were analyzed by measuring the intensity of the blue color produced upon heating with ninhydrin solution (*4*). Ammonia nitrogen was determined by the classical aeration procedure. The use of barium hydroxide for removing the amino acids from the resin would probably cause large losses of any ammonia present; therefore, the ammonia nitrogen of the resin hydrolysate was determined by aerating a hydrolysate in which the amino acids were removed from the resin by use of hydrochloric acid rather than barium hydroxide. Basic amino acids plus humin were determined by phosphotungstic acid precipitation followed by Kjeldahl determination for nitrogen.

The analyses of the two hydrolysates are shown in Table 1.

By using the method of Graham *et al.* (*5*), the tryptophan content of the coffee protein was found to be 1.7%, thus accounting for an additional 0.93 mg of nitrogen in Table 1. Tryptophan is destroyed by acid hydrolysis or by refluxing with distilled water; hence it was not found in either hydrolysate. No hydroxy proline was found using the method of Newman and Logan (*6*). Using paper chromatography techniques, only a trace of tyrosine was detected, and arginine, histidine, and lysine were shown to be present.

It may be observed from Table 1 that ammonia nitrogen is slightly higher for the HCl hydrolysate, indicating perhaps more degradation or deamination in this procedure. Furthermore, a notably low glutamic acid value was obtained in the resin hydrolysate, and some of the others tend to be slightly low when compared with the HCl hydrolysate. It is probable that the glutamic acid in the resin hydrolysate formed pyrrolidone carboxylic acid (*7*). This acid might tend to form salts with the other amino acids and thus interfere with the chromatographic separation. That the low value of glutamic acid in the resin hydrolysate was due to pyrrolidone carboxylic acid formation is borne out by the fact that upon treatment with HCl, glutamic acid appeared in the resin hydrolysates in an amount comparable to that found in the original HCl hydrolysate.

Using commercially available vitamin-free casein, resin hydrolysates have been prepared by the above method. On evaporation, a crystalline, almost white product is obtained. This material readily dissolves in water and will serve as the sole source of nutrients for many microorganisms at 0.5% level. The resin hydrolysis of casein may be hastened by the use of a small amount of HCl. For example, 6 g casein, 30 g Dowex-50, and 600 ml 0.05 *N* HCl, or 60 g casein, 300 g Dowex-50, and 1700 ml 0.1 *N* HCl, show no biuret reaction after 48 hr.

The method of hydrolyzing proteins by the use of ion exchange resins shows considerable promise as a technique in the study of proteins. Recent studies using casein have shown that there may be some simple peptides present in the resin hydrolysates; however, indications are that the method gives nearly complete hydrolysis of the proteins studied. Work is continuing on the characterization of other proteins and the optimum conditions for carrying out hydrolyses using Dowex-50 and other resins.

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Manuscript received August 29, 1951.

Comments and Communications

Teacher Training

In the United States as a whole far too little attention is given to training teachers of science. This is true of the teachers in the grades who must conduct science study periods, of "general science" teachers in junior high schools, and of teachers of physical and biological science in high schools.

This communication is not a plea for more national committees to prepare more excellent reports, which will be studied by too few of the right people and which will probably be acted on by almost no one; rather, it is a plea for the scientists in each college and university to act now. Fortunately, there are appropriate actions that can be taken and that will not entail great expense.

Relatively few of our colleges and universities have adequate teacher-training programs that provide *suitable* courses in science. The usual beginning course in a natural science is almost certain to be aimed at the production of more specialists in that science. To get a broad training in science, the prospective teacher would have to complete at least 30–50 semester hours of such first-year college courses. In addition, the teacher of senior high-school science should specialize in the particular science he or she plans to teach.

To expect such extensive training of our public school teachers is entirely unrealistic. The relatively low salary scales have attracted an entirely inadequate supply of students into teacher-training programs. The immediate problem that needs our attention is how to provide training in science for students who are now preparing to become grade and high-school teachers. This problem may be broken down into two different questions: How can we provide broad science training for the prospective grade school teacher? and How can we provide training for the prospective high-school teacher who may teach both "general science" and a specialized senior high-school science? The standard first-year college courses in the fundamental sciences have not been sufficiently successful in providing the requisite training.

