PRESIDENTIAL ADDRESS

Indiana Scientists

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Indiana has contributed many leaders. We are widely known for our famous authors and journalists. Far less well known is the fact that Indiana has been the birthplace of a large number of scientists, a goodly number of whom have been highly distinguished. For example, two Nobel Prize Winners were born in Indiana, as were 18 members of the National Academy of Sciences and 81 starred scientists. Many other Hoosier scientists who for one reason or another have not won these particular honors, have contributed notably to science and to industry, and are widely respected.

Although every one in the Academy realizes that scientists are important—indeed precious—little research has been done on what conditions are especially conducive to the production of scientists. As a geographer, I have long been interested in where various commodities, such as wheat, hogs, coal, furniture, and works of art, are produced. Geographers are expected to know not only where all sorts of things are produced, but also why they are produced there; that is, what conditions favor their production.

It is coming to be widely recognized that man himself is civilization's most valuable resource. Though this concept is relatively new, it is surprising that so few earnest efforts have been made to learn the conditions conducive to the production of superior men. My own study of the geography of Indiana notables commenced in 1919 when I was writing the geography section of the *Handbook of Indiana Geology* for the then newly-established State Department of Conservation. I had made maps showing where in Indiana the most corn, wheat, peaches, coal, lumber, flour, furniture, etc. were produced. Then the birthplaces of a dozen famous Indiana authors were mapped, and it was seen that most of them come from less than one-fifth of the state. Two years later, a list of the Hoosier scientists starred in the 1921 edition of *American Men of Science* was compiled and their birthplaces plotted. Although their birthplaces are less concentrated in one part of the state than are those of the famous authors, most of the state had yielded few of these leading scientists.

This distribution aroused my scientific curiosity. Additional lists of Hoosier notables were gathered: college presidents, engineers, presidents of leading societies, etc. The evidence accumulating led me to expand the study to include other states. In 1928, "The Geography of American Notables" was published by Indiana University, and the volume aroused such widespread interest as to be soon out of print. During the next 20 years, further studies of notables were made, es-

pecially of distinguished scientists, and partly published in journals. That data on the starred scientists formed the nucleus of a volume published by the Johns Hopkins University Press in December, 1947.

Subsequently, additional studies of Indiana scientists were made and partly published in the "Proceedings of the Indiana Academy of Science." These and other studies of Indiana scientists will appear in a volume, *Indiana Scientists*, soon to be published by the Indiana Academy of Science, with the aid of special grants.

Indiana Scientists has four sections. The bulk of the book consists of brief biographical sketches of certain scientists who were born in Indiana, received their college or doctoral training here, or pursued scientific work here for two years or longer. Those who contributed notably to science in Indiana have fuller sketches than those merely born, college-trained, or briefly employed in the state. Most of the persons sketched are those denoted as significant American scientists by appearing in one or more of the eight editions of *American Men of Science* from 1906 to 1944.

Another section of *Indiana Scientists* consists of summaries by institutions of their contributions of scientists; and summaries by science of the chief contributions of Indiana scientists. These summaries, which are especially notable, are being contributed by specialists, each listed as the author of his section. It is hoped that from time to time more of this much-needed information will be contributed to the "Proceedings of the Indiana Academy of Science" and to the various journals.

A third part of the book is a series of special studies of some of the scientists. This section is partly reprinted from the "Proceedings".

The summary and conclusions make up the other chief part of the volume, which appears as Chapter 1. An abstract of that chapter comprises most of the present address.

Of the (about) 4,334 scientists sketched, slightly more than a fourth are chemists; about one-sixth biologists; nearly one-eighth physicists; and nearly an eighth engineers. In addition, there are about 250 mathematicians, 210 psychologists, 130 geologists or geographers, and almost 100 each of bacteriologists, pharmacologists, and physiologists. A score of other disciplines are represented by smaller numbers, set forth in the book.

Birthplaces of Indiana Scientists

Approximately half of the scientists sketched were born outside Indiana. Of these, 187 were foreign-born. Canada yielded 42; Germany 26, Great Britain 19, other northwestern Europe 27, eastern and southern Europe 32; China 14, other Asia 12; Africa 5; Latin America 8; New Zealand 2.

