supplied with super-saturated or conceited intellectuals, but with unfinished, yet hopeful, human beings still capable of generating enthusiasm." ...

A future researcher learning the basic facts of his discipline should not disregard this statement of the late psychiatrist Ernst Kretschmer; "Science is a matter of character, a matter of denial and firm compliance, it is a matter of integrity, of steadfastness, of honest conviction and of an infinite will to achieve."

MANFRED KROGER

*College of Agriculture,
Pennsylvania State University,
University Park*

Erratum: A Matter of Local Pride

In the article on plankton by J. L. Brooks and S. I. Dodson (1 Oct., p. 28), there appears a photograph identified as an "aerial view of Cedar and Linsley ponds (Branford, Connecticut)." These ponds are located in the Town of North Branford, not Branford, North Branford having been legally set apart from Branford in 1831. As a lifelong resident of North Branford, I know that the residents take particular pride in the fact that these bodies of water, commonly known as Twin Lakes, are situated in their town.

ELLSWORTH B. FOOTE

*Foote and Hannan,
265 Church Street,
New Haven, Connecticut 06501*