wall of prejudice which surrounds the office of the geologist in charge of geology and makes of it a sort of national quarantine station for new ideas, is a direct and natural result of the overgrown kindergarten establishment of the survey—the department of geologic folios. The great extravagance of this enterprise almost precludes changes in the completed folios, and a ready-made pattern of geological work seems absolutely essential to its successful completion. The letters of the geologist in charge of geology in reference to new views upon areas for which folios have been published, contain expressions like, 'This folio is put forward as the final and most satisfactory results to be reached in this region,' and 'The Geological Survey can not afford to entirely reverse itself.' Should it develop that fundamental geological problems have not all been solved, it is conceivable that when the numerous map areas of the geologic atlas are tied together a century or more hence, serious difficulties will be encountered in matching borders prepared at widely different dates.

Reverting now to the conclusions which I have reached regarding the structure of southwestern New England, I may add that during the past year I have found some opportunity to note while in Europe the conclusions which are now being reached by geologists respecting other regions of crystalline rocks. In Calabria, the Vogesen, in southern Norway and especially in Scotland, essentially the same conclusions have been reached by the official geologists of those countries respecting the relative importance of fold and fault structures. I am informed by the director of the Geological Survey of Great Britain that a report will soon appear treating of the crystalline area of Scotland, within which area a definite system of faults has been found to be superimposed upon the flexures everywhere present in the district. These faults are nearly vertical, are comprised in several parallel series, and are so numerous that though the map is covered with them, a small proportion only can be represented.

I trust I have made the reasons for tendering my resignation sufficiently clear. The proper function of a great national geological survey I conceive to be something more than to report upon mining regions and to bring together some tons of geological card catalogues printed in diluted English, otherwise designated as folios. My resignation from the survey will permit me to freely express this view and raise my voice against what I consider a most pernicious influence upon American geology.

I am, sir, very respectfully,

Wm. H. Hobbs.

SPECIAL ARTICLES.

A STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE: THE SELECTION OF A GROUP OF ONE THOUSAND SCIENTIFIC MEN.

The psychologist, like the student of other sciences, can view his subject from different standpoints and pursue it by various methods. He may get what knowledge he can of mental processes by introspection, or he may use objective methods. He may confine himself to the 'inner life,' or he may study the individual in all his psychophysical relations. He may give verbal descriptions, or he may make measurements. He may describe static mental life, or he may study the lower animals and human beings from a dynamic and genetic point of view. He may attempt to determine facts and laws that hold for mental life in general, or he may attend to individual differences. He may ignore the practical applications of his science, or he may investigate them. Psychology has until recently concerned itself chiefly with the first of these various alternatives. But its recent progress and future development seem to the present writer to depend particularly on the second. In this case, our two main methods, which can often be combined, are experiment and measurement in the laboratory, and the inductive and statistical study of groups of individuals. In recent years great progress has been made in both directions. Experimental psychology has become a science coordinate with the other great sciences, and statistics have been extended to include sociological and moral phenomena.

The intensive study of groups of individuals has, however, only been begun. The origin of the method may be attributed to Quetelet, whose 'Essai de physique sociale' was published in 1835, and its principal development to Dr. Francis Galton, whose 'Hereditary Genius' (1869) has been followed by a series of books and articles, including 'English Men of Science' (1874). Another work bearing closely on the subject matter of the present paper is Alphonse de Candolle's 'Histoire des sciences et des savants depuis deux siècles' (1873). Other extensive studies of groups of individuals are: Dr. Paul Jacoby's 'Etudes sur la sélection' (1881), which has as its subject matter the 3,311 Frenchmen of the eighteenth century whose biographies are included in the 'Biographie universelle,' Professor A. Odin's 'Genèse des grands hommes' (1895), which is a study of 6,382 French men of letters; Mr. Havelock Ellis's 'A Study of British Genius' (1906, published in the *Popular Science Monthly,* February–September, 1901), which considers 859 men and 43 women of eminence, and Dr. F. A. Woods's 'Mental and Moral Heredity in Royalty' (1906, published in the *Popular Science Monthly,* August, 1902–April, 1903), which treats 832 members of royal families.

