SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

874 BROADWAY, NEW YORK.

SUBSCRIPTIONS.—United States and Canada.................$3.50 a year.

Great Britain and Europe................. 4.50 a year.

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ON THE UNCERTAINTY OF CONCLUSIONS.[1]

BY T. C. MENDENHALL.

ABOUT seven years ago, on the morning of a cold day in winter, a rough-looking, scantily-dressed man was observed to leave a freight car, which was standing upon a side-track near a small country town, and make his way rapidly into the fields and woods beyond.

From his appearance it was evident that he belonged to that vast army of tramps which is never in need of mobilization and which carries upon its muster-rolls many who possess most of the virtues of the good and none of the vices of the bad, having lost only the power of further resistance against continued antagonism and unfriendly environment.

The behavior of this man excited no comment, and his existence was remembered a few hours later only because of the discovery of the body of a stranger, who had evidently been murdered, on the floor of the car which he had been seen to leave. Pursuit followed immediately, and capture within a day or two. One or two clever detectives interested themselves in finding evidence of his guilt, and within a few days had prepared a case which lacked little in the detail of its elaboration or in its artistic finish.

It was proved that two strangers were seen in the suburbs of the town at a late hour on the previous night, although they were not together. The prisoner was identified beyond doubt as the man who hastily left the car in the morning. The murderer had left no means of identification except a small piece of muslin, evidently torn from the sleeve of his shirt, and which was stained with the blood of his victim. On the arrest of the prisoner one or two blood stains were found upon his clothing, and, what was more convincing than all else, the bit of sleeve found in the car fitted exactly into the place in his own garment, from which it must have been torn in the struggle which preceded the crime.

[1] Address as retiring president, delivered Jan. 20, 1892, before the Philosophical Society of Washington.

While all of this evidence might be classified as "circumstantial," it was so complete and satisfactory that no jury could be expected to entertain serious doubt as to the guilt of the prisoner, and, in spite of his protestations of innocence, a sentence to life imprisonment was in accord with the judgment of the general public.

Only a few weeks since this man was set free and declared to be innocent of the crime for which he had already served seven years at hard labor, the misleading character of the evidence on which he was convicted having been exposed through the voluntary confession of the real criminal. The facts thus brought out were, briefly, as follows: —

There were three men in the case. The first, who was afterward murdered, slept upon the floor of the car when the second, the real murderer, entered it. In the dark he stumbled over the sleeping man, who awoke and immediately attacked him. The quarrel did not last long, the original occupant being left dead upon the floor of the car while the murderer quickly made his escape, leaving the village and neighborhood behind him as far and as fast as possible. An hour or two later the third man, seeking shelter and sleep, finds his way into the car, and dropping on the floor, is soon in a deep slumber. He awakes at break of day to find that a dead man has been his companion, and to see that his own sleeve is smeared with the blood of the victim. Alarmed by this discovery, and realizing in some degree the perilous position in which he is thus placed, he tears off the stained portion of his garment, and, hastily leaving the car, he flees from the scene as rapidly as possible.

Nothing can be more simple or more satisfactory than this account of the affair, and yet nothing is more natural than that he should be accused of the crime and brought to trial. The evidence against him was convincing, and it was all absolutely true. It was not strange, therefore, that his conviction and imprisonment should follow.

It will doubtless appear to many that the foregoing is too closely allied to the sensational to serve fitly as an introduction to an address prepared for a society of philosophers, and I am ready to acknowledge the apparent validity of the criticism. I am led to its selection, however, because it is an account of an actual occurrence, which illustrates in a manner not to be misunderstood a not unrecognized proposition to a brief exposition and partial development of which I ask your attention this evening. This proposition is that, in the treatment of many questions with which we are confronted in this world, our premises may be absolutely true and our logical processes apparently unassailable and yet our conclusions very much in error.

No department of human knowledge or region of mental activity will fail to yield ample illustration and proof of this proposition. An astonishingly large number of debatable questions present themselves to the human intellect. Many of them are conceded to be of such a nature that differences of opinion concerning them must continue, perhaps, indefinitely.

