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THE DEVELOPMENT OF SCIENTIFIC RESEARCH IN THE SOUTH[1]

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FROM the very start of colonization on the Virginia Coast at Jamestown in 1609 and from even the occasion of the explorations of DeSoto in 1539 or La Salle in 1687, the fundamental bases underlying the settlement of the South in its various areas have been precisely different from those responsible for the colonization of New England, the settlement of the Middle West or the migration to and the building up of the far western sections of the United States.

We begin this treatise on the "Development of Scientific Research in the South" with such a statement because of the belief that a study of the historical background of the South in contrast to the historical backgrounds of other sections of the country is entirely essential to an understanding and appreciation of the trend of the South toward the solution of its numerous problems through the application of science. To discuss such a subject as research development requires previously a knowledge of educational conditions, of political influences and of industrial tendencies, since conditions in the South as regards these aspects were precisely unique.

In reality the South should not be considered as a homogenous unit inasmuch as the manifold reasons for colonization and growth of its many subdivisions were wisely diverse. The individual states came into being under considerably variant circumstances, their educational institutions under equally different influences, but withal it may be said that whatever the original manner of territorial settlement, growth or advancement the Civil War served as perhaps the most powerful factor to effect homogenizing of political thought, educational progress and industrial activity.

[1]The address of the retiring president of the Alabama Academy of Science, Birmingham, Alabama, March 11, 1932.

The ante-bellum South had no system of public schools such as that of New England or of the more recently settled sections of the country. Its first public-school system began in the days of the reconstruction, although certain of the Southern states had provided earlier in their administration for public instruction. More often the sons of the more wealthy planters, after being provided with a very moderate amount of training, returned to administer plantation affairs instead of continuing their training through academies or Northern colleges.

While the higher institutions of learning in the South were with some exception established through periods comparable to those during which the corresponding institutions in the North were begun, the progress made in their development was many times retarded. Student attendance and financial support retarded the foundation of chairs in the sciences. Training in scientific subjects in particular was put off—even if regarded with favor—in preference to subjects which might be taught without costly equipment or special facilities.

Washington and Lee organized in 1749, the University of Georgia in 1785, Washington and Jefferson in 1787, the University of Tennessee in 1794, the University of Virginia in 1819, the University of Alabama in 1831, Tulane University in 1834, Duke University in 1838, Louisiana State in 1860, the University of Kentucky in 1865, Alabama Polytechnic Institute in 1872, Vanderbilt University in 1873, Georgia School of Technology in 1888 and the University of Florida, organized in 1905, were much slower in development of the sciences than were Harvard University, established in 1636, Yale in 1701, Columbia University in 1754 or Massachusetts Institute of Technology in 1861. There were many reasons to account for the substantial difference in progress of Southern colleges as compared to Northern colleges. Some of these may be traced to the different degree of development of the communities, to financial difficulties, to difference in states of industrial attainment and to precisely different pursuits followed by the inhabitants of the respective territories.

Whatever be the reasons for the slowness in the development of scientific departments in educational institutions they had a telling effect upon the rapidity with which science was applied to the advancement of industry. To be sure, the political problems with which the South was faced during and after the reconstruction were many. The first trend after the war was to return to agricultural pursuits, but gradually movements developed toward greater and greater utilization of the various Southern natural resources. Manufactures increased, using raw materials throughout the South, and with the advent of manifold processes came the demand for further knowledge for the improvement of products, for the establishment of new products and for the study of new methods of manufacture on the part of industry. These demands of industrial progress made distinct requests for assistance from chemistry, physics, medicine, geology, mining engineering, electrical engineering and chemical engineering. All these factors had important influences upon the general attitude of the inhabitants of the Southern states in regard to education and particularly toward higher education and the opportunities which it afforded in industrial endeavors.

Research, in the sense in which we use the word today, does not find a place until a status of higher education has been made possible. Scientific research in particular, hardly without exception, demands the expenditure of considerable money. The services of scientifically educated individuals are required. To provide these requirements took the South many years, even after the advances of the sciences of medicine, chemistry, mechanics and allied fields were sufficient and available to human knowledge in this country. It was necessary to send her prospective educators to the Northern states or abroad for graduate work and to augment her faculties of higher institutions with men native to the North.