I have myself selected as material for study three groups: a thousand students of Columbia University;[1] the thousand most eminent men in history;[2] a thousand American men of science.[3]

[1] 'Physical and Mental Measurements of the Students of Columbia University' (with Dr. Livingston Farrand). *Psychol. Rev.*, **3**: 618–648, 1896. Cf. also the dissertation for the doctorate of Clark Wissler 'The Correlation of Mental and Physical Tests,' *Psychol. Rev.*, Monograph Supplements, **16**: iv–62, 1901.

[2] 'A Statistical Study of Eminent Men,' *Pop. Sci. Mon.*, **53**: 359–378, 1903.

[3] 'Homo Scientificus Americanus: Address of the president of the American Society of Naturalists,' SCIENCE, N. S., **17**: 561–570, 1903. 'Statistics of American Psychologists,' *Am. Jour. of Psychol.*, **14**: 310–328, 1903. Towards the cost of computation in connection with this research, I have received a grant of two hundred dollars from the Esther Herrman Research Fund of the Scientific Alliance of New York.

Each of these groups seems to me favorable for such work. The students of Columbia College are measured, tested and observed in our laboratory; we are able to follow their academic courses and their careers in after life. The lives of the most eminent men of history are to a certain extent public property, open to statistical investigation and psychological analysis. A thousand scientific men in the United States will doubtless be willing to assist in furnishing the material needed, which is in any case accessible from other sources.

TABLE I. THE NUMBER OF AMERICAN MEN OF SCIENCE AND THEIR DISTRIBUTION AMONG THE SCIENCES.

	Special Societies.	Fellows of Association.	Members of Academy.	University Professors.	Doctorates in Five Years.	Contributors to SCIENCE 13 Vols.	Who's Who.	Biographical Dictionary (Estimated).[4]
Mathematics..	375	81	1	136	61	35	46	380
Physics	149	167	23	105	69	155	73	556
Chemistry.....	1933	174	12	143	137	73	166	656
Astronomy ...	125	40	12	41	16	48	51	212
Geology........	256	121	13	55	32	161	174	436
Botany.........	169	120	7	57	53	94	70	416
Zoology........	237	146	17	83	72	243	131	620
Physiology ...	96	10	2	53	18	22	25	156
Anatomy......	136	10	0	56	1	13	18	116
Pathology.....	138	14	5	68	4	44	56	224
Anthropology	60	60	3	4	5	56	37	92
Psychology ...	127	40	1	37	63	58	21	136
Total.........	3801	983	96	838	531	1002	868	4000

REDUCED TO PER THOUSAND.

Mathematics..	99	32	10	162	113	35	53	95
Physics.........	39	170	240	125	128	155	84	139
Chemistry.....	506	177	125	171	265	73	191	164
Astronomy...	33	41	125	49	30	47	59	53
Geology........	68	123	136	66	60	161	200	109
Botany.........	45	122	73	68	99	94	81	104
Zoology........	63	149	177	99	134	243	151	155
Physiology ...	25	10	21	63	34	22	29	39
Anatomy	36	10	0	67	2	13	21	29
Pathology......	36	14	52	81	8	44	64	56
Anthropology	16	61	31	5	9	56	43	23
Psychology ...	34	41	10	44	118	57	24	34

[4] The distribution among the sciences of those in the 'Biographical Directory of American Men of Science' (published this year by The Science Press, New York) differs rather more than I had expected from this estimate, which was based on the first thousand entries that were written.

The accompanying table, which with most of the data to be discussed refers approximately to January 1, 1903, shows how American men of science are distributed among the principal sciences by various agencies. There are in the table certain facts that require allowance, or at least mention. The American Chemical Society and the doctorates conferred in chemistry represent in part professional work in applied science. Under the special societies there are duplications, as scientific men may belong to more than one society. The American Mathematical Society and the Association of American Anatomists have been rather liberal in the admission of members. As mathematics and the medical sciences are required subjects for large groups of students, there are many teachers, but this has not produced a proportional number of investigators. The membership of the National Academy represents to a certain extent the interests of the passing scientific generation, the doctorates the interests of the coming scientific generation.

