PRESIDENT'S ADDRESS.

H. W. Wiley.

Ye Shall Know Them by Their Fruits.

Members of the Indiana Academy of Science, Ladies and Gentlemen—It perhaps marks a sad epoch in the history of a man when he deliberately chooses a period of reminiscence for a public address. It is one of the privileges of the old to review the preceding years and draw from them such lessons of wisdom or of folly as may happen to be the case. I have therefore, chosen on this occasion to look back over the scientific history of Indiana during a period of a third of a century. Strange as it may seem, that short period covers practically all the progress which has been made in applied science in this great State. I do not forget the early days of the Owens and their associates, and the great contributions which came to the intellectual and scientific development of our people from the center first established at New Harmony, but I speak of the actual accomplishments for the good of the community from the application of the principles of science to mining, manufacture, commerce, agriculture and public health.

It was my fortune to enter upon the period of my education immediately following the great Civil War. This fratricidal struggle for four years had engaged every energy and consumed every resource of our country. The end of the war left our people in a remarkably susceptible condition—ready for the purpose of re-establishing their industries and of utilizing every available means thereto. In the very midst of the period of the Civil War were laid deep and sure, by wise congressional action, the foundations of the system of agricultural and technical education, which has since grown to be the admiration of the world. I refer to the Morrill Act of 1862, setting apart portions of the public domain for the purpose of promoting instruction in agricultural and mechanical arts and military tactics. Every State in our Union received grants of public lands in proportion to size, population and representation in Congress. It is true that some of the States invested this munificent endowment more wisely than others, but all have received from it substantial aid. This munificent gift to technical education was supplemented twenty years later by the Hatch Act, whereby there was established in each State and

Territory of the Union at least one Agricultural Experiment Station with an annual grant of $15,000. Still later Congress added to the income of each of the agricultural and technical colleges by a money grant which now amounts to $25,000 annually. I recall briefly the condition of scientific instruction in the State of Indiana in the five years immediately following the Civil War. I can illustrate these years by brief allusions to the system of instruction in use in our higher institutions of learning. By these I mean especially the colleges and universities then existing rather than the high schools. Beginning with the oldest institutions of learning, I will say that in the State University during the period noted, instruction in the sciences was given by Professors Owen, Kirkwood and Wylie. These three names are intimately associated with the beginnings of scientific instruction in our State. They were all men of remarkable intellectual power. Professor Owen devoted himself chiefly to the so-called natural sciences (I wonder what are unnatural?), Professor Kirkwood to astronomy and Professor Wylie to physics. It should not be forgotten that Professor Richard Owen was chosen as the first president of Purdue, but never actively entered on the duties of the office. His tastes and training were not in the line of executive work, and in addition, his advancing years precluded the possibility of that strenuous service which even in those early days was looked for, perhaps under another name, in the executive office. As there were beautiful women before the days of Helen, so the lives of these pioneers in scientific work remind us that there were great men in Indiana before the days of Jordan and Coulter.

The next oldest institution is the one I am most familiar with in the State, namely, Hanover College. In that institution instruction in the sciences at the time mentioned was given, with the exception of the mathematics, exclusively by Dr. John W. Scott. Having studied for four years with this illustrious man I can speak with knowledge of the great work which he accomplished; work, I am sure, which was only a type of that done by other teachers of science in colleges at that time. Dr. Scott had never received any special training in science more than was given in the old colleges existing in our country between the years 1820 to 1825. He was born with the beginning of the last century and happily lived almost to its close. He was educated for the ministry and devoted practically his whole life to the church. During the period of his professorship he was pastor of the village church, associating these onerous duties with those of the classroom. Doctor Scott taught many sciences, viz., botany, geol-

ogy, biology, entomology, chemistry and physics. In addition to these he often had a class in Latin and occasionally other branches. Doctor Scott was a man of wonderful strength of body and mind, and had a capacity for continued work which was nothing less than astonishing. During the day, after the end of the recitation, he would spend the hours in his laboratory preparing for the experiments and recitations for the following day. The lamp in his study window would often be found burning at night up to 12 and even 1 o'clock, preparing for his sermons on Sunday. He was accustomed to have in his preparatory work in his laboratory the assistance of one of his students, and during my time at Hanover I especially remember the enthusiasm with which Mr. M. L. Amick, now a prominent physician in Cincinnati, displayed in the preparation of the lectures. With a laboratory outfit of the most meager description Dr. Scott was able to give in chemistry a series of experimental lectures which would have done credit to many of the elaborate lecture rooms of to-day. There was absolutely no provision for the students' work in the laboratory whereby the fundamental principles of chemistry could be illustrated by appropriate experimental work. Some of these experiments were very difficult, and at least one of them I have never seen performed in an experimental lecture anywhere else in the world, namely, the preparation of the highly explosive chloride of nitrogen. The preparation of this compound is one of such danger that it should only be attempted with those most skilled, yet every year for three years I saw Dr. Scott perform this experiment in a most successful manner. The small quantity of the explosive made was placed in a safe place out of doors and exploded by means of a long stick, the tip of which had been dipped in turpentine oil. By reason of this devotion to his profession and the success attending his efforts, he made chemistry, which was at that time one of the dry book studies, a most attractive science. In like manner he would conduct his classes in botany to the neighboring woods and fields and teach them not only the principles of botanical classifications, but the means of identifying the various species of plants growing in the vicinity. The hills of the Ohio River, rich in magnificent trilobites and other reminiscences of early geological life afforded a magnificent opportunity for teaching the practical principles of geology as illustrated in those lofty hills and deep ravines. Since those days, when I have seen practically all the magnificently equipped laboratories of the world, the wonder grows more and more in my mind at the great work which this great man could accomplish with