It was necessary to provide facilities for the basic training of its students in the sciences. Considerably long periods have been required for her educational institutions to assemble funds for the customarily expensive equipment for research. Time was demanded also to grant vision as to the problems to be solved. To-day there is being conducted a great deal of scientific research in the South in educational institutions. Three hundred and seventy-six researches are under way at thirty-one of the larger colleges. It is by far at these larger centers that the predominance of investigations exists, since forty-six of the smaller schools have but thirty-one problems in progress of solution. Thirty-five of the Southern educational institutions have no scientific researches at all under consideration, although it is much in evidence that many of these institutions are paying a considerable amount of attention to technical investigations, though lack of enthusiasm or encouragement, lack of buildings or equipment and lack of library facilities handicap the efforts made.

The South is blessed beyond any other section of the country by its temperate climate, its abundant rainfall, its many raw materials of industry and its excellent facilities for all varieties of transportation of industrial products to the wide world. During the last thirty years increasing attention has been paid to development of raw materials into finished products

of much value. Although starting the race of industrial development much later than the other sections of the country in the last years, the South has produced 12 per cent. of the value of manufactured products of the United States, 22 per cent. of the value of mineral products and 28 per cent. of the value of agricultural products.

To say that scientific research did not have an important part to play in this remarkable recovery and sterling advance to a status of industrial prominence would be to omit paying homage to a powerful and effective servant. The recent development of the sciences in the South has not been confined to the mere transplanting of chemical or other scientific processes developed elsewhere to this virgin industrial soil. New things have been accomplished, examples of which are to be found in the naval stores industry, the electrochemical field, the agricultural field, the progress made in the utilization of various clays, blast-furnace slag and minerals, the advances made in paper manufacture from long-leaf pine, the utilization of by-products of the cane-sugar industry, the utility of by-products of the cottonseed and the endeavors that have been made in applying science to natural gas and petroleum. No better way of emphasizing the importance of some of these attainments could be adopted than to permit a few scattered examples of research accomplishment in industrial fields to speak for themselves.

RAYON

Rayon is a radically new textile material, having chemical and physical characteristics entirely different from silk or cotton. Natural silk is an animal fiber produced by certain worms and some spiders. The process of fiber development is long and tedious and consumptive of much material. Worms consuming one ton of mulberry leaves produce only twelve pounds of silk fiber. To produce an "artificial silk" having near strength, beauty and softness of the real silk induced scientists to search into fields offering satisfactory forms of cellulose. To the chemist, cellulose, whether obtained from cotton or wood, is an alcohol similar in type to glycerine. If we treat cotton with nitric and sulfuric acids we obtain cellulose nitrate. This cellulose nitrate, when dissolved in suitable solvents, produces a solution which can be forced through a metal or glass die containing a number of fine holes. On removing the solvent, fine, thread-like filaments are produced. If next the nitric acid radical is removed cellulose in the forms of fine filaments follows. These filaments can be twisted together to form rayon thread. Acetic acid may be substituted for nitric acid to produce by still another process a cellulose acetate rayon which differs from the nitrate rayon by being inflammable. A third method, the cupra-ammonium process, produces cellulose threads by a still different procedure.

At the present time approximately 33,000 tons of cotton linters is consumed by the combined rayon industries of the South, as well as approximately 65,000 tons of sulfite wood pulp, 145,000 tons of 50° Be sulfuric acid and 105,000 tons of caustic soda. All necessary materials are produced in close proximity to the rayon plants. Over one half of the rayon made in the United States is manufactured in the South, specifically in Tennessee, Virginia, North Carolina and Georgia.

PAPER

The paper industry in the South can be traced back to 1744, when a plant existed in Virginia. North Carolina had a mill at Salem in 1766. South Carolina, Tennessee and Kentucky were locations of paper-making establishments about the same time. These small establishments, however, used only certain small amounts of hard woods.

Within the last ten years research developments have shown it possible that a very satisfactory kraft paper may be made from the very widely distributed long-leaf Southern pine. Within this period operations were developed which lead the way to approximately 13 per cent. of the consumption of pulp wood in the country being produced in the South yearly. Kraft paper is made in great quantity in Florida, Louisiana and Alabama for bagging, wrapping papers and many miscellaneous uses. The heavy brown, resinous character of this pinewood pulp renders it unfit for the manufacture of white newsprint. Methods are now in process of trial which are expected to bleach out the undesirable color, and it may be that we soon may expect to read our daily Southern newspapers printed on bleached pulp from the Southern long-leaf pine. Not only does the low cost of these long-leaf pine pulps present an attractive possibility for Southern industry, but considering the fact that rapid all-year growth permits reforestation to continue at a rate more rapid than wood consumption demands, a continuous cycle of production of raw material in excess of requirements is insured. Permanent industrial operation may follow dependent only upon demand for finished product.