In selecting a group of a thousand scientific men, the number in each science was taken roughly proportional to the total number of investigators in that science, the numbers being: Chemistry, 175; physics, 150; zoology, 150; botany, 100; geology, 100; mathematics, 80; pathology, 60; astronomy, 50; psychology, 50; physiology, 40; anatomy, 25; anthropology, 20.

There are in the 'Directory' 4,131 names, of whom 131 are students of philosophy, education, economics and sociology, leaving just 4,000 in the twelve sciences under consideration. They are distributed among the sciences as follows: mathematics, 340; physics, 672; chemistry, 677; astronomy, 160; geology, 444; botany, 401; zoology, 441; physiology, 105; anatomy, 118; pathology, 357; anthropology, 91; psychology, 194. These figures were not at hand when it was necessary to select the thousand men of science for this research. The numbers under physics and pathology are increased by the inclusion under these sciences of engineers and physicians. The chief discrepancy is that there are fewer zoologists than was indicated by the preliminary estimate or by the other data of the table.

The individuals were selected by asking ten leading representatives of each science to arrange the students of that science in the order of merit. There were for each science slips made with the names and addresses of all those known to have carried on research work of any consequence. The total number assigned a position was 2,481, distributed among the sciences as follows: Mathematics, 201; physics, 261; chemistry, 389; astronomy, 165; geology, 257; botany, 213; zoology, 290; physiology, 101; anatomy, 89; pathology, 251; anthropology, 72; psychology, 192. These numbers included duplications when a man was given a place in more than one science.

The memorandum sent to those who were asked to make the arrangement was as follows:

MEMORANDUM.

The undersigned is making a study of American men of science. The first problem to be considered is the distribution of scientific men among the sciences and in different regions, institutions, etc., including the relative rank of this country as compared with other countries in the different sciences, the relative strength of different universities, etc. It is intended that the study shall be continued beyond the facts of distribution to what may be called the natural history of scientific men.

For these purposes a list of scientific men in each science, arranged approximately in the order of merit, is needed. This can best be secured if those who are most competent to form an opinion will independently make the arrangement. The average of such arrangements will give the most valid order, and the degree of validity will be indicated by the variation or probable error of position for each individual.

It is obvious that such an order can be only approximate, and for the objects in view an approximation is all that is needed. The judgments are possible, because they are as a matter of fact made in elections to a society of limited membership, in filling chairs at a university, etc. By merit is understood contributions to the advancement of science, primarily by research, but teaching, administration, editing, the compilation of text-books, etc., should be considered. The different factors that make a man efficient in advancing science must be roughly balanced. An effort may be made later to disentangle these factors.

In ranking a man in a given science his contributions to that science only should be considered. Thus, an eminent astronomer may also be a mathematician, but in ranking him as a mathematician only his contributions to mathematics should be regarded. In such a case, however, mathematics should be given its widest interpretation. It is more difficult to arrange the order when the work can not readily be compared, as, for example, systematic zoology and morphology, but, as already stated, it is only expected that the arrangement shall be approximate. The men should be ranked for work actually accomplished, that is, a man of sixty and a man of forty, having done about the same amount of work, should come near together, though the man of forty has more promise. It may be possible later to calculate a man's value with allowance for age.

In case there is noted the omission of any scientific man from the list who should probably have a place in the first three quarters, a slip may be added in the proper place with his name and address. In case there are names on the list regarding which nothing is known, the slips should be placed together at the end. The slips, as arranged in order, should be tied together and returned to the undersigned.

It is not intended that the lists shall be published, at all events not within ten years. No individual list will be published. They will be destroyed when the averages have been calculated, and the arrangements will be regarded as strictly confidential.