But there is a very large and a very important class of problems, the solution of which is apparently not impossible and often seemingly easy, regarding which the most diverse views are most persistently held by persons not differing greatly in intelligence or intellectual training.

Men whose business it is to weigh evidence and to reach correct conclusions, in spite of inadequacy of information and perversion of logic, constitute no exception to this statement, but, on the contrary, furnish many of its most notable illustrations.

Many of the questions which present themselves to our jurists and juries are simply questions of fact, and the testimony on which the determination of such questions depends often comes from persons who are neither interested nor dishonest. In such cases it ought to be easy to reach a true conclusion, but there is often failure, growing out of honest differences of opinion.

An eminent attorney not long since referred in conversation to a certain decision of the Supreme Court of the United States concerning which there had been a strong dissenting minority. The question was one which involved neither passion nor politics, and he declared that to him it seemed utterly impossible for a disciplined mind to reach other than one conclusion regarding it.

In any review of this subject, such as is here suggested, it is neither necessary nor proper to refer to the numerous instances of utter failure in our judicial system, attributable to a lack of integrity on the part of those who administer the laws or to the mischievous results of appeals to passion or prejudice by unprincipled advocates. It is sufficient to recognize the fact that failure in the administration of law is not uncommon where witnesses are honest, juries intelligent and well-meaning, and judges incorruptible.

The rapidly increasing number of controversies within the church, to say nothing of those in which the disputants are on opposite sides of the wall, show conclusively that the logic of the theologian must sometimes go at a limping gait. In political or social economy there is great diversity of opinion among good and able men. Certain financial legislation by Congress is honestly thought by many people to be necessary to prevent widespread disaster and the financial ruin of one of the largest and most important classes of our citizens; by other equally intelligent and equally honest men such action on the part of the National Legislature is condemned as dishonest in principle and sure to be fatal to the business interests of the country.

A large number of able and patriotic men address themselves to the solution of the problem of the adjustment of duties upon imported merchandise. All have access to the same store of experience; the discussions and investigations of the past are open to all alike. In the end, however, their conclusions, even as to elementary principles, are diametrically opposed to each other.

But I have neither the time nor the disposition to enter into an exhaustive examination into the miscarriage of logic in the regions of politics, religion, or social science. I must restrict myself to some consideration of the uncertainty of conclusions reached by what may be broadly included under the general term "the exact sciences," a division of the subject not unlikely, I hope, to be of some interest to members of this society.

At the threshold of the investigation we are confronted by the term "exact sciences," and it is of the utmost importance to reach a clear understanding of the meaning of this phrase, in the beginning. By some writers its application is limited to the mathematical sciences or substantially to pure mathematics. This does not seem, however, to be in accord with the general usage among scientific men, and a wider significance will be here given to it.

Pure mathematics may, and possibly must, be regarded as a mode of thought; as symbolic logic; as an abridgment of mental processes by the selection of that which is common to all, and its formal expression by means of signs and symbols. Intellectual operations which, on account of their complexity and length, would be possible only to a few of the highest capacity are by the aid of mathematics brought within the range of the many. In virtue of the simple and beautiful nomenclature of the science, one can see at a glance, in a formula or equation, the various relations, primary and secondary, direct and implied, which exist among the several magnitudes involved, which, if expressed or defined in ordinary language, would be beyond the understanding of most intelligent people.

The principles and rules governing mathematical operations have been, in the main, so well worked out and so universally agreed upon that in mathematics one can hardly go astray, at least not without the certainty of almost immediate detection and conviction at the hands of many skilled in the use of this wonderful intellectual device. When dealing with quantity in the abstract, or with matter under just such restrictions or possessed of just such properties as are prescribed, mathematics becomes a machine of certain performance, the output of which can only be in error through the conscious or unconscious mistakes of the operator. As such it challenges the admiration of all, and it must forever be regarded as among the first, if not, indeed, the very first, of the few really splendid creations of the human intellect. When Plato, in reply to a question as to the occupation of the Deity, answered, "He geometrizes continually," he emphasized the dignity and the incontrovertibility of mathematical reasoning.

