year when another study, from the Office of Research and Development of the CIA, predicted "mass migrations" and other forms of global political "instability" as a result of a long-term cooling trend in the Northern Hemisphere. The analysis—which was highly controversial at the time—predicted that U.S. food exports could be the key to resolving the political controversies caused by lack of food. In the course of the debate about this study and others which have been undertaken, a number of leading climatologists have criticized USDA's methods of forecasting crop yields because their weather assumptions, based on the unusually favorable Northern Hemisphere conditions of the last 20 years, are much too optimistic.

Soviet crop production is extremely sensitive to fluctuations in the weather. According to a recent speech by a former Soviet minister of agriculture, 66 percent of Russia's arable land already has insufficient precipitation. (By contrast, only 1 percent of the arable land in the United States has this handicap.) During the 1960's, Khrushchev opened "new lands" to farming by extending Russia's major agricultural region eastward from European Russia across Kazakhistan to the Chinese border. But the new CIA prediction, if true, could mean that these "new lands," which get little rainfall as it is, could become harder and harder to cultivate in coming years. Should this happen, the Soviet Union would become even more dependent on imported food than it is already.

Decker, in his review of Soviet data, is impressed by certain correlations between Soviet weather conditions and the country's political history. Not only did Khrushchev's "new lands" policy coincide with a period of abnormally favorable weather, but the Stalinist era correlates with a period of poor weather, in the late 1930's. "I'm not qualified to relate it to the politics of the era, but boy, there must have been some hunger in Russia in the 1930's," he says. It seems obvious that, as far as CIA goes, such correlations will not go unnoticed.—DEBORAH SHAPLEY

Dicing with Nature: Three Narrow Escapes

A new life-form often cited as a theoretical example of the health hazards that could be created by the gene-splicing technique has already been constructed, *Science* has learned. Since it was made by an in vivo method, it is not covered by the NIH guidelines, which define recombinant DNA organisms in terms of the gene-splicing technique, a test-tube method, instead of by their inherent properties.

The organism is an *E. coli* bacterium carrying the gene for cellulase. *Escherichia coli* is a common inhabitant of the human gut; the cellulase enzyme breaks down the plant structural protein cellulose which, being indigestible by humans, gives bulk to the feces. Should such an *E. coli* gain a selective advantage and spread throughout the population, the result might be a large number of people suffering from chronic, maybe fatal, diarrhea, theorists warned.

A cellulase-containing *E. coli* was put together by A. Chakrabarty of the General Electric Research and Development Center at Schenectady, New York. Chakrabarty planned also to insert methane-forming genes into the bacterium so that it would be able to turn wastes such as sewage sludge directly into usable methane gas.

After he had inserted the cellulase enzyme gene it occurred to him that such an organism might not be a comfortable thing to have in one's gut. The cellulose breakdown products might not be properly absorbed in the lower intestine, and other bacteria might turn them into gas. "Every time you ate a lettuce you might have a lot of gas in the stomach and that is not a very bright prospect," Chakrabarty observes. "So because of this consideration, without any other kind of evidence, we destroyed the bug." The incident occurred 2 years ago, and the gene transfer was conducted with the use of plasmids, not with the restriction enzymes used in the present gene-splicing technique.

Another potentially scary incident, also involving a recombinant DNA constructed by methods antedating the gene-splicing technique, concerns a family of laboratory-made viruses that are hybrids between the tumor virus, SV40, and the adenoviruses which cause the common cold. The hybrids are a useful research tool for mapping the genes of SV40, a monkey virus which causes tumors in some animals but not, it would seem, in man. The threat posed by the viruses is that should they escape they could, like the pure adenoviruses, become established in the population for generations to come, exposing people meanwhile to the effects of SV40.

Andrew M. Lewis, the NIH virologist who developed the hybrids in 1971, realized this danger and, with the advice of his institute, asked scientists needing samples of the viruses to sign an agreement promising to take certain safety precautions. This seemingly minor restriction on the traditional free exchange of scientific materials ran into considerable resistance. Even three of the eleven-member group that later called for the Asilomar conference on controlling gene-splicing research were among those who initially refused to sign the agreement, Lewis recalls. One of the three even threatened Lewis with congressional action, action by the director of NIH, and collective pressure from the scientific community, if the viruses were not immediately made available to other laboratories.

A third example of a possibly unpleasant recombinant organism is the experiment contemplated by Paul Berg of Stanford in which an SV40 virus genome would have been inserted into *E. coli*. As with the adenovirus × SV40 hybrids, such an organism might, if it got loose and survived, expose people to the unknown effects of SV40 virus. It was this experiment, never performed, that set in train the process which led to the NIH guidelines on gene-splicing research.

These three incidents all show how easily with modern techniques the biologist can stumble, almost before he has realized it, into making research organisms of potentially grave hazard. The past 30 months of debate have probably made most biologists more aware of such dangers. Even without this advantage, the scientists concerned in these three incidents behaved in a responsible manner. Chakrabarty destroyed his cellulase-containing *E. coli*, Lewis asked for a safety agreement from the recipients of his viruses, and Berg decided not to carry out his experiment. But in wielding their ever increasing powers for manipulating the stuff of life, will all biologists in the future always act with as much intelligence and restraint?

—NICHOLAS WADE