The ten positions assigned to each man were averaged, and the average deviations of the judgments were calculated. This gave the most probable order of merit for the students in each science, together with data for the probable error of the position of each individual. The students of the different sciences were then combined in one list by interpolation, the probable errors being adjusted accordingly. The list contains 1,443 names, of whom the first thousand are the material used in this research.

It should be distinctly noted that the figures give only what they profess to give, namely, the resultant opinion of ten competent judges. They show the reputation of the men among experts, but not necessarily their ability or performance. Constant errors, such as may arise from a man's being better or less known than he deserves, are not eliminated. There is, however, no other criterion of a man's work than the estimation in which it is held by those most competent to judge. The posthumous reputation of a great man may be more correct than contemporary opinion, but very few of those in this list of scientific men will be given posthumous consideration. I am somewhat sceptical as to merit not represented by performance, or as to performance unrecognized by the best contemporary judgment. There are doubtless individual exceptions, but, by and large, men do what they are able to do and find their proper level in the estimation of their colleagues.

In order to obtain the 10 arrangements in each science, or 120 in all, it was necessary to ask the assistance of 192 scientific men. Twenty-three of these did not reply to my letter; 16 declined to make the arrangement, usually on the ground that it was not feasible; 23 consented, but afterwards gave it up or did not send the slips in time, and 10 made arrangements that could not be used, in most cases because the names were arranged in groups instead of being ordered serially. As the arrangement resulted, those who made it and those who were asked but failed were distributed in the different hundreds of the thousand, as follows:

TABLE II. THE STANDING OF THOSE WHO MADE THE ARRANGEMENTS AND OF THOSE WHO WERE ASKED BUT FAILED.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	Total.
Observers..	47	26	20	9	6	3	1	1	3	4	0	**120**
Failed......	29	20	10	5	1	0	3	1	0	1	2	**72**
Total.....	76	46	30	14	7	3	4	2	3	5	2	**192**

Thus 76 of those who proved to be in the first hundred men of science were asked to make the arrangement and 47 of them did so. Only twelve of those who made the arrangement are not in the first five hundred. In anthropology, for example, there are only twenty representatives in the list, of whom but two would probably be in the first hundred, and of the twelve sciences there are only three that would be expected to have more than ten in the first hundred. It is, therefore, evident that the ten scientific men who gave the judgments in each science are among the leaders in that science. But their standing must of necessity vary with the different sciences, one half of all the anthropologists having made the arrangement and only two thirty-fifths of all the chemists.

Those asked to arrange the names were distributed among different institutions, as shown in Table III.

TABLE III. THE DISTRIBUTION AMONG INSTITUTIONS OF THOSE WHO WERE ASKED TO MAKE THE ARRANGEMENTS.

	Number in 1,000.	Number Asked.	Per Cent. Asked.	Number of Observers.	Per Cent. of Observers.	Per Cent. of Those Asked.
Harvard	66.5	23	.35	7	.10	.30
Columbia	60.0	20	.33	13	.21	.65
Chicago.	39.0	17	.44	15	.38	.88
Cornell	33.5	6	.18	4	.12	.67
Geological Survey	32.0	7	.22	4	.12	.57
Depart. of Agriculture.	32.0	3	.09	3	.09	1.00
Hopkins	30.5	13	.43	5	.16	.38
Yale	26.5	8	.30	6	.23	.75
Smithsonian Institution.	22.0	9	.41	5	.23	.55
Michigan	20.0	9	.45	7	.35	.78
Wisconsin	18.0	3	.17	2	.11	.67
Pennsylvania	17.0	10	.59	6	.35	.60
Stanford	16.0	3	.19	3	.19	1.00
Princeton	14.5	3	.21	0	0	0
New York University	9.5	5	.53	4	.42	.80
Clark	7.0	5	.71	3	.43	.60
New York Bot. Garden.	6.0	2	.33	2	.33	1.00
One at each institution		46	.08	31	.06	.67
Total		**192**		**120**		