It is no reflection, then, upon the importance and value of the science of mathematics to leave it upon the pedestal which it rightfully occupies, considering it as separate and apart from other sciences. In their development it may and does play a most important part, in which, however, it is identified rather with the investigator than with the subject investigated; for, in studying the elementary principles of abstract dynamics, one may follow the now somewhat antiquated and cumbersome processes of Newton or the more simple and elegant methods of Clifford or Maxwell, but the results will in all cases be the same.

Before finally dismissing the pure mathematics, however, especial attention must be invited to one or two principles involved in their application by way of contrast with the condition of things which exists in the domain of the other sciences. It is sometimes declared by way of a criticism of mathematics that "what comes out of it is never better than what goes in." In a certain narrow sense this is true, but in a broader and truer sense it is as false as it would be to say that grain and fruit are no better than the soil from which they spring.

The mathematician has the great advantage over the physicist, the chemist, or the geologist that he not only can, but almost necessarily must, completely define the elements with which he has to deal. If he deals with matter, before he can put it into his equations he must needs restrict it as to form and dimensions and endow it with definite physical properties, the relations of which are capable of analytical expression. If, after this, his power of analysis is sufficiently great, the conclusions which he reaches can have no element of uncertainty in them, provided always they are considered as referring only to the supposititious material with which the investigation was begun. That the conclusions are not in harmony with known phenomena is evidence only of the fact that the material of nature is not the material which is symbolized in the formula, and that certain properties which are common to both are modified in the former by the presence of others which are not attributed to the latter. When MacCullagh, Neuman, Stokes, Sir William Thomson, or Maxwell, each evolves a dynamical or mechanical theory of light, a lack of agreement among them or with known principles of optics can generally be traced to the fact that the medium in which they suppose the action to take place has not been endowed with the same common properties by all, and that in every case it falls short of an exact representation of the real ether itself. With this important restriction upon mathematical reasoning kept continually in mind, mathematics may be safely set aside as the "one science of precision."

What, now, are the characteristics of the so-called "exact sciences" other than pure mathematics? Without attempting a rigorous definition or a precise classification, it is sufficient for the purpose at hand to declare that the exact sciences are those whose conclusions are capable of being, and for the most part are, established by experiment and verified prediction.

Among these exact sciences the most notable, in degree of exactness, is the science of astronomy. Although the conclusions reached in the study of astronomy may not in general be established by experiment, the marvellous accuracy with which its predictions are verified has long ago placed it far in advance of other sciences. An inquiry into the cause of this excellence will not show that the logic of the astronomer is any more rigorous than that of many others engaged in scientific research, but rather that the premises on which he reasons are simpler, and, what is of greater importance, more nearly sufficient. Until a very recent period in its history, astronomy, although dealing with matter, has been concerned almost entirely with only one of its many properties. The one property thus far assumed to be common to all matter is that long-known but still mysterious attraction in virtue of which there exists a stress between every particle and every other particle in the universe, according to a law the discovery and exposition of which justly entitles Newton to be considered the greatest philosopher of all ages. It happens that the hundreds and possibly thousands of other properties possessed by, or inherent in, matter have little if any influence on the dynamics of masses widely separated from each other, and therefore a knowledge of the law of gravitation seems to be sufficient to enable the astronomer, having, of course, obtained the necessary data from observation, to trace the paths of the planets and to foretell the configuration of the heavens many years in advance. Within the past twenty-five years, however, the splendid discovery of spectroscopy, aided by great improvements in photography, has given rise to a new astronomy, known as physical, as distinguished from gravitational astronomy. The new science deals with a matter of many properties, some of which are but little understood. While its conclusions are of vital importance and of intense interest, they result from deductions in which the premises are insufficient and are proportionately uncertain. The new astronomy must for a long time abound in contradictions and controversies, until, and largely through its development, we shall possess a knowledge of the properties of matter when subjected to conditions differing enormously from those with which we are now quite familiar. Because one astronomer declares that the temperature of the sun is 20,000° F., and another, equally honest and capable, says it is not less than 20,000,000° F., it must not be inferred, and it never is, except by the superficial, that the whole science of solar energy is a tissue of falsehoods, and that those engaged in its development are deliberately planning an imposition upon the general public. Even such widely varying results as these may be based on observations that are entirely correct and experiments that are beyond criticism. The discussion of the results obtained by observation and experiment may follow, in both cases, the very best models, and yet the conclusions may be erroneous and contradictory, owing to the insufficiency of data in the beginning.