Of the American-born, New England produced 131, New York 179, Pennsylvania 156, New Jersey 34, Maryland 35, Virginia 24, and other eastern and southeastern states a total of 51.

Kentucky yielded 68 (mostly from Louisville and other points near Indiana), Tennessee and West Virginia each yielded 21, Texas 38, and

all other southern states 63. The Rocky Mountain states produced 87 and the Pacific states 65.

About half of the native Americans not born in Indiana were born in the other states of the Midwest: 299 in Illinois; 254 in Ohio; 125 in Michigan; 109 in Iowa; 75 in Wisconsin; 77 in Kansas; 64 in Missouri; 57 in Minnesota; 44 in Nebraska; and 34 in Dakota. Chicago alone yielded 94.

Of the about 2,036 born in Indiana, Indianapolis accounted for 163; five places accounted for from 40 to 55 each; six places from 20 to 27; 25 yielded seven, eight, or nine; 34 yielded five or six; 60 produced three or four; 102 places yielded two; and 257 places, one. Hence, 489 Indiana places are given as the birthplace of these scientists. Each county is credited with at least one. Many of the places of birth were small, and scores of them no longer appear on even detailed maps. Presumably, most of the 77 men and women who gave their birthplace by county only came from farms; and doubtless some who gave their birthplace as a village or town were actually born on a nearby farm.

When the number born in each Indiana county is compared with the then-existing population of the county, it is seen that some counties yielded many times as many scientists relatively as did certain other counties. Details as to which counties were exceptionally productive or sterile are in the volume.

The causes for these differences are of broad social significance. In order to illuminate them, the data must be studied deeply and from many angles. First, let us consider the cities and towns which are outstanding. Those which yielded 20 or more, arranged alphabetically with the number, are: Anderson 20, Bloomington 26, Evansville 31, Ft. Wayne 51, Indianapolis 163, Kokomo 27, Lafayette (including West Lafayette) 46, Logansport 21, Muncie 20, New Albany 20, Richmond 50, South Bend 41, and Terre Haute 55.

Places which yielded from 7 to 19 scientists are: Aurora 9, Bedford 10, Brazil 7, Brookville 7, Columbus 7, Columbia City 9, Connersville 11, Crawfordsville 14, Elkhart 13, Elwood 7, Frankfort 16, Garrett 7, Goshen 9, Greencastle 13, Greenfield 8, Hammond 8, Huntington 16, Huntingburg 10, Jeffersonville 10, Kendallville 12, LaPorte 13, Lawrenceburg 7, Lebanon 13, Liberty 8, Linton 10, Madison 14, Marion 14, Michigan City 9, Mt. Vernon 13, Newcastle 8, Noblesville 8, North Manchester 14, Peru 8, Portland 8, Princeton 8, Remington 7, Rensselaer 7, Rockport 7, Salem 12, Shelbyville 13, Tipton 7, Union City 7, Valparaiso 7, Vincennes 13, Wabash 10, and Warsaw 8.

Some smaller places which yielded fewer than 7 but were outstanding in proportion to their smaller populations are: Angola 5, Attica 5, Batesville 5, Bloomfield 5, Bluffton 6, Butler 6, Delphi 6, Economy 5, Fowler 5, Franklin 5, Goodland 5, Lagrange 5, Marshall 5, Moores Hill 5, Mulberry 4, Oakland City 4, Orleans 6, Paoli 5, Pendleton 5, Plainfield 5, Sheridan 6, Upland 5, Walkerton 5, Waynetown 4, Whitney 4, Windfall 4, Worthington 4, and Zionsville 5.

A detailed consideration of these statistics and of similar data on other groups of notables has led to the conclusion that several factors

help to explain the contrasts in yields of various places. One of these is contrasts in local educational opportunities. Many of the more productive places had academies or high schools which were recognizedly successful.

