THE WORLD'S WORST CORN CROP

Dr. Ernest G. Anderson, Professor of Genetics in charge of Caltech's Experimental Farm, records data on a dwarf descendant of corn seed exposed in the Bikini bomb test.

Corn from seeds exposed in the atom bomb tests helps Caltech biologists study the effects of radiation on plants and humans

AT THEIR EIGHT-ACRE experimental farm in Arcadia, California, Caltech biologists have produced one of the world's weirdest corn crops. They have grown dwarf corn just a few inches high, plants without silks or kernels, plants with intricately twisted leaves and no ears, plants that wither in the noonday sun, and plants that give off a ghostly blue glow under ultraviolet light.

Most of these freak plants are descendants of seeds which were exposed in the Bikini atom bomb test in 1946 or in the Eniwetok test of 1948. They are invaluable in fundamental studies of heredity and transmitted traits, but the Caltech biologists are also using them to study the effects of radiation on food crops, on other plants and—indirectly—on human beings.

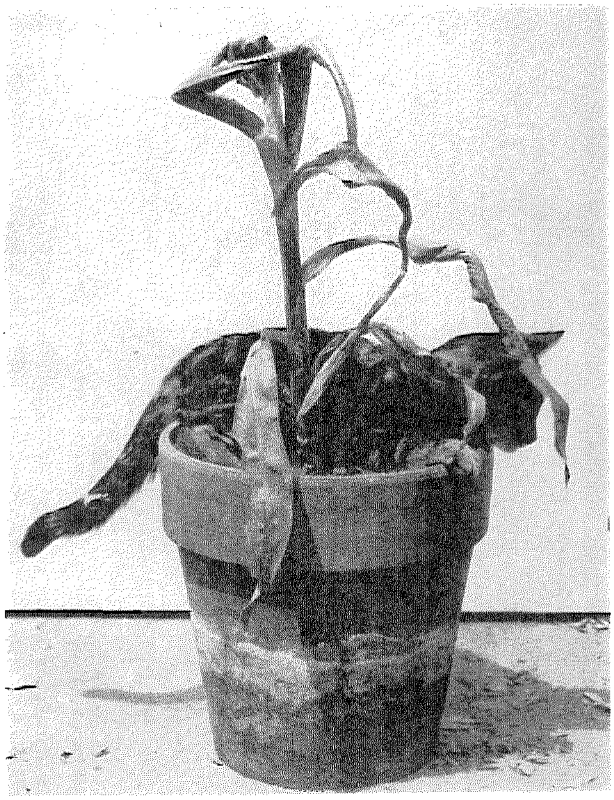
To measure the biological effect of an atom bomb explosion, Caltech researchers exposed normal corn samples to measured doses of X-rays. By comparing these with similar corn material from Bikini and Eniwetok it was possible to express bomb effect in terms of the X-ray dosage needed to produce an equivalent effect.

One Bikini sample, for example, showed an effect about equal to that produced by 15,000 roentgen units of X-radiation. (According to the Atomic Energy Commission's publication on *The Effects of Atomic Weapons*, from 3 to 300 units might be expected to double the normal gene mutation rate in man.)

To determine the frequency of chromosome damage in this Bikini sample, Caltech researchers studied the lateral branches of the corn tassels for evidence of semi-sterile pollen—a condition in which half the pollen, or male germ cells, is sterile.

About 31.5 per cent of the branches examined had semi-sterile pollen. Since this is a direct measure of the extent of gross chromosomal damage in the reproductive tissue, it means that 31.5 per cent of the structures which were potential germ cells carried gross chromosomal abnormalities induced by the radiation.

Some types of these abnormalities cannot be transmitted to the next generation. Others are transmitted to one-half of the offspring. If transmissible and non-transmissible alterations were equally frequent, about 4.7 per cent of the semi-sterile plants would be expected among the offspring. In actual fact, about 4 per cent were obtained—indicating that somewhat less than half of the chromosome alterations were transmissible.



The Experimental Farm's pet kitten furnishes a scale in this picture of an Eniwetok descendant which grows with tightly twisted leaves to a full height of only two feet.

In other words, among the plants grown from seeds exposed to the equivalent of 15,000 r, about 4 per cent of the pollen cells may be expected to transmit semi-sterility to future generations.

All in all, Caltech researchers have found hundreds of mutations in the progeny of seeds exposed at Bikini, and more than a thousand in descendants of seeds irradiated in the Eniwetok test. So many were discovered, in fact, that only the more interesting variations are being studied intensively.

The seeds exposed at Bikini, however, were commercial varieties in which many mutants might have occurred naturally. Careful analysis and selection reduced the number of mutations positively identified as radiation-induced in the Bikini "crop" to 60. This sifting was not necessary in the Eniwetok crop, since all the seeds exposed there were taken from stocks at the Caltech Experimental Farm which were known to be free of mutations and to have constant characteristics throughout.

The principal effect in the mutants as a group—in 46 of the 60 positively identified Bikini mutations, for example—was noted on chlorophyll, the green coloring matter of the plant. Many of these mutants showed a mottling or mosaic of normal green with abnormally pale green, yellow or colorless areas, and some were albinos.

The remainder ran the gamut of known mutations and added many more. Virtually everything described previously as a mutation has been picked up in the bomb-exposed material.

In one rather extreme type the seeds germinate prematurely on the ears. Ordinarily, a seed forms on an ear, matures, dries and germinates when it is planted in soil. But in some mutants one in four seeds is abnormal, germinates on the ear, and one hundred or more little corn plants may be grown directly from the ear.

Another type shows its abnormality only by fluorescing in ultraviolet light.

Paper strip chromatography used in studying the type known as Blue fluorescent-1 (found in Bikini progeny) indicated that one of the substances causing the glow under "black light" was anthranilic acid. Another chemical which the researchers found was a major constituent, has not yet been identified. They have learned, however, that it is converted into anthranilic acid by treatment with acid or alkali.

Six more blue fluorescent mutants are known—from Eniwetok and gamma-ray progeny. Three of these are of the first type (Bikini), all showing similar spots on chromatograms. Chromatograms of the other three blue fluorescent mutants showed fluorescent spots different from the first type. Little more is known about these, except that their blue glow apparently is not due to anthranilic acid.

Some of the seeds from A-bomb tests never grow. These evidently were exposed too close to the blast center. The distances from the bomb explosion center at which the seeds were exposed have never been announced by the Atomic Energy Commission. The Caltech findings are reported by lot number as supplied by AEC.

Some seeds start their growth in the soil but lack strength to push through the surface. Some extend only three or four inches above ground at full growth, while others grow naturally and reach maturity—only to have their progeny exhibit peculiar characteristics.

Further studies are being made in virtually all phases of this radiation genetics project at Caltech. Though the research is not designed to produce immediate practical applications, its results are potentially of great value.

"Because of the possible importance of the subject for the future of the human race," says the AEC's *Effects of Atomic Weapons*, "no discussion of radiation injury would be complete without consideration of the genetic effects."

The Caltech findings are helping to close what the AEC publication calls "the large number of gaps in our knowledge which make it hard to arrive at meaningful practical recommendations."

The work is being supported by the Atomic Energy Commission operating through the Office of Naval Research. Dr. Ernest G. Anderson, Professor of Genetics in charge of the Experimental Farm, heads up the project. His colleagues include Dr. Albert E. Longley, Research Associate in Biology, and Drs. E. E. Dale and Howard J. Teas, Research Fellows in Biology.