COTTONSEED

The cotton crop of the United States for 1928, expressed in units of 500 pound gross weight, amounted to 14,477,000 bales, the total cottonseed produced being 6,435,000 tons. Twenty years ago this enormous tonnage of seed would have been largely discarded, but in 1928, 5,061,000 tons of cottonseed were put through refining processes which produced materials worth $200,000,000.

Research discovered that the lowly cottonseed may be split up into three components—linters, hulls and inner kernels. From the linters processes have been developed for manufacturing rayon, absorbent cotton, twine, rope, artificial leather, lacquers, celluloid, photographic films, varnishes, pyroxylin, carpets, writing paper, artificial felts, guncotton and other similar products.

From the hulls of the cotton seed are produced cattle feeds, paper in a variety of forms, stuffing material for upholstery, adhesives, fertilizer, potash, xylose and numerous other analogous materials.

From the kernels or "meats" of the seed, products are now available which we now see and consume as though they were always existent. Salad oils, lard compounds, emulsions for medical purposes, cosmetics, soaps, cattle feeds, flour for bread, cake and crackers, sardine packing oils, stearic acid for candles, washing powders, roofing tars, insulating materials, cotton rubber and compositions for phonograph records. To these many products industrial research workers are adding new and more spectacular achievements each day. Only recently we are advised by authorities that there is protein enough in a 16,000,000 bale cotton crop to furnish all the protein food requirements for 53,000,000 people for a year.

Fertilizers

In the field of fertilizers the South with the aid of research now enjoys a peculiarly enviable position, for the abundant supply of a great variety of materials are applicable to fertilizer manufacture. As an agricultural territory it is important that there is to be found large quantities of by-product sulfuric acid, phosphate deposits, a nitrogen fixation industry, considerable potash resources and raw materials for the manufacture of organic ammoniates.

Research has presented the South with an abundant supply of phosphoric acid and phosphoric acid salts. Even the Southern steel industry has deviated sufficiently from its primary purpose to supply in its basic open hearth slag a material of high phosphate availability to plant life. Nitrogen fixation plants in Virginia have joined hands with coke oven ammonia to supply large quantities of combined nitrogen. For potash to be obtained within the boundaries of the South here exist the possibilities of extraction of Georgia shales, recovery from certain industrial wastes or isolation as a by-product of cane molasses.

Within recent months we have been advised of another attainment of industrial research—the production of a fertilizer of 68 per cent. richness in plant foods—which commercial production was accomplished through the successful chemical engineering feat of the coprecipitation of the three constituents, phosphates, potash and nitrates in one homogeneous, granular product.

Scientific investigations have revealed the chemical characters of many of the Southern soils, and from these investigations steps have been taken to provide the lacking elements. Certain notable researches were performed in connection with soils found to be lacking in lime and magnesia and with the soils of the Florida Everglades which were found to be markedly benefited by additions of copper salts. Mention has already been made of the use of by-products of the cottonseed as fertilizing material.

Naval Stores

Approximately 300,000 people in the South are dependent upon the production of rosin, turpentine, pine oil, tar and pitches from the pine tree. Attributable to many varied researches the by-products of the Southern pine are now finding their way into such finished materials as soap, varnish, paper size, printing inks, linoleum, insulation materials and synthetic camphor. The raw products themselves have a market value of $70,000,000 annually. Yet the possible utilities of these raw materials of the Southern pine forests are but slightly developed.

Tung Oil

For years China has exported annually 100,000,000 pounds of tung oil into the United States for use in the paint and varnish industry. This oil is produced by tung oil trees, whose dried and hulled nuts are crushed to yield a neutral oil. From investigations of soils and climate in sections of Florida as to suitability for growth of tung oil trees, satisfactory conditions were found, and to-day over 560,000 trees are producing tung oil of satisfactory quality. Some 5,500 acres of land is thus being profitably utilized in the cultivation of trees whose fruits are yielding relatively high oil content. An American tung oil industry is thus in its infancy.

