The knots in the biophilia hypothesis resemble those in other genetic theories of human action. Sociobiologists notice commonalities across societies and historical eras and then leap to genetic explanations. They vastly underestimate learning. For example, probably the most habitual human activity throughout the world today after sleeping is watching television. Should we posit a TV gene? Probably not. Social learning can better explain this nearly universal behavior, as well as the widespread liking for nature scenes.

Genetic theorists have yet more problems with differences among groups or eras. Americans today differ from their great-grandparents as Sierra Club members differ from lumbermen on the environment—and on many other matters, too. These differences cannot be explained genetically, only socially.

And there is perhaps a final irony: Wilson and colleagues want to mobilize people to love and protect nature. Yet they propound a theory that says, put simply, that loving nature is in our genes. Like other theories of predestination, this notion justifies doing nothing. The real leverage for environmental activists lies in understanding the culture of nature-loving—the history of conservation, the social structure of environmentalism, nature ideologies—not its biology. Exploring these ideas might empower bio-activists to mobilize people, to make "biophilia . . . a religion-like movement" (p. 454)—in other words, a product of human culture.

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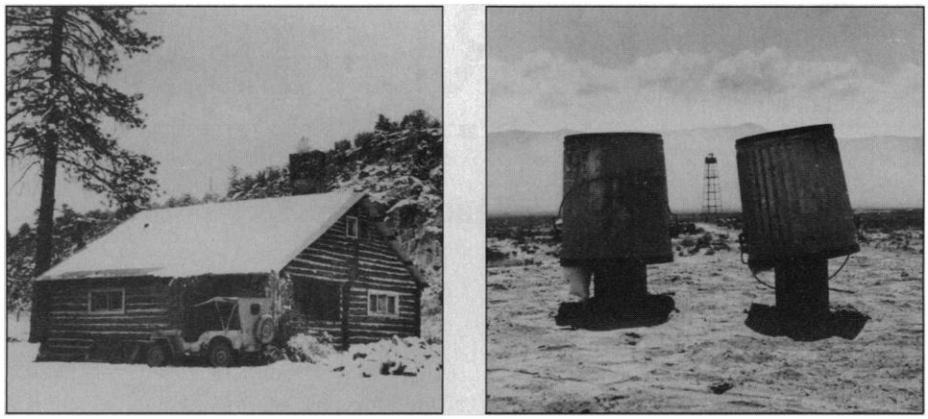
Atomic Science

Critical Assembly. A Technical History of Los Alamos During the Oppenheimer Years, 1943–1945. LILLIAN HODDESON, PAUL W. HENRIKSEN, ROGER A. MEADE, and CATHERINE WESTFALL, with contributions from Gordon Baym and five others. Cambridge University Press, New York, 1993. xvi, 509 pp., illus. $39.95 or £45.

This is the story of the work done during the Second World War at the Los Alamos laboratory, which designed and made the first nuclear weapons. Though the Los Alamos enterprise was not the largest or the most expensive part of the Manhattan Project, it had probably the largest-ever accumulation of scientific talent working under great pressure on a wartime project.



Left, Site of experiments by the spontaneous fission group of the physics research division at Los Alamos. For these experiments the group, according to George Farwell, sought a site with "peace and quiet from electrical and audible disturbances, and shielding from cosmic rays," exploring "caves at the bases of various cliffs . . . that might be easy to dig into" and eventually obtaining the use of this Forest Service cabin 14 miles from the technical area. Photo courtesy of George Farwell. *Right*, View of the Trinity test site near Los Alamos, with the tower positioned at Ground Zero for the July 1945 test of the plutonium "gadget" in the background. "The garbage cans were used to protect equipment from the elements." [From *Critical Assembly*]

Initially the task of the laboratory seemed fairly straightforward. The assembly of a supercritical mass of fissile material, uranium-235 or plutonium, from two subcritical pieces was planned to be carried out by firing one piece at the other inside a gun barrel. This had to be done fast enough to avoid predetonation—that is, a chain reaction starting before the system reached its maximum supercriticality and producing an inefficient explosion. The gun method of assembly was fast enough for this purpose, and this design proved satisfactory for the uranium weapon. Confidence in this design was, in fact, so great that it was used in the attack on Hiroshima without previous test.