Thus 23 scientific men connected with Harvard University were requested to sort out the slips; this was done by 7 of them. Sixty-six and five tenths of the thousand, as the list resulted, are at Harvard University; about 10 per cent. of them made the arrangement, which is about 30 per cent. of those asked. Seventeen of the 39 scientific men at the University of Chicago were asked to make the arrangement, of whom fifteen accomplished it and two did not. Or 38 per cent. of all its men made the arrangement, who were 88 per cent. of those asked. The numbers are in most cases too few to give a correct measure of the cooperativeness in such a scheme of the different institutions, but, so far as they go, they are not altogether without interest. They are not, however, printed here for that purpose, but in order to show the geographical distribution of those who made the arrangement. It appears that different institutions are fairly well represented, there being no great preponderance of any one of them. Of the 120 who made the arrangement 89 are connected with the 17 institutions given in the table, although these institutions contain only 450 of the 1,000 scientific men. They, however, have, as will be shown later, a much larger proportion of the more eminent scientific men.

Those who made the arrangements are not likely to possess equal information, impartiality and good judgment. If there were only two arrangements of each group it would not be possible to decide objectively which is the better. We have, however, ten arrangements, and the average is more likely to be correct than any one of them. The conditions are the same as in the case of observations in the physical sciences. As the personal equation of the astronomer is determined by comparing his observations with those of other astronomers, so here we can measure the accuracy of judgment of each observer by determining how far it departs from the average judgment.

I have counted up the departures of each of the ten observers from the average result for one of the groups, namely, the fifty psychologists. The data are given in Table IV. by groups of ten.

The observer A is always more accurate than any other observer, except in one case in the fifty. The validity of judgment of the ten observers varies from 7.9 to 17.26, or about as 1:2, which is approximately the variability that I have found in normal individuals in other mental traits, such as accuracy of perception, time of mental processes, memory, etc. The departures from the mean reliability of judgment, given in the last line of the table, indicate that accuracy of judgment tends in a general way to follow the normal distribution of the probability curve, though with so few cases this may be accidental. As the

TABLE IV. MEASUREMENTS OF THE ACCURACY OF JUDGMENT OF TEN OBSERVERS.

	A	B	C	D	E	F	G	H	I	J	Average.
I.	1.6	5.2	2.3	3.1	1.9	2.8	1.8	2.4	5.0	2.6	**2.87**
II.	4.9	7.0	8.7	7.8	6.3	4.2	10.2	6.1	7.0	5.1	**6.73**
III.	7.1	11.1	13.5	12.4	24.2	16.2	12.5	12.0	16.9	27.6	**15.35**
IV.	13.8	18.0	16.7	18.4	18.8	18.1	22.7	25.4	21.9	25.5	**19.93**
V.	12.1	17.4	21.1	21.1	13.2	26.6	21.7	24.7	22.9	25.5	**20.63**
Av.	**7.9**	**11.74**	**12.46**	**12.56**	**12.88**	**13.58**	**13.78**	**14.12**	**14.74**	**17.26**	**13.1**
A.	*—5.20*	*—1.36*	*—0.64*	*—0.54*	*—0.2 5*	*+0.48*	*+0.68*	*+1.02*	*+1.64*	*+4.16*	*±1.60*

validity of the judgments varies to a measured degree, the arrangements made by the individuals could be weighted. I have not undertaken the somewhat tedious calculations necessary; they would not considerably alter the order, but would make it somewhat more exact, at the same time decreasing the probable errors.

There is here measured for the first time, I think, the accuracy or reliability of judgment. This is obviously a complex and imperfectly analyzed trait, depending on a large number of varying conditions. A man's judgment may be good in some directions or from certain points of view, and bad in other ways. Still we understand vaguely what is meant by good judgment and value the trait highly in ourselves and in others. Thus most people complain that they have a bad memory, but I have never heard any one acknowledge that he had a bad judgment. It appears that the measurement of the reliability of judgment of individuals may have wide-reaching applications in civil service examinations and in all cases where individuals are selected for special purposes, a balanced judgment being nearly always more important than the kind of information that can be tested by a written examination. I have measured the accuracy of observation and memory[5] and Dr. F. B. Sumner has measured the validity of beliefs.[6] When we learn to look upon our observations, recollections, beliefs and judgments objectively, stating in numbers the probability of their correctness and assigning probable errors to them, there will be an extraordinary change in our attitude in religion, politics, business and all the affairs of life.

