require the cooperation of college science departments, departments of education, and the state agencies that certify the teachers. I believe that our state departments of education and our colleges of education will be more than pleased to have the cooperative assistance of the scientists of our colleges and universities, in their attempt to improve elementary and secondary instruction in science. We scientists should find out just how we can assist in bringing about this desirable result, each in his own locality. Let us exercise a spirit of research and base our actions on the facts which the public school teachers and administrators will be only too glad to supply. Improvement cannot go far until teachers with appropriate training are available.

If science is to receive adequate attention in our educational structure, it must receive the general support of the voters, including especially our state and local lawmakers and officials. Adequate support is not likely to be obtained until citizens have much more information about science than they have at present. This, in turn, is not likely to be achieved until science is taught by reasonably competent teachers throughout our elementary schools and high schools. Is it not a most important proper function of college scientists to supply appropriate courses in science for prospective public school teachers? Why not attack the problem immediately in your own college?

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Age of Folsom Man

IN 1950, a Texas Memorial Museum party made excavations in valley fill near Lubbock, Texas, where five superimposed, fossiliferous, late Quaternary strata are present. From the next to oldest of these strata, a diatomite horizon, charred bison bones were obtained and submitted to the Institute for Nuclear Studies, University of Chicago. The radiocarbon test on the charred bones gave an age determination of 9,883 ± 350 years (Libby, letter of Dec. 8, 1950). Excavations at the locality were continued during the summer of 1951, when additional occurrences of burned bones were observed in the diatomite horizon, and in this deposit also were found four Folsom projectile points, one small scraper, and numerous flint chips. Of the projectile points, two were complete and two broken. Each of the four points showed distinctive Folsom fluting. The upper and lower boundaries of the diatomite horizon are definitely marked, and there is no question but that the Folsom artifacts and the charred bones are in the same horizon in the section and are of the same age, proving that Folsom man hunted the bison at this place about 10,000 years ago.

From a gray sand stratum next underlying the diatomite, one artifact was found, a combined scraper and graver, or a scraper subsequently reworked as a graver. This older artifact may represent a culture older than Folsom, which has been found at a similar position in the section in the Clovis-Portales area in New Mexico. The excavations at the Lubbock and Portales localities were carried on under direction of Glen L. Evans. The conditions in New Mexico were briefly reported by the writer at the 1950 meeting of the Geological Society of America (*Bull. Geol. Soc. Am.*, **61**, 1501 [1950]).

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Selective Application of Selective Herbicides in the Study of Vegetation Development

THE successional stages in the development of vegetation have been one of the chief—and most fruitful—fields of inquiry for American plant ecologists. Changes of vegetation with time, as on abandoned agricultural lands and sites subject to natural catastrophes, and the spatial belting of plant communities in bogs and swamps, have provided basic data for the formulation of hypotheses and theories that are now firmly—perhaps too firmly—entrenched in our thinking.

The study of this aspect of vegetation development has been furthered primarily by the use of permanent charted quadrats that are periodically checked, and by the assumption, sometimes but not always valid, that communities of different growth forms—as grasses, shrubs, and trees—are necessarily related to one another in a temporal sequence, especially when they occur in parallel belts, as along seacoasts and riverbanks.

The study of vegetation development on abandoned agricultural lands at Aton Forest, Litchfield Co., Conn., dates from observations and photographic records of 1927. It early became evident that "plant succession," although apparently normal for the Northeast, was not progressing in the conventional manner. For a period of six years, 1946–51, the selective application of selective herbicides, applied intensively to a total of 40 acres, has been yielding results of considerable interest. In view of the fact that, so far as the author is aware, others are not using herbicides for this purpose, this note is presented to stimulate basic research elsewhere.

The most critical phenomenon in any succession of plant communities is that of "invasion," involving migration of the propagule, germination, and successful establishment of the young plant. Too often the stage of invasion of a species has been assumed by its physiognomy. Thus, trees are assumed to have invaded shrubs when both are found together; and shrubs to have invaded grass when together. An alternative working hypothesis is that species of diverse growth form may have invaded a particular site at the *same* time, and that the present mixed communities may be the result of differential height growth, and of fortuities in the distribution of individuals. Evidence pro or con can be obtained by carefully removing all the individuals of selected species,

with observations on subsequent *re*invasion. The only technique available in earlier years was physical removal with shovel, mattock, or axe. The procedure was a failure in that pieces of rhizomatous or root-suckering plants were invariably left in the soil, new seeds were planted, bare inorganic soil was exposed, and the plant community ceased to be the one originally under investigation.