This was not achieved without much intensive work. There were nuclear physics problems, including the precise determination of the critical mass for various shapes of the fissile core and for various scatterers surrounding it to reduce the escape of neutrons; an initiator, that is, a source of neutrons that would ensure that the chain reaction would start when the assembly had reached the right stage, had to be designed. The chemistry and metallurgy of uranium and plutonium had to be studied to develop methods of fabrication. The details of the gun mechanism had to be developed and estimates made of the energy released in the explosion and its effects.

So the laboratory needed nuclear accelerators and detectors, state-of-the-art metallurgical and chemical equipment, and much else, in addition of course to a staff with experience in all these fields. But there was no doubt that all the problems would be solved in good time.

When the first samples of plutonium from reactors became available, it was discovered that the rate of spontaneous fission was much higher than expected. This came as a great shock at Los Alamos, because, since a single neutron from a nucleus undergoing fission can start the chain reaction, the time taken by the assembly from the critical point to a configuration of high efficiency had to be shorter than was possible with the gun method, and one had to look for a different method of assembly for the plutonium bomb that was ultimately dropped on Nagasaki.

The principle of a faster method was available in the principle of "implosion," which Seth Neddermeyer had suggested and was beginning to develop. The idea was to surround a spherical shell of fissile material by high explosive and ignite this in many places so as to form a converging detonation wave, which would collapse the shell.

This was an ingenious idea, but making it work proved very difficult. Detonation waves tend to expand rather than converge, and the intersection of expanding waves causes great and undesirable complications. This difficulty was overcome by the use of explosive "lenses," suggested by James Tuck and analyzed by John von Neumann. Detonation waves travel in different explosives at different speeds, just as light travels at different speeds in, say, glass and air. By suitable shaping of the boundary between them one can generate converging waves, just as optical lenses make beams of light convergent. These explosive lenses were successfully developed, but they required much hard work both in calculation and in experimental studies.

It was necessary to start the detonation from several points simultaneously with great precision. This required developing new electric detonators and the electronics to control them.

Even so, the motion of the shell of plutonium turned out to be unstable, leading to ragged surfaces and even jets, which prevented the desired uniform collapse. The remedy was ultimately found in Robert Christy's suggestion to implode not a spherical shell but a solid plutonium sphere.

To deal with all these new problems, the work was reorganized so as to give highest priority to the implosion work. Experts with special experience in relevant areas were brought in, and in the end the implosion method was developed in time to use the plutonium that was arriving from the reactors in Hanford. Because of the complexity of the implosion bomb it was decided to test it in the New Mexico desert. This test took place in July 1945 at the "Trinity" site. This test at the same time confirmed the theories about chain reactions in general.

The book under review is a full account of the history of this work. It is not concerned with life in Los Alamos, and the historical and moral aspects are touched on only briefly in the epilogue. It is all about the scientific and engineering problems and their solutions. It is not a starry-eyed account of the achievement, but the achievement emerges from the facts.

Chapters 2 and 3 set the scene by discussing the events leading to the foundation of the Los Alamos laboratory in 1943. They are not written with the same care as the rest. One is mystified by the title of chapter 3, "The early materials program: 1933–1943." What program could there have been between 1933 and, say, 1940? Indeed, nothing in this chapter happens before 1941. I would suspect a misprint, if this title were not repeated in the table of contents and as a heading to notes. These chapters contain a number of minor inaccuracies.

Generally the presentation is clear and shows the care one expects of the four distinguished authors. According to footnotes, different chapters were written by the authors in different combinations, but they are well coordinated and read coherently.

The presentation can easily be followed by a scientific reader, and a non-scientist will get an interesting impression of the events. The book is organized in sections, each of which covers a specific period of a specific problem. This method has the advantage that it allows the authors to explain the progress of each activity in full detail, but it makes it more difficult to visualize the interplay of the various activities in time. For example, the discovery of the high rate of spontaneous fission of plutonium is reported *after* the reorganization of the laboratory to which it gave rise. The many illustrations, mostly photos from the Los Alamos archives, help to make the book attractive.