There are two cases in which these judgments were subject to special conditions which it may be worth the while to notice—that in which a man of science gave his own position and that in which he gave the positions of his immediate colleagues. In sending out the slips, nothing was said as to whether it was expected that a man should include his own name. Of the 120 who made the arrangement, 34 gave positions to themselves; 20 assigned positions to themselves lower than that resulting from the average judgment, twelve higher positions and two the same positions. On the other hand, 22 gave themselves positions higher than the average grade (which is lower than the position, being related to it somewhat as the average is to the median), ten lower and two the same. The judgments were somewhat more accurate than the average judgments. In 21 cases the departures from the mean were less than the average departures and in 13 cases they were larger. It thus appears that there is on the average no constant error in judging ourselves—we are about as likely to overestimate as to underestimate ourselves, and we can judge ourselves slightly more accurately than we are likely to be judged by one of our colleagues. We can only know ourselves from the reflected opinions of others, but it seems that we are able to estimate these more correctly than can those who are less interested. There are, however, wide individual differences; several observers overestimate themselves decidedly, while others underestimate themselves to an equal degree.

[5] 'Measurements of the Accuracy of Recollection,' SCIENCE, N. S., **2**: 761–6, 1895.

[6] 'A Statistical Study of Belief,' *Psychol. Rev.*, **5**: 616–31, 1898.

We tend to overestimate the positions of our immediate colleagues, though the departure from the average judgment is not considerable. Here again there are decided individual differences; thus one man assigned positions to six of his colleagues, all of which were above the average, and another assigned positions to five of his colleagues, all of which were below the average. Most of us also overestimate those whose lines of research are similar to our own.

These factors affect the order of the names in the list but slightly, though they increase the probable errors. A more considerable variation is due to the fact that the names were divided among twelve sciences, whereas the lines between the sciences are artificial. A man's work may not fall naturally in one of these conventional sciences, or it may fall in two or more of them. In such cases he is likely to receive a lower position than he deserves. It is not clear how this difficulty could have been avoided, for if more departments of science had been used, the overlapping would have been greater.

TABLE V. THE NUMBERS OF THOSE WHO WERE ASSIGNED A POSITION IN MORE THAN ONE SCIENCE.

	Mathematics.	Physics.	Chemistry.	Astronomy.	Geology.	Botany.	Zoology.	Physiology.	Anatomy.	Pathology.	Anthropology.	Psychology.	
Mathematics...	—	1		3	1							1	6
Physics	11	—	1	4	1								17
Chemistry		3	—		3			2		1			9
Astronomy......	9			—									9
Geology				1	—	1	2		2				6
Botany			1		2	—				1			4
Zoology					4		—	3	15	1			23
Physiology... ..			2					—	1	4		2	9
Anatomy........							4	3	—	1		1	9
Pathology			3					2	1	—			6
Anthropology..					1				4		—	1	6
Psychology								1			1	—	2
	20	4	7	8	12	1	6	11	23	8	1	5	106

Table V. gives the cases in which the thousand scientific men were given places in the lists of two or more sciences, even though in the science in which they were given the lower position they did not come within the thousand, but only in the 1,443 who made up the total list. The horizontal lines of the table give those who were assigned the higher position in the science named, and the vertical lines those who were assigned the lower position. Thus there was one man whose higher position was in mathematics, but who was also given a position in physics, and there were eleven men who are primarily physicists and secondarily mathematicians. There are 93 men who have a position in two sciences, five who have a position in three sciences and one who has a position in four sciences. It thus appears that about one tenth of our scientific men do work of some importance in more than one of the twelve sciences here defined.