so few material appliances to help him. I shall never forget the last time he visited my laboratory in Washington. After leaving Hanover he had come to Washington and taken a position as a clerk in the Pension Office. At the time I speak of he was 90 years of age, but still clear of mind and firm of step. It was soon after the inauguration of Benjamin Harrison as President of the United States. One morning Doctor Scott stepped into my office. He seemed uneasy and wore a worried look. When I inquired in regard to his health, he said it was most excellent, but he added, "Strange to say, I have become a victim of the Republican administration. General Harrison has insisted on me coming to the White House to live with him and has dismissed me from my position in the Pension Office." He continued, "I am a gentleman of leisure now, and I think I would like to come and study chemistry with you." It is only when we can look back on a life-work such as that done by Doctor Scott that we can realize the inestimable blessing of his career to humanity. Two years after that the end came peacefully to his existence. I can not help thinking that the feeling of love and interest taken in him by the President, expressing itself in the desire that he should pass his last days in the comfort and honor of the White House, may have shortened his life. If he could have kept at work, which was his normal condition, he might have rounded out the century.

Scientific instruction given during the period I speak of at Wabash College was in charge of Professors Campbell and Hovey. Professor Campbell is still in the harness—possibly almost the only one of the old guard that still wears his armor.

At the present time chemistry, biology, botany, mathematics, physics and astronomy are all separate departments. The change at Wabash has taken place gradually and progressively, so that it is not possible to designate these segregations by any particular period. It will be sufficient to say that it has been the constant effort at Wabash to keep up with the new without disparaging the old. Wabash is another of the so-called small colleges which has established for itself a place and a reputation of the highest character. We have so many illustrations of institutions of this kind in Indiana that the sneering remarks which are often made about the small colleges of Indiana meet with a merited rebuke when one takes the trouble to investigate the great work which has been accomplished by them.

At Earlham College instruction in science was given by Professors

Erastus Test, William B. Morgan and Joseph Moore. In the period from 1865 to 1870 the text-books used at Earlham in chemistry was Stockhardt's; in botany, Gray's Structural. Herschel's work on astronomy was the one used in the classroom, and Dana's was, of course, the one used in geology. Two of these veteran instructors I have had the pleasure of knowing personally, namely, Professor Test and Professor Morgan.

Earlham College enjoys the distinction of having been one of the foremost among the educational institutions of the West in the promotion of advanced practical instruction in science. In the year 1853 it made the first beginning in Indiana toward a permanent collection of material in geology and natural history for purposes of college instruction. The present Earlham College museum, with its more than 14,000 specimens, is the outgrowth of that beginning.

About the same time the first astronomical observatory in the State was established at Earlham. A room in Earlham Hall, adjoining the present quarters of the Christian Associations, was the location of the first chemical laboratory for the use of college students in Indiana.

At present Earlham offers courses in science as follows, a year's high school laboratory work in some one science being required for matriculation: Chemistry, six terms' work; physics, six terms' work; biology, ten terms' work; geology, four terms' work; astronomy, three terms' work; psychology, two terms' work.

Earlham now has a complete set of laboratories devoted to chemistry, biology, physics and psychology. These laboratories are equipped with all modern appliances, and although not as large as those in many institutions, they are complete in every respect for the prosecution of research and for purposes of instruction.

At Butler College, at that time known as Northwestern Christian University, instruction in science was given by that distinguished geologist and chemist, Dr. R. T. Brown, assisted part of the time by Professor Fairchild. During the years of 1869 and 1870 I learned to know Doctor Brown intimately, for during that period I served as instructor in Latin and Greek in the Northwestern Christian University. Interested, as I was, at that time, in scientific studies, I accompanied Doctor Brown on some of his geological excursions. I remember particularly the trip which was taken in the spring of 1869 down as far as Spencer. It was at the time that the railroad from Indianapolis to Vincennes was building and it was finished practically all the way to Spencer, and part of this trip