In meeting their responsibilities to society university scientists have three continuing duties: (1) As students they must continue to increase their knowledge of science; (2) as research workers they must advance science and make practical applications of it; and (3) as teachers they must transmit science to the next generation and train future teachers of science. The first duty need not be discussed here. Unfortunately, all too often the second is given so much emphasis that the third is almost entirely neglected. And this attitude often evolves from the practical point of view taken by the scientist—he emphasizes those activities he believes the university administration considers most valuable when awarding increases in rank and salary.

Actually duties No. 2 and No. 3 are of equal importance to society. To argue otherwise would be like arguing that, for the production of power by a steam engine, the water in the boiler is more important than the fire under it. Duty No. 3 involves research in the methods of, and on apparatus for, transmitting science to future generations. The scientists in each major branch of science must take an active, vigorous part in the solution of the problem of training its teachers and of developing its teaching methods and equipment. This must be done for our public schools, as well as for our colleges and universities.

It is important, therefore, that each fundamental science department have on its staff at least one high-ranking member who devotes his time to the study of teacher-training problems, to research in methods of, and apparatus for, instruction, and to the communication of his findings to future teachers of science.

Society is demanding that our school children receive some instruction in science in every grade from one through nine. The director of elementary education in the New York State Department of Education has stated, "Next to reading, science is the most important subject." Since only a fraction of the children who complete high school ever go to college, it is essential that several courses in biological and physical science be offered for senior high-school students, and this cannot be done without teachers trained in science. We scientists, in our respective colleges, must plan and offer *suitable* courses in science for public school teachers at appropriate levels of difficulty and completeness. In addition, appropriate courses in the methods of presenting science subject matter and of obtaining and using the necessary teaching materials must be organized and taught on a cooperative basis by *suitable* staff members in the science departments.

The plight of physics in the high schools of the U. S. today is indicated by the recent change in the rules governing admission to the U. S. Naval Academy—training in physics is no longer required. Without doubt this admittedly undesirable change was made because so few high-school students have an opportunity to study physics. One of the most important causes of the scarcity of physics courses has been the lack of available teachers. Public school officials have not been able to find persons with even a bare minimum of proper training to teach the subject, because the number of physics graduates is rather small and industry has been able to monopolize the supply by offering much higher monthly salaries for all twelve months of the year.

Perhaps physicists and chemists should take their cue from botanists and zoologists, and assist in the adoption of a recognized course in "general physical science" for the high schools, corresponding to the usual course in "biology." Why should the college physicists and chemists not encourage such a move? It is not a question of physics (or chemistry) *or* "general physical science;" rather, it is a question of "general physical science" or no course at all in any physical science in senior high school. Such a general physical science course would be somewhat less advanced than either a physics or a chemistry course; it would require less expensive apparatus, and it could be taught successfully by a teacher who has had somewhat less specialized training in physics or chemistry. In the large high schools students could even be given a choice of "general physical science" and physics and/or chemistry.

It is useless for scientists to stand on the side lines and criticize present grade- and high-school science teaching, or the lack of it, without making concrete, *practical* suggestions for improvements, and without making such changes in our college offerings, entrance requirements, and degree requirements as are necessary to achieve the ends in view. In planning action we must remember that the high school is not primarily a college preparatory school; only a fraction of its students enter college. We must also remember that all children below a certain age *must* attend school; this is the law of the land, and it prohibits flunking the lower third of the children out of school. And, most important of all, we must not forget that all of them will soon be voters.

Compulsory school attendance brings into the upper grades and into high school children with a tremendous range of native abilities. A recent Associated Press story quoted Arthur S. Adams, president of the American Council on Education, as saying that a score of 70 on the new Selective Service aptitude test will be made by "only about one sixth of the general population, or about half of the college freshmen." Thus, in comparison with public school pupils, college freshmen are, on the average, a very able group of people. These facts must be kept in mind when a practical course of action for improving science teaching in the public schools is being planned.

Providing teachers who have had appropriate training in science for our grade and high schools will 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,