Highly significant also is the presence or absence in the community of serious-minded people. Scientists seldom come from families conspicuous for their lack of concern for the general welfare and for the future. In Indiana, the groups yielding relatively many scientists were the Quakers; people of Yankee ancestry; and those of Scotch and German ancestry. The number of German names in this book is truly astounding to a non-German such as I.

Partly because many of these scientists were the children of scientists, a few data on the number of children of these scientists may be inserted here. Of 2,595 scientists who reported being married, nearly a fourth reported no children and a fourth only one. Forty per cent had two children and 20 per cent, three. Fewer than a tenth had four or more children (55 had five, 10 had six, 4 had seven, and 4 had eight or nine.) As three children are normally required to maintain the population, more than two-thirds of these scientists are slated for biologic extinction unless their offspring have more children than they themselves reported.

The future of our country is somber if the bearing and rearing of the next generation is left largely to families poorly qualified biologically and culturally to rear children.

Of great consequence in a youth's choice of a vocation—meteorology, merchandising, teaching, or professional gambling, for example—is encouragement from one or more persons whom he deeply respects. Such encouragement may change the direction of his life. Stimulating high school and college teachers are notably significant. Specific illustrations of stimulating teachers are given in the discussion of starred scientists. Also significant is the influence of other highly-respected people in the communities. The scientist's mother may exert a profound influence. A considerable number of scientists were children of educators and scientists. The success of others from the boyhood community also has a bearing. Doubtless this influence helps to explain why certain small Indiana places yielded first one outstandingly successful scientist and later more scientists.

Highly significant in the yield of a particular place are the opportunities there for work in science. Some Indiana cities and towns have relatively many opportunities for able and earnest young people. This helps to explain the important yield of college towns, notably Lafayette and West Lafayette, where Purdue University and the United States Experimental Station operate.

Indiana Colleges and the Education of Indiana Scientists

Of these scientists many graduated from an Indiana college or university. Indiana University conferred the bachelor of arts or the bachelor of science degree on 532, Purdue on 486, DePauw on 208, Wabash on 127, Notre Dame on 108, Earlham on 95, Butler on 74, Valparaiso on 51, Indiana State Teachers (Normal) College on 46, Rose Polytechnic

Institute on 43, Manchester on 31, Hanover on 21, Franklin on 19, Indiana Central on 15, Evansville on 11, Marion on 10, Taylor and Tri-State each on 9, Ball State, Goshen and Oakland City each on 8, Moores Hill on 6, Danville on 4, Winona on 2, and St. Joseph's and St. Mary's each on 1. There were 1,924 bachelor's degrees from Indiana institutions.

Native Hoosiers comprise the bulk of the graduates of the state-supported schools. More came from outside the state to attend Purdue University than to attend Indiana University. The non-state-supported institution with the largest percentage of its alumni from other states is DePauw; the next is Notre Dame; and the third, Earlham.

Of the scientists here studied, 784 received doctorates in Indiana: 361 from Purdue, 328 from Indiana, and 95 from Notre Dame. All but a few of Notre Dame's total went to non-Hoosiers, as did most of Purdue's. By contrast, nearly two-thirds of Indiana's doctorates went to Hoosiers. Purdue and Notre Dame both conferred doctorates on many of their faculty; a large share of Notre Dame's science faculty consists of local Ph.D.'s, as does almost half of Purdue's. Indiana University, however, awarded few Ph.D.'s to its own faculty.

In the total number of their alumni sketched, Purdue and Indiana are far ahead. The institutions which have yielded most in proportion to total enrollments of men students are Wabash, DePauw, Earlham, and Indiana, in that order. Wabash, Earlham, and Indiana were especially notable before 1910. In recent years, DePauw, first, and Purdue, second, have been outstanding. But Purdue has had many more men students in recent decades than has any other Indiana school—nearly twice as many as Indiana University has had. As *Indiana Scientists* sketches many engineers and agriculturalists, as well as the more conventional types of scientists, Purdue's alumni appear in numbers. Indeed, nearly a quarter of the scientists sketched are Purdue alumni or one-time faculty members.