was made on the railroad, and then the rest on foot, several days being spent in studying the geological formations. Doctor Brown was a man of practically the same type as Doctor Scott, full of enthusiasm, a wonderful capacity for work, a magnificent physique, and a faculty of interesting his students in the subjects under consideration. These two men, whom I knew so well, were typical teachers. They had the genius docentis. Mr. Brown's services to the State are written in its Geological Reports of the coal fields and in the promotion of its industries. Like Doctor Scott, he was also a preacher, and there was rarely a Sunday that he did not deliver at least two sermons. He was particularly fond of walking, and thought nothing, even at the age of seventy, of a tramp of ten or fifteen miles to fill an appointment. I remember a story which he told in regard to one of his trips when he was a young man and soon after he entered the ministry. He was too poor to have a horse and was in the habit of going from one appointment to another on foot, inasmuch as the railroads were then not in vogue. One morning after a long tramp he stopped at a farmhouse with the expectation of being entertained at dinner. The farmer happened to be a quaker, and, of course, devoid of any ceremony. Doctor Brown was a modest young man and was not quite accustomed to the directness of the quakers' hospitality, and when the hour for the meal arrived the host said, "Thy dinner is ready; will thee come in to dine?" He very politely said, expecting to be invited a second time, "I thank you, but I am not very hungry;" to which came the reply, "Very well, thee can sit there until we have finished." Whereupon the dinner was served with all the good things which a quaker farmer can put upon a table, while the young preacher was left to regale himself with all the delicious odors from the table and the thought of what he could do with all the excess of peptic ferments which the odor of the dinner were producing. After that experience he learned never to decline the first invitation from a quaker.

Instruction in Franklin College in science at the time I mention, was given by Professor Hougham. Professor Hougham was also a remarkable man in industry and in ability. I afterward had the good fortune to know him quite intimately when he was one of the professors in the early days of Purdue. In his laboratory work he was the perfection of neatness and order. In fact this was one of the predominating characteristics of his character, and his great success in life was, in a large measure, due to it. Professor Hougham was particularly interested in physics

and had charge of that branch of science in the early days of Purdue. He had a happy constructive faculty and could make a very modest collection of appliances serve for extended illustrations. Professor Hougham was a manufacturer of philosophical apparatus, and Franklin College had the benefit of many of the pieces of apparatus which he built. He took post-graduate work at Brown University, and the first chemical laboratory built at Purdue was constructed on the exact plans of the laboratory at Brown. The Civil War had a depressing effect upon Franklin College, and I believe it was the only institution of higher learning which was closed for a period as a result directly or indirectly of that conflict. There was an interregnum at Franklin from 1865 to 1869. When the institution opened again in 1869, President Stott took temporary charge of chemistry, physics, physiology, botany and geology. The text-books used then were Youman's in chemistry; Ganot and Olmsted's in physics; Dana's in geology; Gray's in botany; and Hitchcock's in physiology. At the present time there are four large rooms devoted to chemistry, one to physics, and three to biology. There are two full professors giving instruction in these sciences and the laboratories are well supplied with apparatus and with working libraries. Franklin has also an excellent biological collection, mostly the gift of Mr. Gorby, at one time State Geologist.

DePauw University, in those days, was known as Asbury, and perhaps the only science teacher in the institution was Joseph Tingley. I never had the good fortune to know Professor Tingley very well, but met him on one or two occasions. One of these I should like to recall. It was, I think, in the winter of 1870, when he gave an illustrated lecture on electricity in Indianapolis. This was the first occasion on which I ever saw an electric light produced by the current passing between two carbon points. This current was generated by a battery of a great many cells (I have forgotten just now how many) composed of the elements of carbon and zinc. It was not a very big light, but very intense, and I imagine that none of the audience present, and it was a large one, had ever seen an electric light before. I have no doubt I address some here who were students of Professor Tingley, and they, without question, can say the good things of him which I, from my personal acquaintance, have said of Doctors Scott and Brown. In connection with the exhibition of the electric light which is now so universal in all our cities and towns, I might call attention to the fact that the first electric light generated by a dynamo seen in Indiana was at Purdue University. During the Centennial Exposition of

1876 there were exhibited three or four dynamos manufactured by Gramme, of Paris. One of these was purchased for the physical laboratory of Purdue University and one by Professor Barker for the physical laboratory of the University of Pennsylvania. Professor Barker, doubtless, got his apparatus before Purdue, since it was nearby. As soon as the exposition was over the machine belonging to Purdue was sent to Lafayette and early in November, 1876, the first modern electric light ever seen in Indiana blazed forth from the tower of the Purdue chemical laboratory. It was one of the wonders of the age and was the talk of the newspapers and the town for many weeks. It seems almost incredible to think that twenty-seven years ago one electric light would cause such a commotion in a community. But this fact should fully illustrate to the young people how much more keenly we of advanced age can understand the progress of science in our State. Prof. Joseph Tingley, at Asbury University, had a room 26x30 feet as a lecture room and one 9x12 feet for his store room. At the present time there are four departments of science teaching at DePauw, namely, chemistry, physics, botany and zoölogy. These departments are in charge of Dr. W. M. Blanchard, chemistry; Prof. J. P. Naylor, physics, and Prof. Mel. T. Cook, biology. Each professor has an assistant and their rooms, taken in the aggregate, amount to more floor space than the entire old college building of Asbury University. One of the latest acquisitions at DePauw is the Minshall laboratory, 80x130 feet, three stories, constructed of stone, brick and iron, fireproof, and with the most modern appliances for teaching chemistry and physics. Plans are now practically completed for the departments of botany and zoölogy.

