Chemistry in the Education of a Forester*

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INTRODUCTION

The sciences of physics and chemistry are concerned with the phenomena of the physical world, i. e., with all the materials and energies of the universe. The boundaries of these two sciences merge, and, in their broader aspects, they may be considered as one. Today physics is generally considered as the science of matter, involving no chemical changes Chemistry is concerned with the composition of substances and of their transformations. Chemistry and physics are, therefore, basic sciences whose laws and principles extend inexorably through all other natural sciences.

Living organisms are peculiar and uncommon (in a universal material sense) aggregations of materials. Their existence and behavior is governed and motivated by physical and chemical laws. Every cell and every organization of cells is a most delicate and intricate chemical-physical laboratory. The internal physical and chemical phenomena of living organisms, such as colloidal surface reactions, diffusion, capillary flow, organic synthesis, and delicate catalytic reactions are influenced by external physical and chemical factors such as temperature, light, wind, gravity, water, other living organisms, and the soil. Since a forest is a very complex association of trees, other plants, animals, and micro-organisms, the effect of external factors and of competition is most complicated on a forest community.

The problems with which forestry deals are highly diversified and require a broad basic training in the natural sciences, mathematics, surveying, and economics. Forestry is an applied science based on chemistry and physics, the botanical sciences, soils and geology, and zoology. Of the foundation studies for forestry none is more important than chemistry. A very excellent and concise statement on this subject is given by Graves and Guise[1] in their book on "Forest Education." I quote directly:

> "It is unnecessary in this report to discuss the reasons for providing instruction in chemistry and physics, either from the standpoint of general education or in preparation for the subsequent courses in forestry. The subjects are basic to all study of science. Our knowledge of the natural phenomena with which we deal in forestry in the final analysis is based on chemistry and physics. In these subjects the student is brought into contact with fundamental facts of nature, and he is given training in accurate observation, in the method of analysis, and in reasoning from observation. The acquisition of knowledge of direct service in technical work in forestry, the acquaintance with the profound truths of science that enables one to understand better the world about him, and the training in scientific method are all of importance in a preparation for the profession of forestry. These facts are generally recognized by the forestry schools."

NEED FOR CHEMISTRY IN THE PRACTICE OF FORESTRY

Although the reasons for instruction in chemistry as a preparation for forestry may be generally recognized, there is, nevertheless, considerable difference of opinion as to how much chemistry should be required and how it should be taught. Is one year sufficient or are more desirable? Should

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chemistry be taught to foresters in a thorough fundamental course as is required for majors in chemistry, or is general survey course more desirable?

Before answering these and other questions, let us examine the need for chemistry in the practice of forestry and in the education of a forester.

As Basic Education.

One of the objectives of education is to give the student a better comprehension of the world about him. Chemistry (and physics) acquaints the individual with the fundamental concepts and laws of nature. It gives him a better understanding and appreciation of the world of which he is a part. Therefore, chemistry should be an important part of any scheme of higher education. A law professor recently stated that chemistry should be included in the law curriculum, because many of the industrial and other cases which come up involve chemistry, and if the lawyer has no ability to understand and evaluate the chemistry involved, he is severely handicapped.

Now forestry is an applied science based on the natural sciences, including chemistry. Furthermore, chemistry is basic to all natural science. Chemistry, therefore, should be a part of the basic training of all foresters. It may be further argued that the training in the techniques of observation, analysis and reasoning obtained in chemistry are of vital importance and value to a forester.

In Silviculture.

The practice of silviculture is based on a knowledge of botany, particularly dendrology, ecology, and physiology, on pathology and entomology, and on geology, soils and meteorology. Training in the principles of chemistry is essential for a porper understanding of physiology, ecology, and soils. The chemistry involved in the growth and life processes of trees, the effects of environment on the biochemistry of the tree, and the chemistry of the soil and its relation to nutrition, growth, and the character of the stand are all essential to the intelligent practice of silviculture. The chemical composition of the soil has a very important, but as yet little understood, effect on the growth of trees and the nature of a forest. Certain chemicals are essential to growth, others have been recently discovered which, when added in exceedingly small amounts to the soil, greatly stimulate growth and even change the behavior of the trees.