Unfortunately the omission of one or more important quantities from the equations of condition is not always known or suspected. The older, more exact astronomy is occasionally caught tripping in this way. An interesting example of recent occurrence is to be found in certain observations for stellar parallax made a few years ago by members of our own society. The observations were long continued, the instruments used were of a high character, and the observers were skilful. These conditions unquestionably promise success. It was something of a surprise, therefore, when a reduction of the observations gave for the parallax a negative result. As such a result could in no way be possible, except, perhaps, through the assistance and intervention of a curvature in space (in virtue of which if a man's vision was not limited he would, by looking straight forward, see the back of his own head), it was assumed that the work was not as well done as it seemed to be, or that some imperfection in the instrumental appliances had been overlooked. It now appears, however, that this record may be reopened, and that the results may prove to be of as great value as originally anticipated. Researches carried on during the past year or two have with little doubt established the fact that the latitude of a point on the earth's surface is not a fixed quantity, but that on the contrary it varies through a small range during a period somewhat greater than a year. It is believed that if this hitherto unsuspected variation be applied to the parallax observations, referred to above, the seeming absurdity of the result will vanish.

If astronomy, the foremost of the exact sciences, is not free from the fault of basing conclusions upon insufficient premises, it will not be expected that among other sciences the evil will be of less magnitude.

When we consider the sciences of heat, light, electricity, magnetism, and other specially investigated properties of matter, all of which are usually included under the general head of "Physics," we meet with a formidable rival of astronomy in the extent to which they are entitled to be considered as exact sciences.

Physics treats of all the properties of matter, not omitting that which is the special domain of astronomy. As if this were not enough, the demands upon the science are such that it must also deal with that which is not matter, or, at least, is not matter in the ordinarily accepted sense. Although physics deals with all of the properties of matter, no physicist knows them, or, possibly, half of them. Perhaps not one of them is entirely and completely known. It would seem, therefore, that this science must of necessity be one of uncertain conclusions. That it is far from deserving so sweeping a criticism is due to the fact that the properties of matter are not so closely interrelated as to make it impossible to isolate one or more of them in experiment, and thus the problem is vastly simplified. It is probably impossible to do this rigorously in any case, so that there must always remain a small residuum of uncertainty due to the interference of unknown or imperfectly understood properties of matter.

Thus it is possible to treat a mass of matter as though it possessed mass only, ignoring its electrical, magnetic, or optical properties, its relation to heat, its elasticity, and other physical characteristics, and investigate its behavior under the law of gravitation alone; its optical properties may be found to be nearly independent of its relation to heat, electricity, magnetism, etc., and so, in turn, each characteristic may be studied alone and equations obtained in which the number of constants is comparatively small. It is only after this plan has been pretty thoroughly worked out that it becomes possible to investigate the interrelations of these various properties, which are often obscure and difficult of detection. Their discovery, however, especially one or two great generalizations pertaining to them, such as that of the conservation of energy, must be regarded as the grandest triumph of physical science.

The science of physics is that which is most drawn upon in the formation of the so-called applied sciences. Wedded to mathematics as it is (and no amount of personal abuse on either side can ever furnish good reason for divorce), it becomes the mother of engineering in all of its various forms. Through and by it, the forces of nature have been directed, the elements have been subdued and some of them overcome, and man has made himself master of the world. Its marvellous progress has, therefore, been observed by the people, and is understood by them perhaps to a greater degree than that of any other science. The most eloquent orators and the ablest writers have employed their genius in sounding its praises.