One of the earliest contributions to the material prosperity of Indiana from the sciences was made by geology. I have no time here to review the voluminous geological reports which have been made from time to time in the history of our State. There are a few salient points, however, in the history of economic geology which may prove of interest.

I have already made allusions to the services of Dr. R. T. Brown to the geological development of our State. I have now to speak of a period in our geological development of most remarkable significance. I refer to the services of that distinguished scientist, Prof. E. T. Cox. Trained under the Owens, he had imitated their zeal and their industry, and was active in all his habits, both bodily and mental. He pushed with utmost vigor the investigations of a geological nature into the extent and character of the coal deposits of the State. He early saw the importance of

utilizing the assistance of chemistry in this work, and established the first chemical laboratory for research, I suppose, ever built in the State of Indiana. I remember well this laboratory in one of the dingy rooms of the old State House as I first saw it in 1869 or 1870. Professor Cox had associated with him a chemist of skill and great industry, Dr. G. M. Levette. Doctor Levette was not only a skilled chemist, but had also a working knowledge of other sciences, and, therefore, his aid in developing some of the phases of the Geological Survey was of the greatest helpfulness. It was in this laboratory that I first saw a quantitative determination, and I remember the feelings with which I used to watch Doctor Levette, who patiently permitted me to hang around his laboratory and probably greatly interfere with his work without exhibiting any signs of petulance or resentment. All the different varieties of coal which were then known in the State were submitted to the most careful chemical examinations. He also erected and operated a small apparatus by means of which bituminous coal could be heated under pressure, making, as he termed it, an artificial coke or anthracite, illustrating probably some of the methods by which nature has secured the deposits of hard coal from those of a soft or bituminous nature. I shall never cease to be grateful for the interest which these two distinguished men took in my visits to their laboratories, which, I fear, were all too frequent for the even march of official business. The personal friendship which I formed for Professor Cox at that time, I am glad to say, has continued until the present. He is now an old man retired from work and spending the evening of his life in the grateful climate of Florida. The services, however, which he rendered to the economic development of Indiana will be more and more appreciated as the years roll by. It was also my good fortune to know one of the successors of Professor Cox personally and intimately, namely, Mr. John Collett, who was first an assistant to Professor Cox and became State Geologist in 1880. Mr. Collett had a wonderfully keen insight into the nature of scientific problems and great ability in developing them. His chief work toward the economical development of the State was directed to the building-stone industry. He called attention to the remarkable character of the deposits in Lawrence County, and it was during his incumbency of the office that the present State House was constructed of the stone of that locality and the Soldiers' and Sailors' Monument begun. Mr. Collett was chiefly active as a geologist, though contributing in many other ways to the development of applied science in the State. He was the author

of the first fertilizer control law which was enacted in this State, a law which did so much to protect the farmers from fraud, and in its application to point out to them the fundamental principle of applying artificial fertilizer. This is another remarkable instance in which the geological development of the State was associated with the chemical. Mr. Collett had a strong personality. His snow-white beard and hair, his bright blue eyes, and his ruddy complexion made him a striking figure everywhere. The end of Mr. Collett's administration of office was followed by a remarkable innovation of a scientific nature. A distinguished poet and novelist, James Maurice Thompson, was elected to succeed Mr. Collett as State Geologist. Mr. Thompson has shown in his writings an intimate acquaintance with nature, but it was a poetic rather than a scientific knowledge which he possessed. Evidently the courses of scientific research were not found compatible with his efforts so signal and successful in the fields of poetry and fiction. After two years he resigned his office. There was perhaps little loss to geology in his resignation, but evidently a marked gain to literature, for had he remained as State Geologist that delightful romance, "Alice of Old Vincennes," would probably not have been written. Mr. Thompson was succeeded by Mr. S. S. Gorby, who held the position until the present incumbent assumed control of the office. We are so familiar with the valuable work which Mr. Blatchley has accomplished that it will not be necessary for me to dwell long upon it. One of the innovations which has been of distinct value in the prosecution of the geological survey of the State by Mr. Blatchley was the abolition of the method of county surveys formerly in vogue. In their stead he adopted the plan of taking up each of the natural resources in detail, and preparing a monograph or special report thereon, accompanied by maps, cuts, engravings and tables of chemical and physical tests. Another successful application of economic science to industry has resulted from a study of the clay deposits in the State. The description of the character of these clays, with their chemical and physical composition, has become valuable to intending investors and more than twenty large factories have been established in Clay, Vigo, Fountain, Vermillion, Parke, Morgan and other counties for the manufacture of clay products. The total value of the output of these factories in 1900 was $3,358,350. Another result of the geological studies of Indiana was the discovery of petroleum oil deposits. The output of oil in the State of Indiana in 1901 was 5,749,975 barrels, of which the market value was only a little less than $1.00