The chemical changes taking place in humus, the effects of thinning, logging, and fire on the chemistry of a forest are other important factors to consider in silviculture. A more simple yet important application of chemistry to silviculture is the treatment of seeds by certain chemicals to hasten and stimulate germination.

It is not expected that every forester should be a specialist in soil chemistry or physiological chemistry, but he should know sufficient chemistry to understand, interpret and apply chemical data and make simple observations.

In Forest Protection.

In protection from fire, physics is more fundamental than chemistry. A knowledge of the effects of temperature, humidity, and other meteorological factors on the inflammability of duff are a direct application of physics. Chemistry, however, may play a part in fire control in the future. For example, chemical sprays might be used to check or retard fires. A recent article by H. R. Offord and R. P. d'Urbal[3] contains a discussion on the use of chemicals in burning wet brush piles. This holds interesting possibilities for controlled slash burning.

In forest pathology, a knowledge of chemistry is necessary for an understanding of the action of fungi and

other parasites on wood or other tree tissues. Control measures involve the use of toxic chemicals in many cases.

In Forest Utilization.

Wood is an organic tissue produced by biochemical processes from air and water. The soil furnishes the water and various essential catalytic chemicals. Wood is a very complex chemical substance, and is an important raw material for chemical industries. From wood there are manufactured by chemical processes pulp, paper, fiber boards, textiles, cellulose wrappers, plastics, solvents, acids, tannin, preservatives, charcoal, oils for paints and as chemical solvents, and many other useful commodities.

Chemical utilization of forest trees is an important part of forestry and will undoubtedly increase in importance in the future. The theoretical or laboratory possibilities for further practical developments in chemical utilization are most promising. Much research is being done over the world in wood chemistry. Since chemical processes deal with the minute units of wood, the fibers, the colloidal particles, and the molecules, wood wastes should be ideally suited for utilization by chemical means. A number of lumber companies and lumber associations are interested in the chemical development of by-products from their mill wastes and are surveying possible research programs. At least two companies in the West already have research laboratories and chemists working on waste utilization problems.

In the large and important field of preservation of lumber and timber products, a knowledge of chemistry is essential.

It is evident that chemistry is of vital importance to the specialist in utilization, even to the sudent who goes into commercial lumbering. The general forestry student does not need the detailed knowledge of wood utilizationist, but he should have sufficient knowledge of chemistry to understand and appreciate the problems and new possibilities of utilization of the forest.

In Forest Research.

Practical forestry must build on research. In fact, research should always be ahead of forestry for otherwise practice must move by rule of thumb, and such blind practice is frequently costly or even disastrous. Research is a large and important branch of the Forest Service and many other institutions are carrying on technical and scientific forestry research. Such research, to be carried out intelligently, must be done by men with thorough training in their specialties and with broad fundamental training in the sciences basic to forestry, among which chemistry is important for reasons already given.

In Forest Management.

A knowledge of chemistry is no criterion for a successful forest manager. But, nevertheless, a forest administrator who has a general understanding of chemistry is better able to appreciate and interpret certain data and problems with which he may have to deal. He will be in a better position to understand and apply the results of research work to the practical management of his forest areas.

NATURE OF TRAINING IN CHEMISTRY

The need for basic training in chemistry for foresters is apparent. However, there is considerable difference of opinion with respect to the nature and extent of chemistry courses necessary for foresters.

With the exception of certain specialized curricula, such as wood utilization, we cannot expect to teach more than the elements of chemistry. The usual requirement in most forestry schools is one year of general chemistry. In most cases, this general chemistry course is

the same for all groups of students, i. e., foresters, engineers, science majors, and others. In principle, this is as it should be. I shall elucidate this point.