In tabulating the place of college training of these scientists, it was interesting to note what a large fraction graduated near their birthplace. This illustrates again the importance of nearby colleges to a community's yield. The local reputations of Wabash and DePauw appear to have been especially good, as relatively few natives of their localities graduated elsewhere. In contrast, most of the 50 born in Richmond graduated outside of Indiana as did many of the 163 born in Indianapolis. A considerable number from Lafayette and West Lafayette graduated at Indiana University, and several from Bloomington graduated at Purdue.

One of the characteristics of embryo scientists is that they are observing and earnestly seek better conditions. These traits tend to encourage them to attend colleges whose shortcomings are less evident to them than are those of their local colleges.

Indiana Places of Employment of Scientists

The number of scientists depends to no small degree upon the number who can make a living as scientists. Many people who are not scientists have much curiosity and desire to discover new truth. Many

also possess two other qualities needed: initiative and perserverance. Some of these might have become scientists if favorable conditions had prevailed. Consequently, the opportunities afforded able young scientists is highly significant.

Indiana has been the birthplace and the place of college education of many more scientists than the number to which it has afforded adequate opportunities in science to earn a living. Consequently, many of our scientists have had to enter non-scientific endeavors—largely teaching—or go to other states for employment.

A tabulation was made of the type and place of employment of those employed in Indiana. Indiana educational institutions employed 1,528 and Indiana industry 853. Indiana industrial firms have employed a sharply increasing number. For example, a competent elderly Indiana scientist believes that in 1895 fewer than 25 scientists were thus employed in contrast to several hundreds in 1950.

Purdue University has been the leader by a wide margin in the number which it has at one time or another employed: a total of 631. Indiana University has employed not many more than half that number, 350. Notre Dame has employed 111, DePauw 59, Wabash 54, Butler 45, Earlham 41, Rose Polytechnic 33, Valparaiso 33, Indiana State Teachers 27, Ball State 20, Evansville 19, Franklin 16, Hanover 11, Indiana Central 11, Manchester 10, Taylor 10, Marion 9, Vincennes 8, and Goshen 7. Employing 4 or 5 each were Oakland City, St. Mary's-in-the-Woods, Tri-State and Danville.

Purdue's outstanding leadership in the number of Indiana scientists employed reflects at least three conditions. One is the aforementioned many opportunities for scientists in the United States Experimental Station there and in part-time teaching in the University, one of the largest in agriculture and engineering. A second is that master's degrees or doctorates furnished part of the compensation to many of these scientists. A third explanation of the large Purdue total is the fact that many remained for only a short time, perhaps no more than the two years minimum necessary for listing in this book. Purdue has employed briefly numerous subsequently well-known scientists. Some of the faculty have remained for many years, but on the average the annual turn-over has been relatively large. This is also true for Notre Dame and Valparaiso. Purdue's record of attracting professors from other Indiana institutions is notable.

Although Purdue has led by a wide margin in the number of scientists employed, Indiana University has led in the distinction of some of its faculty. Consistently since starring commenced in 1906, Indiana University has had most of the starred scientists in the state, generally over two-thirds of the state total. It has also had the only members of the National Academy of Sciences. Members of its faculty who have risen high in the scientific world after leaving are also far more numerous than for the other schools.

Among industrial firms in Indiana, two have been outstanding in employment of the scientists sketched. The Standard Oil Company of

Indiana has employed 173, and Eli Lilly and Company 110. Both of these have employed many experts who have contributed notably to the advancement of science. Indeed, each has had a few starred scientists. A large majority of the Standard Oil scientists were from other states, as were somewhat more than half of those of Eli Lilly. But both have also employed many Indiana scientists, especially Ph.D.'s. (A total of 228 Ph.D.'s from the University of Chicago are sketched in this volume. Most of them have been employed by Standard Oil (Ind.), Eli Lilly, Purdue or Indiana University.)