It is not too much to say that when intelligent people speak, in a general way, of the wonderful things which science has accomplished during the past half-century, they have in mind, for the most part, the applications which have been made of discoveries in physical science. I think no one can justly question the assertion that of the several causes which have produced the splendid advances in the material interests of the whole world during the nineteenth century, science has contributed far more liberally than all others. So remarkable have been her achievements that all the people have come to look upon her as being nearly, if not quite, infallible. A reputation of which the votaries of science may be proud has been established, but, at the same time, one difficult to maintain. Here, as elsewhere, it is a good name only that is worth counterfeiting. It is quite worth the while of one devoted to the interests of pure science alone to occasionally inquire whether an impure article is not being placed upon the market. However indifferent he may be to the welfare of the general public, his own selfish instincts should incline him to such a course. He cannot clear his own skirts by declaring that the public deserves to be humbugged if it permits itself to be, for in this, as in everything else, the counterfeit when successful is not readily detected, and it is often made to appear more attractive than the genuine article.

In respect to this matter physical science presents two aspects. In a large degree it is a science of certain conclusions, and any false deduction is readily exposed by means of the many severe tests to which it may be subjected. On the other hand, in some of its branches it has not yet been found possible to isolate the elements which form a rather complex whole, and it therefore remains an observational rather than an experimental science. In the latter aspect it becomes comparatively easy prey for charlatans and well-meaning but ignorant non-professionals.

In no department of physical science is this better illustrated than in meteorology, the oldest and most abused of all sciences. From its early days, when weather forecasts were expressed in simple rhyme, to the present, when they are issued in a prose which in its scope and richness of vocabulary sometimes excites our highest admiration, meteorology has been a favorite victim of pretenders, conscious and unconscious. For years the people, after having first believed in, have patiently borne with, the predictors of disaster in the form of abnormal meteorological disturbances. They have suffered great mental distress, and they have lost enormous sums of money on account of floods, tidal waves, and earthquakes which never came, rains that never fell, and winds that never blew. They were becoming accustomed to this sort of thing, and were beginning to understand the spirit which guided the real meteorologists as manifested in the efforts of the great weather bureaus of the world, our own among the first, to foretell with a good degree of certainty what might happen within the next twenty or thirty hours. But not many months ago they were again brought to a high pitch of meteorological excitement by the somewhat sudden and certainly unexpected appearance of the "Cloud-compelling Jove." He came not in the singular, but in the plural, and each of him brought the best and most scientific device for producing a rainfall whenever and wherever a sufficient thirst was found to exist. The history of this new industry cannot yet be written. It is still in its infancy. The fallacy of its methods has already been commented upon in a public journal, by a distinguished member of our own society, but a few remarks upon its somewhat meteoric career during the past season will not be out of place in connection with the subject now under consideration.

The columns of the daily press reflected the general interest which was felt in the matter, especially in parts of the country where rainfall was greatly needed. As is always the case under such circumstances, the strong and entirely natural desire that its artificial production might be accomplished was soon converted into a belief that it had been, and a readiness to accept the flimsiest sort of evidence of relation between the means employed and the end sought. This confidence materialized, or better, perhaps, was taken advantage of in the formation of an "Interstate Artificial Rain Company, Limited" (I am quoting from the daily papers of Nov. 10, 1891), which, after the manner of its kind, was apparently organized not for the purpose of actually producing rain, but for the formation of other joint-stock companies ready to purchase the secret method of doing it. An alleged experiment, on which a business transaction was based, is thus described: —

"The party arrived in the city on Sunday, Nov. 1, and commenced operations on Sunday evening in a small outhouse on the edge of town. The conditions were extremely unfavorable for rain. No results could be seen at first, but on Friday the sky became overcast with clouds. On Saturday a high south wind prevailed, and on Saturday night some rain came from the south-west. On Sunday rain fell all day, and at night a norther arose. Reports from 100 to 150 miles around this town show that rain fell on Sunday in most localities in considerable quantities." So convincing was this to the buying company that the secret process was purchased by them for the sum of $50,000, "after which," the account rather unnecessarily adds, the selling company "left for home." But a business so profitable as this was not to be long without competition, and a few weeks later a telegram is sent to the leading newspapers of the country, announcing that a professor in a western State (it is pleasant to note that most of these public benefactors are "professors") is prepared to furnish rain more promptly and at less cost than the genius whose machinery and methods have invited public approval. Proposals to do the county sprinkling at so much per acre are invited and offered, and at one time it seemed as if the whole business would be ruined by overproduction.