Foresters, after graduation, go into a diversity of jobs. In some of these jobs, the value of chemistry may not be immediately apparent. In others, particularly in research, a knowledge of chemistry at once becomes useful. Some graduates train to become specialists, either by self-study and experience or by graduate work. Therefore, the undergraduate work in chemistry must be such that it gives the general forest production student sufficient understanding of the subject for the intelligent practice of forestry, and will also enable him to build onto this work without loss later on if he wishes to specialize. This means that if only one year of chemistry is required, as is usual, no more than the elements and basic principles can be taught, but this should be taught thoroughly. A special course for foresters (meaning usually a simplified course) or a general survey or laymen's course is undesirable and inadequate both in the subject matter taught and in the scientific methodology learned.

One year of chemistry is the barest minimum of preparation for a forester. Additional courses in analytical and organic chemistry would be very desirable preparation for studies in physiology, ecology, forest soils, and silviculture. However, the forestry curriculum is already so crowded with essential material that this is impossible. Instead of the standard second and third courses in chemistry (analytical and organic), a better arrangement might be to design a second year of chemistry for foresters to give them some understanding of organic chemistry and plant chemistry. At Idaho a second course of one semester duration was designed for agricultural students. In involves the elements of analytical and organic chemistry. We are now requiring our forestry students to take this course. A half-year course in plant chemistry should follow this. Such an arrangement would extend and apply the fundamentals of the introductory course to the chemistry of the tree. In a five-year curriculum, it would be possible to include these courses.

In discussing the deficiencies of forest education, Graves and Guise[1] point out that the most significant criticism by those best qualified to form a judgment is the lack of thoroughness in fundamentals. They also point out that many graduate foresters feel that their basic work was of little value. Analysis indicates that the trouble lies not in the inclusion of fundamentals and of the theory and principles of the subject, but lies in the fact that the work was not thorough or the training was poor in quality, or the student himself failed to take advantage of the opportunities offered by the school.

Our introductory fundamental science courses are, unfortunately, frequently deserving of criticism. More unfortunately, this criticism often results in a weakening of the course by curtailing theoretical work, emphasizing practical examples, and generalizing by teaching the subject as a survey course.

A common fault in the teaching of introductory chemistry and physics is that in the attempt to cover the ground, a great mass of factual information is handed out. This is because these subjects have expanded greatly in recent years and the instructor fails properly to organize the material. The student, even a good one, may fail to assimilate it and his mental powers are certainly not stimulated. Warren K. Lewis[2] of the Department of Chemical Engineering, Massachusetts Institute of Technology, in discussing the education of engineers, point out that students who are trained

in the above described manner " . . . have grandiose concepts but cloudy notions of their relations to the facts. Many a graduate student, who will talk glibly of the third law of thermodynamics, is unable to give any idea of the nature of energy or the reasons for assuming its existence, or will define temperature as what the thermometer reads." In other words, as Lewis points out, the acceptance of any of the knowledge taught is an act of faith and not an intellectual appreciation of its background and meaning.

A course in chemistry—or in any science—should be so taught that the student grasps the logic of the development of the scientific laws and principles from the facts presented. The logical development of theories from known facts given the student teaches him not only the facts and theories and the limitations of the theories, but trains the student to think logically along scientific lines. It develops analytical and creative thought which is important in meeting new problems in the profession.

LITERATURE CITED

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A Preliminary Report on the Eocene Flora From Franklin Butte, Oregon

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Outcrops of a sandy shale on the west and south sides of Franklin Butte have yielded an Eocene flora of approximately 25 species. The majority of the specimens are leaves of angiosperms with *Sequoia langsdorfii* the single gymnosperms. Among the angiosperms are some genera found in the modern temperate forests, as *Amelanchier, Ribes, Tilia* and *Vaccinium.* Other genera, as *Laurus, Ilex* and *Tetracera* are warm temperate to subtropical in distribution. Such an association probably indicates a warm temperate climate, not a subtropical one, with abundant rainfall and no frosts.