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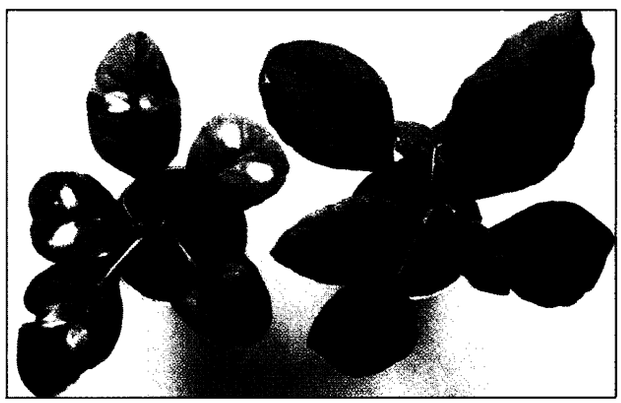
Protecting Plants

Biotechnology in Plant Disease Control. ILAN CHET, Ed. Wiley-Liss, New York, 1993. xvi, 373 pp., illus. $99.95 or £83. Wiley Series in Ecological and Applied Microbiology.

The age of agricultural biotechnology entered the public mind with the image of someone in a "moon suit" spraying genetically engineered microbes on a potato field near Tule Lake, California. This relatively innocuous experiment to reduce frost damage by introducing recombinant DNA ice-minus bacteria into the microflora of potato leaves was a lightning rod for fears about how the new genetic engineering technology might upset the ecology of our crop and natural lands. The transfer of genes into plants from another plant bacterium, *Agrobacterium tumefaciens*, formed the basis of the development of plant genetic engineering. Plant pathogens have thus played a pivotal role in both the development of and the types of applications deemed suitable for agricultural biotechnology. On the eve of commercial availability of recombinant DNA plants, this book provides a timely overview of the current status of the use of biotechnology in plant disease control.



"Disease development on the leaves of tobaccos inoculated with *P. syringae* pv. *tabaci*." *Left*, "Untransformed tobacco plant with chlorotic symptoms at the inoculation sites on the leaves." *Right*, "Transgenic tobacco plant (TAB7) without any chlorotic halo at the inoculation sites on the leaves." [From Yoneyama and Anzai's chapter in *Biotechnology in Plant Disease Control*]

To control plant disease, biotechnologists can either manipulate the resistance of the plant or perturb the ecological fitness of the pathogen. We are able to grow most crop plants intensively on a grand scale today because we have been able to incorporate into them resistance to a number of diseases. The cloning of known disease resistance genes and the identification of novel resistance genes are now considered to be the most promising approaches in plant disease biotechnology. It is envisioned that once such genes are cloned we will be able to pull them from the shelf and rapidly incorporate them into plants as needed. An optimistic and thoughtful discussion of the potential use of cloned resistance genes has been contributed to the book by Keen, Bent, and Staskawicz. It is generally thought that resistance genes function by encoding membrane receptors, which after binding of signal molecules, such as elicitors, induce host defense responses. Since the response mechanisms are likely conserved between plants, it is hoped that the receptor proteins, or resistance genes, could function in any plant attacked by a particular pathogen. Initial findings on the functioning of resistance genes have not provided support for this theory, however. The first resistance gene to be cloned, the *Pto* gene of tomato, encodes a protein kinase, a type of protein that normally functions in signal transduction rather than agonist binding. The *Hm* gene of maize appears to neutralize a pathogen-produced, host-specific toxin.

Single-gene resistance to disease is probably more of an exception than the rule in nature, and genes that confer strong resistance against many of the most damaging pathogens have not yet been identified. Interest in identifying novel resistance genes is strong, and much of the book is devoted to describing progress that has been made in this regard. The first recombinant DNA plant that will become commercially available will be one with a novel resistance gene: a gene encoding the protein coat of a virus. Why such genes provide resistance against some viral diseases is not known. Genes encoding small peptides with antimicrobial properties, enzymes that degrade fungal cell walls, toxin-degrading enzymes, and viral proteins have each been transferred into plants; various chapters of this book discuss the promise of such genes for