# Letters to the Editor

## Nuclear Energy and the Polar Icecap

Probably no scientific development has ever aroused as much discussion as that of atomic energy, or nuclear energy, which is a more descriptive title. This is properly so. It is inevitable that informed discussion should be accompanied by preposterous ideas, such as automobiles running on engines the size of one's fist supplied with nuclear power.

The statements that have been made recently by prominent people that with the advent of nuclear energy we are now in a position to melt the polar icecaps have evidently been put forth seriously, and have even caused concern in some quarters because of the threat of a general raising of the level of the oceans, the effect on weather conditions, etc.

On the bare possibility that some readers of *Science* have not bothered to go through the simple calculation that shows the absurdity of this proposal at the present stage of developments, it is presented herewith.

The icecap has been estimated to cover 5,000,000 square miles and to average 1,800 feet in thickness. To melt it from a temperature of $-40°$ F. would require $2.5 \times 10^{23}$ B.T.U. of heat, which is equivalent to $3 \times 10^{26}$ joules or $2 \times 10^{45}$ electron volts of energy. This energy could be supplied as nuclear energy in two ways: by dropping bombs or by setting up so-called piles such as are used in the production of plutonium.

Each atom of U-235 releases about $2 \times 10^{8}$ electron volts of energy. Operating at 100 per cent efficiency it would, therefore, require $10^{37}$ atoms or something over four billion tons of U-235 to do the job. At present costs of something over $10,000 per pound no comment is needed regarding the feasibility of this approach. The idea of using uranium piles is no more feasible. Surely a pile that dissipates 1,000,000 kilowatts would be considered a large one. The power output would be about equivalent to that of the Grand Coulee dam. With 10,000 such piles one could melt the icecap in about 1,000,000 years.

The foregoing remarks are not intended to detract in the slightest from the enormous possibilities that have been opened up by the introduction of nuclear energy. Those possibilities are surely great enough to tax the imagination of anyone to the limit and offer enough perplexing problems without introducing such ridiculous propositions as the one dealt with here.

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## Transmission of Papaya Bunchy Top by a Leaf Hopper of the Genus *Empoasca*

A serious disease of papaya (*Carica papaya* L.), widely known under the name of "bunchy top," has been reported from different regions of the world where the plant grows. The disease is characterized during its initial stages by a faint mottling and chlorosis of its upper leaves, followed by a marked reduction and yellowing of the leaf lamina and a decided shortening of petioles and internodes, ending finally in a complete cessation of apical growth and bunchiness of the top which gives the disease its peculiar name. Another conspicuous symptom of the disease is the presence of hydrotic-like streaks, sometimes called "oil spots," along the stem and petioles.

Although long suspected to be a virus disease, nobody, as far as we know, has been able to transmit it either mechanically, by grafting, or through the aid of insect vectors. In 1937 J. H. Jensen (*Rep. Agric. Exp. Sta. Puerto Rico*, 1938, p. 125), working at the Federal Station at Mayaguez, Puerto Rico, found a leaf hopper, later described by Oman as *Empoasca papayae*, associated with papaya trees affected with bunchy top. His attempts to transmit the disease with this leaf hopper were inconclusive, however, as he had the misfortune of losing his experimental plants accidentally shortly before leaving the Station.

We have recently obtained evidence of the successful transmission of bunchy top with a leaf hopper of the genus *Empoasca* which, based on an examination of the male genitalia, we presume to be identical with the one used by Jensen. Seventy-one out of 90 healthy trees exposed to leaf hoppers collected on diseased plants began to show symptoms of bunchy top in about a month and a half. Most of the experiments were performed in insect-proof cages, but in some cases the insects were released inside cellophane casings inserted on the upper stem of the test plant after trimming the leaves. Unexposed controls (5 for every 10 plants exposed) remained healthy.

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## Geopathology, a Branch of Biometeorology

In his recent article on "Tropical diseases and geopathology" (*Science*, 1945, **102**, 656) Dieuaide stresses the fundamental importance of studying "the peculiarities of disease in relation to topography, climate and the distribution of pathogenic and disease-transmitting organisms," suggesting that "geopathology" be used to designate such a field of investigation. With this point I agree, but the author is in error when he states that (1) geopathology is in its infancy, (2) there are no geopathologic treatises even moderately comprehensive, and (3) our knowledge is fragmentary.

Although the fact is not widely known, geopathology is a branch of an already established science called biometeorology. Hippocrates knew of these problems when he wrote his *Airs, waters and places,* and Hirsch's and Drake's treatises on geopathology, published in the 1850's, are classics of medical literature. For many years, however, interest in these problems has been lacking, but along with the recent growth of interest in the problem of constitution, investigations of the influence of the environment on man have appeared in increasing numbers. In particular, workers both in this country and in Europe have been studying the influences of weather, climate, and altitude on plants and animals. This study has been designated biometeorology, and in 1939 a section devoted to the literature of this field was founded in *Biological Abstracts* under the section on Ecology. Some of the divisions of biometeorology are medical climatology, meteoropathology, geopathology, and climatotherapy. At the present time the Committee on Climatology of the American Geophysical Union is attempting a classification of the branches of biometeorology so that the existing and forthcoming literature will be readily available to the interested workers.

Although our knowledge is incomplete, it is certainly not fragmentary; for there is already available a vast literature on biometeorology. In recent years a number of excellent monographs have appeared, summarizing some of that knowledge. W. F. Petersen's *The patient and the weather* (4 vols., 1934–1938) and M. Piery's *Traité de climatologie: biologique et médicale* (3 vols., 1934) are among the most extensive. B. de Rudder's *Grundriss einer Meteorobiologie des Menschen* (1938) outlines many of the fundamental principles of the science. C. A. Mills' *Medical climatology* (1939) is an analysis of the seasonal and geographical variation of disease. A. G. Price has admirably analyzed the problem of the *White settlers in the tropics* (1939), and D. H. K. Lee (*Univ. Queensland Pap.*, 1940, 1, 1–86) has summarized the literature on the physiology of acclimatization.

I do, however, agree with Dieuaide that there is a great need for a systematic investigation of these problems, for a correlation of available literature to serve to focus attention on the problems requiring further study, and for collaboration among the interested investigators so that the research may be carefully planned and efficiently executed to reveal the facts and make the acquired knowledge applicable.

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### Retention of High School Science

When I read the recent comment of Charles A. Gramet concerning secondary school science courses (*Science,* 1946, 103, 149), I felt that a reply was necessary.

A few years ago I gave a college pretest in biology, at the time requesting that those who had studied the subject in high school indicate that fact. The results astonished me. Of some 50 students who had studied secondary school biology, only 10 ranked higher than