The third Indiana corporation in the number of Indiana scientists employed is Commercial Solvents Company of Terre Haute, with 50. Concerns which have employed about a dozen are General Electric (all Ind. plants), Meade-Johnson (Evansville), Servel (Evansville), Pitman-Moore (Indianapolis), and Schenley (Aurora). Companies which have employed seven to nine are Bendix (South Bend), Magnavox (Ft. Wayne), Miles (Elkhart), Sinclair, and three Indianapolis firms, Presto-Lite, Reilly Tar, and Swan-Myers. Concerns employing four or five of these scientists are Diamond Saw, Central Soya, Glidden, Grasselli, Linde, Seagrams', Studebaker, Van Camp, Universal Atlas Cement, and U. S. Rubber (Ind.).

Some Conclusions

Indiana has been the birthplace, place of higher training, or place of employment of numerous scientists, including some of the nation's most-honored. Some 485 Indiana cities, towns, and hamlets are given by these scientists as their birthplaces, and each Indiana county has been the birthplace of one or more. Some areas have, in proportion to their population at about the time of birth of the scientists, yielded exceptionally large numbers.

Contrasts in the yield of this valuable resource, scientific leadership, are of such profound social significance that prolonged, detailed studies of their causes not only are justified but are highly desirable. The present study supplements, extends, and supports other studies and conclusions. Four of these conclusions may be summarized here.

(1) Encouragement or stimulation is deeply significant in the production of leaders. Indeed, although some business men and a few others have bragged that they were "self-made," the evidence clearly indicates that no scientists are self-made. Encouragement is essential to the development of a scientist. This encouragement may come from one or more sources. If it comes from the immediate family, that is a great help. Some receive it from an especially stimulating high school teacher or college professor. Many scientists have acknowledged that encouragement from their mother was especially significant in their earlier years, while a college teacher played a major role in their specialization and in their later career. Sometimes the stimulus comes from a friend or from a cousin, aunt or uncle. The proven great significance of encouragement justifies each of us to be generous in encouraging our own more promising students and young friends. A few appreciative words may alter their life!

(2) A second major influence facilitating the production of scientists is the presence of opportunity to obtain adequate training—and this presupposes the opportunity to obtain the benefits of studies made by previous workers in the field. The presence in Indiana of several excellent educational institutions is therefore highly significant. Since the most effective form of education is working individually with an able, enthusiastic specialist—not mere 'book learning' or mass lectures—the type of instructor available is of vital import. All interested in increasing the number of scientists should constantly remember that individual instruction of a high order is almost essential.

(3) As nearly all scientists must earn a living, the opportunity to do so is essential. Employment close at hand is of great assistance, especially to beginners. It is evident that in the present world there is great need for more scientists and for greater scientific achievement in diverse fields. Hence, scientists should be more adequately recognized and should be afforded better opportunities for their work, which, in nearly all instances, is for the benefit of mankind and not for their personal gain. It is a reflection on the good name of Indiana that we have afforded good living opportunities for so few scientists, except perchance indirectly, as teachers.

(4) Most fundamental in the yield of scientists is the presence of a favorable biologic and cultural background. An ever-increasing mass of evidence indicates that leaders in science come from families well above average in ability, earnestness, vigor and ambition. Some productive families are found in unexpected places, often because the mother, the most significant parent biologically and culturally, married out of her cultural group. However, families which yield leaders are most numerous in favored communities; for example, college towns, county seats, and attractive suburbs of cities. Such families are also relatively numerous in certain occupational groups, especially in the professional class and particularly among educators and the clergy. Productive families are also more numerous in some human stocks than in others, including, in Indiana, the Quakers, the Scotch, the Yankees, and the early Germans. Wherever they are, it is evident that families biologically and culturally distinctly above average have an opportunity to contribute more than their proportionate share of leaders, and should be strongly encouraged to make earnest efforts to do so.

The deductions just mentioned are not merely academic. Each of us here can aid somewhat. Let us resolve to do better than we have hitherto done with respect to encouraging potential scientists, partly by giving them more individual attention, and partly by increasing their opportunities to earn a living in science. Last, but not least, we should all endeavor to increase the number of children born into families qualified to produce future scientists.