per barrel. The magnitude of the building-stone industry which has grown as a result of geological investigations, has raised Indiana to the first rank in the States of the Union in the output of limestone for building purposes, as shown by the following statistics: The quantity mined in 1901 was 7,781,320 cubic feet. Five State capitol buildings, namely, those of Indiana, Illinois, Georgia, New Jersey and Kansas, have been constructed wholly or partly from it. Numerous custom houses and public buildings of the United States have also been made of this stone, and twenty-seven court houses in the State of Indiana are built of it. Mr. Blatchley has also taken up again the study of the coal fields of the State, as little has been done in that line since the time of Professor Cox, and the output of coal in Indiana has almost doubled in the last few years, amounting in 1901 to 7,019,203 tons. In conjunction with chemistry the Geological Survey of the State has also developed the resources for the manufacture of marl and cement. As a result of these investigations a large output of cement similar to that known as Portland is now credited to Indiana. It is estimated that the output of this cement for 1902 will be fully equal to 600,000 barrels. The adaptability of the oölitic and other limestones of Indiana as suitable material to be used in the manufacture of cement has been described, and, as a result of this, factories have already been able to make use of these materials. It has been shown that Indiana has the raw materials to supply not only the United States, but the whole world with a first-class article of cement for hundreds of years to come. The mineral waters of our State are justly celebrated for their medicinal and curative properties, and their development is the joint work of geology and chemistry. There are now known in the different parts of the State eighty-six wells and springs whose waters are valued for therapeutic purposes. The natural gas industry has also added hundreds of millions of dollars to the development of the State, and this development is largely associated with the work of the Geological Survey. It is hard in so brief a time to do anything like justice to what geology as a science has done for the industries, and also to recognize the services of the distinguished men who have been connected with this work. It is enough for our purpose here to call attention to the leading characters of the work done by geologists in the development of our industries.

The contributions made by botany, entomology and zoölogy, and animal and vegetable pathology, to the material welfare of the State are no

less striking in character, though perhaps less in magnitude, than those which have been rendered by the science of geology. Botanical studies, which have ever been far advanced in Indiana, have disclosed the nature and character of our various forests and have especially been concerned with the improvements of economic plants for agricultural and horticultural purposes. The study of economic botany is one which lies near to the welfare of many of the fundamental industries, chief among them being agriculture and pharmacy. Especially the study of the development of special characteristics of plants useful in the arts is one of the phases to which botany in this State has made large contributions. Without discriminating against the other botanical laboratories in the State, I can best illustrate the useful character of this work by what has been done at Purdue University, the work of that institution being more familiar to me in applied botanical science than of the other institutions of the State. From the botanical laboratories of Purdue University there have been, from 1884 to 1898, fifty bulletins published on botanical subjects of practical importance to the industries of our State. These were chiefly from the fertile pens of Arthur and Coulter. It will, of course, be impossible to even give a brief review of this magnificent work. I must confine myself merely to quoting the titles of some of these important contributions in order to show how closely allied they are to the industries of the State. Among these titles I might mention the following: "What Is Common Wheat Rust?" "A New Factor in the Improvements of Crops," "Black Knot and Other Excrescences," "Living Plants and Their Properties," "The Forest Trees of Indiana," "Science and the State," "Forest Fruits," "The Flora of Indiana," etc.

If you add to the contributions which have been made from Purdue University those which have been made from other centers of botanical studies and investigations you have a sum total of most important practical results. In general, it may be said, that by reason of the activity of the botanical science in this State and the application thereof to our industries we have a far more accurate knowledge of those plants which are most intimately related to our industries. In the second place, we have a systematic and scientific conception of the methods of treating these plants in order to produce the greatest economic results. Third, we have a more advanced knowledge of the proper distribution of these plants in such a manner as to take advantage of the natural qualities of the soil or topographical features of the State and the meteorological environments. In

the fourth place, we have an advanced knowledge of the nature of the diseases which affect the value of plants and the methods of successfully combatting them. What has been said of botany is true, also, to a large extent, of the science of entomology, although perhaps Indiana has not been so prominent in entomological as it has been in botanical studies. Nevertheless, most valuable contributions have been made by the entomologists of our institutions of learning to the general store of knowledge. In regard to animal diseases, we find also that science has been of immense use to our industries. The State has been well mapped in regard to the plague of hog cholera and other animal diseases. Careful studies have been made of the causes of these diseases and their distribution coupled with the regulations for the restriction of these diseases and their suppression. These studies have come largely from Purdue University and the reports issued by Doctor Bitting of that institution upon animal diseases have been of the highest utility. The health of the human animal has also not been neglected in the application of science to the public welfare. The Indiana State Board of Health, which is charged with the general oversight of the hygiene of this commonwealth, has been established on a truly scientific basis. The State Board of Health is composed of eminent physicians in active practice and its executive officer is a chemist and pharmacist of national reputation. You are so familiar with the contributions which this distinguished body has made to the welfare of your people that I can not enlighten you to any extent upon the subject. There is one thing that I ought to say in reference to this work, and that is, it should be supported more generously by the people. What the State Board of Health needs from Indiana is a fund for the enlargement of the activities, and to make its work more useful, a laboratory of hygiene is necessary for the study of the foods and waters and a control of the pathogenic germs therein.