The chief interest of the table is that it gives a certain measure of the relationships of the sciences. Thus mathematics, physics and astronomy, on the one hand, and zoology, anatomy and physiology, on the other, are the most closely interrelated groups. This might have been foreseen, but the table gives the definite relations. There are but few who are anatomists only, whereas botany is the science which is the least likely to be combined with any other. One of the most serious obstacles to the advancement of science is the lack of men who are expert both in an exact and in a natural or biological science.

There are in all the leading countries academies of science, whose membership is supposed to consist of their most eminent scientific men, and one of the principal functions of such academies appears to be the election of members as an honor. The methods of selection used in this research are more accurate than those of any academy of sciences, and it might seem that the publication of the list would be as legitimate as that of a list of our most eminent men selected by less adequate methods. But perhaps its very accuracy would give it a certain brutality.

Of the first hundred scientific men on the list who are eligible, 61 are included among the 97 members of the National Academy of Sciences, and of the first 30 men on the list 28 are members of the academy. The elections to the academy tend to follow the list pretty closely in the order in which men are arranged in the separate sciences—usually falling within the probable error of position. But the academy has no method of comparing performance in different sciences, and if one science has less than its proper representation, the disparity is likely to increase rather than to decrease. Thus there are in the country about half as many astronomers as botanists, but there are twice as many astronomers in the academy. The second principal variation in the membership of the academy is due to the fact that men do not always retain the positions that they hold when elected. Apart from the somewhat greater accuracy, the superiority of this list consists in the assignment of probable errors of position. Thus the probable error at the close of the first hundred is about 25 places, that is, there are about 25 men not in an ideal academy of a hundred, whose chances of belonging there are at least one in four. A list such as this would also give us academies of any desired size—the sixty most eminent men of science, as in the Paris Academy, the hundred or thereabouts as in the National Academy, or the 450 or thereabouts, as in the Royal Society.

While under existing conditions of sentiment, the publication of a list of our thousand leading men of science in the order of merit with the probable errors would not be tolerated, I have indicated those who are included in the thousand in my 'Biographical Directory of American Men of Science,' a work of reference that may be regarded as a by-product of this study. I did this with some hesitation, but it seemed best to place on record those who were the subjects of this research, more especially as this could be done without any invidiousness. The probable error toward the end of the list is about 100 places, so there are one hundred others who have at least one chance in four of belonging to this group. Further, several scientific men of standing were omitted from the lists as originally drawn up, and were not considered in making the arrangements. Consequently, while each of those indicated in the Biographical Directory is probably one of the leading thousand American men of science, there are others not indicated who belong to this group. This, however, is a minor factor, and we have with sufficient accuracy for statistical purposes a group of the leading thousand American men of science arranged in the order of merit with the probable errors of position known.

J. McKEEN CATTELL.
COLUMBIA UNIVERSITY.

A NOTE ON ASSORTATIVE MATING.

IN the natural selection and topographic isolation theories combined there is offered a plausible explanation of the means whereby species may be derived from other species, granted that the derived species do not occupy the same geographic (topographic) range as the parent form. Where they do, some new aid to natural selection in place of topographic isolation must be invoked to explain how slight variation may be progressively increased until differences of selective worth exist between parent and splitting-off types. Determinate variation and physiological isolation are two such aids proposed. The latter (with which Romanes's name is familiarly associated) assumes that among the members of a species living in the same locality there may be among the inevitable slight fluctuating variations some of such a character as to lead to assortative mating, *i. e.*, that individuals of certain like variation may tend to mate together, either because of mutual attraction between like, or of mutual repulsion between unlike forms. This tendency to selective or assortative mating between like individuals may come to result in time in such an increase of differentiation among groups of individuals of the species, although these groups may live side by side or confusedly mingled with each other in the same locality, that mating between unlike groups will become physiologically impossible. That is, that these groups will constitute distinct species.

The facts of observation or experiment adduced to support this theory are very few. Indeed, I do not recall any at the present moment. Nevertheless, the need of an aid to selection capable of bringing slight continuous fluctuating variation up to a life-and-death selective value, and the generally plausible character of this theory of Romanes (and of