Blast-Furnace Slag

The blast-furnaces of Alabama, located principally in the Birmingham district, produce pig iron at the rate of 2,700,000 tons annually, a large percentage of which is basic iron, which is later made into steel. The iron ores of Alabama, which are smelted to produce the pig iron, are not as concentrated as are the ores of Northern furnaces and hence there is produced approximately 1,800 pounds of slag for each long ton of pig iron made. Some 2,300,000 tons of blast-furnace slag, therefore, are available from the furnaces of the district annually. Fifteen years ago this slag was cast off as a waste material, but to-day a large portion of this tonnage is converted to profitable use either as a basis for slag cement or as aggregates for cement or bituminous concrete.

The only blast-furnace slag cements of the country

are being made at this time in the Birmingham district. These puzzolan products utilize not only the water-granulated slag of the blast-furnace but hydrated lime from the lime industry of the South.

Slag from the blast-furnaces is cooled in huge graded pits, mined, crushed and graded for use as aggregates. Five hundred miles of Southern roadways are made of Alabama slag and Portland cement. Forty-five hundred miles of Southern roadways are constructed of Alabama slag and bituminous binders. Numerous buildings are made of slag concrete. Practical and scientific research both in the South and North have converted this once undesirable material from a waste to a useful raw material.

These are but a few of the prominent instances where scientific research has aided in the industrial development of the South. To these may have been added mention of many interesting discoveries in the fields of cotton textiles, cotton dyeing, tobaccos, cultivation and preservation of fruits, ceramics, soils, insecticides, petroleum refining, the production of diphenyl, production of helium, the manufacture of aluminium oxide, the production of celotex, the recovery of xylose and many other investigations pertinent to the industrial field.

For the most part these advancements have been largely responsible for industrial chemical research. In the solution of these problems industrial chemistry has been prominently aided and encouraged by geological researches and developments in chemical, electrical and mechanical engineering, so that the sum total accomplishments have not in many cases been attributable solely to the application of any one of the sciences.

To speak of accomplishments of research in the field of industrial development without enumerating some of the important scientific findings contributed from sources usually recognized as being independent of industrial activity would be to neglect paying tribute to many fine attainments.

We were permitted the pleasure one year ago of listening to an accurate account of the South's contribution to the sciences of botany, zoology, medicine, anatomy, surgery, pharmacology, pathology and several other of the sciences. In each of these fields distinct offerings have been made by Southerners. Investigations on the mechanism of heredity, on twins and twinning, oyster culture and mussels, coral formations, absorption spectra of solutions, viscosities of solvents, muscular discoveries, nervous system investigations, the transmission and control of yellow fever, surgical anesthesia, physiological behavior of poisonous alkaloids, ptomaines and cellular toxins and certain researches in connection with epilepsy and its relation to pellagra—these and many other important investigations have been contributed by Southern workers.

In the field of physical research we have to acclaim the attainment in connection with the recent discovery of two of the hitherto undetected members of the much discussed chemical family elements. Through the development of a magneto-optic method of chemical analysis exceptionally fine traces of elements have been made possible of identification and measurement, in concentration even as small as one part in 10^{11}. While academic interest in this accomplishment has centered considerably upon the discovery of the elements "Alabamium" and "Virginium" much promise is to be attached to this magneto-optic method of analysis as an effective tool of quantitative estimation.

To mention, however briefly, the many problems, industrial and academic, which are undergoing scientific investigation in the South at the present time, would be impossible. Likewise to set out the various influences which have stimulated the wide application of technical research in its various forms would be considerably complicated. Suffice it to state that the agricultural and industrial South has not only profited greatly by the relatively small number of contributions it has made to scientific discovery, but it stands to reap much greater benefits from its research conquests of the future. May the splendid accomplishments of the last fifty years serve as an ever accelerating stimulus to finer academic and industrial attainments to the end that in all the fields of science she may currently come to contribute her proportionate share of fruits of scientific research.

THE EARLY DAYS OF THE AMERICAN PHYSIOLOGICAL SOCIETY[1]

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As a survivor of the prehistoric period of physiology in the United States, I am asked to speak on the early days of the Physiological Society. Like all such survivors, I find myself in the position of the lady who, after the surgeons had finished with her, reported that she had only lungs and reminiscences

[1] Address at the dinner of the Federation of Societies for Experimental Biology, Philadelphia, April 29, 1932.