Herbicides now afford a "tool" of extreme value in this field of research. Various formulations of 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) are available commercially. Most broad-leaved and coniferous plants are sensitive to them; grasses, ferns, and certain rhizomatous plants are resistant. With a knapsack sprayer equipped with a nozzle of low output, or using an oil-can, squirt gun, paintbrush, or one's fingers, a high degree of selectivity in application can be effected. Even with a knapsack sprayer one can basal-spray a tree or bush, and leave unharmed a plant 6 in. away. The chemicals are organic compounds that disintegrate in the soil in a matter of weeks or months, leaving no known residue. In the six years of application at Norfolk, no cumulative adverse effect has yet been noticed in the treated vegetation. In short, the selective application of selective herbicides allows one to pin-point out all individuals of most unwanted species, with apparently no ultimate physical or chemical changes in the soil, and with the rest of the plant community undisturbed.

Evidence now available from the author's study of vegetation development with the use of chemicals is sufficiently unprecedented to merit tests of this technique by others. For example, following local elimination of over 100 species of plants, reinvasion is resulting in a subsequent development totally different from that anticipated. Among the 70 kinds of woody plants eliminated, fewer than five give any evidence of staging a significant comeback even in the more open of the covers, and those five are returning in different proportions than they originally held. The significance of these phenomena for forest, range, wildlife, and other aspects of land management is worth critical consideration. They open up new vistas for research and development on the conversion to, and low-cost maintenance of, plant communities of all kinds, including those that are critical in the conservation of our natural resources.

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Book Reviews

Laboratory Design. National Research Council Report on Design, Construction and Equipment of Laboratories. H. S. Coleman, Ed. New York: Reinhold, 1951. 393 pp. $12.00.

If Stone Age man were to sit in judgment on our twentieth-century civilization, he might well be confounded by the seemingly endless operations involved in picking up the rock and hurling it at the charging beast—and, after the felling of the critter, by the long sequence of doings that delayed the meal. But, regarded in terms of result, this magic that is science would no doubt capture his imagination and command his attention.

There is no doubt about the wholesome respect for value that has directed the National Research Council and Mr. Coleman to so commendable an effort as publication of *Laboratory Design*—not to mention the research activity that forms the basis for the volume. Not only is there evidence of far-ranging and careful application to detail; there are clear signs of constant attempt at integration. In a field of endeavor that stretches so wide and deep, such fruitful means as the economical module of laboratory space and the standardized components of equipment are valuable contributions. These devices and yardsticks, born of the urgencies of science, attest to the concert of action and indicate a concern for end product. In this propitious climate, it would nevertheless seem appropriate for architect Roland Wank to warn, *as he does* in his introduction, against possible overconcurrence—and to speak for new approach when change and new discovery have reduced old systems to irrelevance. Perhaps, however, neither Mr. Wank nor the other contributors have placed enough stress on the role of the architect. Or perhaps there have been enough words; however, the majority of the buildings shown tell a story of arbitrary limitation. Meaningless bilateral symmetry, forced façade, insipid ornamentation, stand in the way of full realization. The factor of environment has been neglected. There has been but little brought forth that illustrates atmospheric quality of a space. There seems to be scant awareness of the need for the pleasant and the inspiring; little regard for the welfare of these humans who work for the general welfare. But these are the faults of the architects. They are the ones whom vision must lead to a deeper comprehension for this synthesis. This volume could have benefited from a more judicious selection of architecture.

Presentation is designed for easy reference—a refreshing change from the majority of factual publications. However, the book does not rise to the possibilities inherent in so colorful a realm. Where is there reflected the daring, the adventure, the beauty, of precise circumstance? Why should not typography, photograph, word, and drawing reveal the potencies and dignities of science? This failing seems to be part of a pattern of behavior that endures life in a medium-