One of the most interesting phases of this subject was the attitude in reference to it assumed by a large part, possibly the greater part, of the intelligent public. It was one of expectancy and limited confidence. "Why not?" was commonly asked. "Look at what science has done within the last twenty-five years. Can anything be more astonishing? and is the artificial production of rainfall more difficult and more wonderful than many things which are now commonplace?" To many the logic of the experiments was convincing. After many battles rain had fallen, long lists of examples have been prepared, and hence it must be possible to produce rainfall by cannonading. If these views were entertained by a considerable number of intelligent people, and it is believed that they were, the situation is one which ought to be full of interest to men of science, involving, as it does, both a tribute and a warning.

It would be good for all if the intelligent public was in the habit of looking a little more below the surface of things. It is too much in the way of assuming that the president of the company engaged in exploiting an important invention or device is the genius who first discovered the principle in virtue of which it operates. It loses sight of — no, it does not lose sight of, because it never knew — the patient toil, the unselfish devotion, and, what is perhaps more important, the unflinching honesty with which a few men of the highest intellectual capacity have from the earliest times given themselves to the study of the laws of nature.

It would surprise the public to know how long ago and by whom many of the most recent and most brilliant applications of science were made possible. Would it not be in the interest of all if men of science were more ready and willing to take the intelligent public into their confidence; and would not the public, if familiar with the history of scientific investigation and accustomed to scientific modes of thought and criticism, be less the prey of charlatans and well-meaning but ill-informed enthusiasts? A better knowledge on both sides would lead to a better appreciation of both sides, and the real worker in science would seldom go without that public recognition which has too often been denied to the ablest men. No better illustration of this can be found than in the life of the distinguished first president of this society, to stand in whose place must always be an honor to any man. With his great work as secretary of the Smithsonian Institution the public is fairly well acquainted, and it has not been backward in bestowing honors in recognition of that work. Unfortunately, comparatively few know of what must be regarded, I think, as his greater work, the original researches in which he was engaged, and in which he was so singularly successful, before he became identified with the institution to which he gave the greater part of his life. Scant justice has yet been done to this important part of a career which must always be an inspiration to members of this society.

But I am warned that the brief time during which I can claim your attention to-night is quite insufficient for anything like a full exposition of the theme which I have selected, and I must, I fear, somewhat abruptly turn about in order that I may leave with you in somewhat more definite language one or two thoughts which I have attempted to develop by illustration and example.

Recurring to the unfortunate victim of circumstantial evidence, whose experience was related in the beginning, it will be admitted that the judge who charged, the jury who convicted, the witnesses who told the truth, and the approving public were all in error, in that they failed to recognize that there was another way of explaining what had happened. It does not necessarily follow that the explanation which explains is the true one. There are many natural phenomena which are in entire accord with more than one hypothesis. Indeed, there are some things which may be perfectly accounted for on an infinite number of suppositions, but it does not follow that all or any one of them must be accepted. There is nothing especially novel in this proposition, but I submit that to a failure to keep it in sight must be attributed a large measure of the uncertainty of the exact sciences, as well as much useless and bitter controversy in science, religion, ethics, and politics.

As a sort of corollary to this proposition I suggest that many reasoning and reasonable people are indifferent to, if not ignorant of, the fact that the value of evidence is greatly dependent on the way in which it arranges itself. To many this may be made a little clearer if I borrow a phrase from one of the most exact of modern sciences and speak of evidence as presenting itself in series or in parallel. Without pushing the analogy further, the superior strength of the latter arrangement will be evident upon reflection. On another occasion, I have referred at some length to the numerical representation of the value of testimony, and to some conclusions which are easily reached. As bearing upon the subject in hand, a single example of this method of treatment may be useful.