The execution of the pure food law which was enacted, I believe, by the last Legislature or the one before, is of prime importance. No one will doubt the benefit which the pure food law gives to the people and its helpfulness to the prosperity of agriculture and the honesty of commerce in foods. There is perhaps little lacking in the letter of the law which has been carefully prepared and worded. I must say, however, that from a careful study of the facilities at the disposal of the health office I fear the law can not be administered to the full measure of its letter and spirit. The population of Indiana in round numbers is 2,750,000 at

the present time. There must be at least 500,000 wage earners in the State, and statistics show that the average amount earned by each wage earner is about eighty cents per day. This enormous sum of from $400,000 to $500,000 is paid daily in wages to the workers. It is safe to say that fully three-fourths of the wages earned per day are spent for agricultural products, that is, foods and clothing, so that the average amount spent each day for these necessities of which food is the chief, is not far from $350,000. Researches of chemists in all parts of the country show the enormous extent of food adulteration resulting in selling at the high price of the genuine cheaper and inferior articles. The wage earners are the principal victims of these frauds, not perhaps in actual magnitude of expended money, but in proportion to their income. A very conservative estimate would place the magnitude of the financial fraud practiced upon the wage earners of the State in the matter of adulterated foods alone at from $15,000 to $20,000 daily. Not only is this condition of affairs reprehensible by reason of this enormous tax upon the daily wages of hard working men, women and children, but it is a moral crime of a still more heinous nature. Twenty thousand dollars a day for fraudulent foods, mean a tax of 5 per cent. on all wages of all workers. When a fraud of this magnitude is considered it does not seem unreasonable to ask the Legislature for an endowment which will support the hygienic laboratory in its investigations of the nature and character of these fraudulent foods and in order that the evil effects of these can be properly ascertained. Great as have been the contributions of the Board of Health to the welfare of the State in securing immunity from disease, freedom from plagues and from contagious and epidemic diseases, we look forward to a still more useful career of this institution when it is fully equipped for the hygienic work outlined above. An admirable historical sketch of the Indiana State Board of Health and a statement of the benefits it has conferred upon our people is found in a paper contributed to the Indiana State Medical Society by J. N. Hurty, read at the Lafayette meeting, May 6, 1898, and published in the proceedings for that year. In that paper Dr. Hurty gives an admirable summary of the progress of sanitary science in Indiana.

The development of medical education of the State must not be forgotten when speaking of the public health. I attended the first lecture of the Indiana Medical College, given in the Senate Chamber of the old State House. Later I was one of the first students in the laboratory established by Dr. Thaddeus Stevens, where students really worked at the desk.

Doctor Stevens had a real enthusiasm for chemical studies connected with medicine, and I believe supported his laboratory chiefly from his own funds.

You now have in the city at least two, probably more, thoroughly equipped schools of medicine, with commodious and well-appointed laboratories of chemistry, physiology and pathology, and these institutions are doing a great work for the public welfare.

Intimately related with the benefits which could be conferred upon the State of Indiana by its Board of Health are those of a somewhat similar nature which have come from the State Board of Charities. This academy is also honored in having among its leading and most industrious members the Secretary of the State Board of Charities. It is hard to speak in an unbiased manner of any of these contributions to the State because of my intimate personal acquaintance with the men who are most active in the work. It is hard even for scientific men, and one who has lived so long away from the home of his youth, to banish from his heart a very affectionate and praiseworthy prejudice in favor of his friends. For that reason it is pretty difficult for me to find fault with what such men as H. A. Huston, Stanley Coulter, J. N. Hurty, W. F. M. Goss, A. W. Butler *et id omne genus* do. When I know that they have done something I am convinced without further investigation that that something is good for the State. There are some features of the work of the Board of Charities which perhaps are not fully comprehended even by those who have read its reports. They have introduced into the study of the public charities of the State a truly systematic method of investigation. In their studies of causes and effects they have endeavored to use every means of securing accuracy. They have striven to get at the individual and family history of every person who is an inmate of these institutions. The results of these endeavors have been the collection and tabulation of the most accurate and complete set of sociological statistics in this country. Mr. Butler developed one phase of this work in his vice-presidential address before the section of Anthropology of the American Association for the Advancement of Science at its Denver meeting. In this address he took up the study of the heredity effects of feeble-mindedness. This study of feeble-mindedness had been pronounced by competent experts to be one of the most exhaustive and thoroughly scientific of any that has ever appeared. Its excellence has been recognized across the water and it has been reprinted in Great Britain for public distribution.

Another phase of this work is the study of the problems in these records which have been secured in order to determine those conditions which are preventive of dependency, delinquency and degeneracy. The charitable institutions of our State have long been the admiration of the whole country. The great work of the State Board of Charities looking to the prevention of crime will perhaps bring more lasting benefit to our people than the institutions themselves over which this board has control. The successful efforts of this board in bettering the condition of our people has been seen especially in the enactment of the Child Labor Law, the Child Saving Law, the Poor Relief Law, the Indeterminate Sentence and Parole Law, the Compulsory Education Law and the law for the custodial care of feeble-minded women. It is evident, therefore, that in enacting the laws providing for the State Board of Charities by the Legislature, in 1889, Indiana took a great step forward, both in a scientific direction and also from an economic standpoint. There is no institution of our State more worthy of support and encouragement than the State Board of Charities, and no one, if properly supported, will do more for the honor and welfare of our people.

As a direct effect of the establishment of this Academy we may point to the law regarding the protection of birds and game. Birds may be taken for scientific purposes only by persons having permits through the Indiana Academy of Science. The bird law is well supplemented by the game law enacted by the last Legislature. There still remain, however, to be enacted some desirable features of one of these laws, and that is, the enactment of a provision for the taking of fish. The Commissioner of Fish and Game has the oversight of fish and game protection, but it might be well to have the law changed so as to have this official in organic connection with the Academy.

I have already alluded to some of the services of chemistry to the State of Indiana in connection with the development of its geological resources and also in its services to the State Board of Health. The chief value, however, of the science of chemistry to the State of Indiana has been in its application to our agricultural industries. The enactment of the Morrill Law, already referred to, in 1862, resulted in the establishment of Purdue University, an institution devoted to the study of agricultural and mechanical arts and military science. The foundation thus provided was generously increased by a gift of Mr. Purdue, and with the assistance of citizens of Lafayette, a commodious home was secured for the institu-

tion, and the work based upon the foundations thus given has been generously sustained by the State by annual appropriations. The enactment of the Hatch Law, already mentioned, about twenty years after the Morrill Act, gave a magnificent impulse to agricultural research. By the terms of the Hatch Law there were established in each State at least one Agricultural Experiment Station charged with the investigation of the problems relating to agriculture, horticulture and forestry. As a result of these generous endowments no other country in the world has a system of agricultural research which can compare in magnificence of endowments, number of workers and practical results obtained, with the agricultural institutions of this country. The services which have been conferred upon the State by these endowments have already been pretty fully exploited in this address.

But I must be permitted still to call attention to the fundamental place which one of the sciences, viz., Chemistry, holds in these investigations relating to the progress of agriculture. Before the establishment of the Agricultural Experiment Station of Indiana Mr. John Collett, State Geologist, as previously mentioned, secured the enactment of a law by the Legislature establishing the office of State Chemist. I, as most of you know, had the honor of being the first incumbent of that office. A peculiar feature in the history of the enactment of this law is the way in which Mr. Collett secured it. He did not consult, in so far as I know, any of the officials connected with Purdue University. The first intimation that I had of the enactment of the law was a commission signed by the Governor sent by the Secretary of State appointing me to the place. On looking into the law I found that the duties of the State Chemist were particularly confined to the fertilizer control, and thus there was established in 1882 at Purdue the first laboratory for the control of fertilizing products sold in the State. The laws before this were crude and powerless to protect the farmers of our State against barefaced frauds. At that time any kind of mixture could be sold as a fertilizer for a fancy price and there was no official method of detecting a fraud and no provision for its punishment. Under the provisions of the law the farmer is now completely protected in the character of the goods which he buys. This has been a saving in hard cash to our farmers in sums difficult to estimate, but this is not the most valuable result which has been obtained by the establishment of this office. In addition to analyzing the fertilizers offered for sale the State Chemist commenced a study of their effects

upon the crops to which they were applied. This led naturally to an examination also of the soils for the purpose of determining their needs in fertilizing materials. The result of all this is that the farmer at the present day is enabled not only to purchase his fertilizers in a fair and honest market, but also to have them so balanced in respect of the plant food they contain as to give the most economic results in the crops. If the farmer of Indiana at the present day adds phosphoric acid, nitrogen or potash to the soil when it is not needed, he simply does so because he does not take advantage of the facilities which the State affords him of learning the true method of fertilizing his farm. Thus the contributions which chemistry has made with the assistance of the sister science of geology, and through the medium of the Board of Health to the welfare of our people have been vastly increased by its solution of some of the agricultural problems which confront us. With this aid and the efforts of agricultural chemistry the exhaustion of the virgin soils of our State, which are among the most fertile of our country, has been checked, and a start has been made on the up-grade toward the restoration of that fertility which our early settlers found. It would have been glory enough to have checked the deterioration of our soils, but it is an additional glory to our science when it has commenced to build them up again. We can consistently look forward to the near future when fields and farms which have been practically abandoned by reason of exhausted fertility will be again brought into cultivation and made to produce abundant and profitable crops. The investigations which chemistry has made have also shown to a large extent, how our agricultural crops could be distributed with the greatest advantage. In this respect chemistry collaborates with her sister science, botany, which study I have already referred to. As a marked illustration are seen the investigations which have pointed out the fact that the beet sugar industry in Indiana could only prove profitable in its northern part and that it would be economic waste to try to establish it, for instance, in the southern third of our State. Similar studies in connection with botanical science will aid in marking the areas most suitable for other agricultural crops, such as Indian corn, tobacco, etc.

As a final result of all these scientific investigations, the farmers of our State will eventually grow only those agricultural crops which are best suited to the environment and therefore most profitable. Thus agriculture will be made more productive and profitable by such specializa-

tions as render great manufacturing industries most useful. As the skilled worker in a great manufacturing establishment is placed at that task which he can do best, so the farmer will utilize the field for that which it can best produce.

These brief surveys of the contributions which science has made to the industries of our State would be incomplete without some tribute to the wonderful work which technical education has accomplished. I mean by technical education, that instruction in the mechanic arts which was practically unknown a third of a century ago, and which has now advanced to such a degree as to place Indiana in the front rank of states in developing this branch of applied science. We have in this State two great centers of technical education, namely, the Mechanical and Engineering Laboratories of Purdue University and the Rose Polytechnic Institute. In addition to these, attention should be called to the splendid courses given in manual training in many of our high schools and other institutions of learning. The Hoosier of fifty years ago was the butt of every jibe. His agricultural skill was supposed to be confined to the growth of pumpkins, and his mechanical genius was occupied with the manufacture of the svelt hoop pole, but his State is now the home of the most famous poets, novelists, statesmen, engineers and scientists.

My friends from other institutions will, of course, pardon me if I speak particularly of the wonderful work at Purdue developed first of all by Professor Goss, who is now assisted by a large corps of mechanical and electrical engineers. It is evident from the activities of Purdue and other institutions that we are in the progress of educating as engineers at least 1,000 of the sons of the State. During the past five years from 50 to 100 have been graduated each year from the engineering classes of Purdue University, and this great influx of men has been absorbed by the industries of this and other states. Purdue has already a thousand graduates in engineering. Without stating in detail the influence of this great institution upon the material prosperity of Indiana, the fact that so many of its young men have been prepared for this useful life work is in itself significant.

The whole industrial activities of the State of Indiana have derived their life and vitality from the instruction which I have outlined. It would increase to an undue size an address of this kind to go into a minute detail. This technical instruction of our State is touching every branch of our industries. Without speaking specifically of what it may be doing

for each of the industrial interests of the State, we may say that wherever there are waterworks recently designed, or street railway lines, or electric lighting stations, or a manufacturing plant of any kind, and in general, wherever the people are enjoying the benefits of modern engineering, mechanics and electrical development, there you will find the representatives of the technical education of which I have spoken. The graduates of these technical schools are everywhere. Whatever progress the State is making in industrial lines they are instigating and conducting it. They are in charge, or assisting in the management, of the great manufacturing plants of the State. They are superintendents of motive powers and machine shops. They are found in smaller corporations in charge of the machinery or of the technical processes. Wherever industry is progressing and where manufacturing is growing and where technical skill is adding to the prosperity and welfare of the people, the graduates of these technical schools are found.

It is a good old proverb that you should judge the tree by its fruits. In this free land of ours we judge a man for what he is and from what he does, and therefore, we are justified in applying this same rule in estimating the value of the sciences in the material development of our State by what they have accomplished. I have given in merest outlines some idea of the services of science to our industrial development. Industrial development is always intimately associated with intellectual advancement, moral welfare and spiritual well-being. The first stone in the foundation of a national edifice is material prosperity. No nation, no matter how perfect its ancestry may be and how lofty its purposes, could flourish in a desert, or on an iceberg. The insistent demands of humanity are for food and clothing and comfort. He who would elevate his State must begin by ministering to these primeval wants. It is useless to try to educate the boy who is starving and to preach religion to a man who is shivering. The inventions which increase the power of man to do things, along mechanical lines, the development of those forces of nature which give power such as heat and electricity, the discovery of laws which increase the fertility of soil such as are disclosed by chemistry and botany, the mastery of those sciences which reveal the wealth of the earth, such as geology, mineralogy, and mining, the utilization of those sciences which prevent disease, such as serum therapy and inoculations, the application of the principles of biology to the common affairs of life, as in economic entomology and zoölogy, all these underlie and sustain not only our in-

dustrial life but form the basis on which to build our magnificent systems of education, morality and politics. As human knowledge advances the realm of superstition and bigotry contracts because there can be no superstition where knowledge is and no bigotry where broad views of things exist. Science shows that all processes of nature are based on immutable laws. Many of these are known, others are foreshadowed by the brilliant conceptions of the scientific imagination, while some are still unknown and belong to the category which was once regarded as supernatural, but which is now relegated to the undiscovered. If science in its comparative infancy has thus been able to make such magnificent contributions to those elements which make life worth living, what may we not expect of the future years, when the knowledge which we have to-day will seem only as ignorance to our descendants? We judge science by what it has already accomplished. We know it by its results. When these wonderful contributions to human welfare shall have been made in the future, the words of our text will be no less true: "Ye Shall Know Them by Their Fruits."

Transmissible Diseases in College Towns.

Severance Burrage.

The college town of moderate size is unique in some respects, unique in the possession of certain opportunities for the contraction and dissemination of various diseases. College students, as a class, are looked upon as healthy to an unusual degree, and in many respects this view is a correct one; and yet when looked at from the standpoint of sanitary science, we find them exposed to many dangers that are oftentimes overlooked. Many of these dangers do not exist in other communities.

The herding together of a lot of men or boys into unhygienic quarters in unsanitary dormitories is one of the features of the student's life that must be looked upon as a danger. It is also an added responsibility to the college authorities. When the dormitory fulfills all the requirements of the rules of hygiene and sanitary science; and when there are good hospital facilities for students living in the dormitory who may become ill with a contagious or an infectious disease, then the above statements might be somewhat modified.