Let there be two witnesses, A and B. Suppose that A tells the truth 51 times out of 100; that is to say, assume that honesty holds the controlling share in his stock of moral principles. Let B be equally truthful and no more. Then if these two testify independently to the occurrence of a certain phenomenon it is more likely to have occurred than if either one alone bore witness. This is evidence in parallel. If, however, A testifies that B declares that the thing happened, it is less probable than if based on the testimony of either alone. This is evidence in series. Put as boldly as this, no one doubts the higher value of the first arrangement; but it is believed that a more careful consideration of this distinction will do much to secure a better judgment, not only where human testimony is involved, for here it has long been an established principle, but where conclusions are based on observation and experiment.

It is of the utmost importance, therefore, that men of science, before accepting a theory or a hypothesis as final, should carefully scrutinize the steps by which it has been established to see that they are not only sufficient but necessary. The true philosopher will be slow to claim that the theory which he finds sufficient to explain all of a given class of facts is the necessary and true one; he will be constantly on the lookout for a new fact which his theory will not quite explain, and he will have much consideration for his friendly competitor who finds a different hypothesis equally satisfactory and efficient. Above all, he will not pride himself on the steadfastness of his views, and will rarely bind himself to be of the same opinion this year as last.

If the general public could be made to understand the limitations by which science is circumscribed, the tentative and ever progressive character of scientific investigation, it would be good for the public and good for science.

The human race is greatly handicapped by the presence of a good number of people who strenuously object to being disturbed. During a decade, generation, or century these good but sometimes unpleasant people plant themselves along certain lines in the domain of science or politics or religion, proclaiming essentially that "here and here only is the truth, and here we fix ourselves forever." After awhile they somewhat unwillingly and with no very good grace move forward into a new position, again honestly affirming and believing that the end has been reached. A better knowledge and a broader human sympathy would reveal to them the hitherto unsuspected fact that truth may at the same time be here and there.

In the dissemination of this knowledge and the cultivation of this sympathy, science should lead, not follow. No scientific organization so young in years has done more along these lines, especially by reason of its extensive membership and the vigor and enthusiasm of its branches, than the society over whose deliberations during the past year I have been permitted to preside.

For the honor thus bestowed I beg now to make my formal and grateful acknowledgements.

REMARKS UPON THE GRAPHIC SYSTEM OF THE ANCIENT MAYAS.

BY HILBORNE T. CRESSON, A.M., M.D.

A MAYA hieroglyph may be a single character by which a meaning is expressed by the sound of the name of the thing represented, or it may have a number of components that convey by a similar method a series of ideas. The 'glyphs of *Kukuitz* and of *Cauac* in the Codex Troano are examples, and another is that over the figure of *Kukulcan*, or *Ikilcab*, the so-called long-nosed god, of whom representations appear so frequently in the different Maya codices.

The figures of gods, with their head-dresses and the objects represented by the Maya scribes in the Codex Troano and other manuscripts, may be composed of a series of hieroglyphic elements suggesting the names of gods and their attributes or of some of the various characters which they impersonate. An example of this is the head-dress of the long-nosed god of the Codex Troano, which reads *Ikilcab*, while his girdle expresses by phonetic elements the name *Kukuitz*, who seems also to have been *Kukulcan*, *Ikilcab* or *Cauac*, and *Itzamna*. It is not improbable that *Kukuitz*, *Kukulcan*, *Ikilcab*, and *Itzamna* is the *Hunakbu*, or one God spoken of in the Codex Troano and referred to on the hieratic tablets, Casa No. 2, Palenque.

I notice that in the photographs of the ancient cities of Yucatan and other portions of Central America, that which we have hitherto considered as *architectural ornamentation* of *Maya design* is *ikonomatic decoration*, and a notable instance is the name *Chi-chen-itza* on the palaces of that ancient city, which are repeatedly recalled by *Chi* and *itza*, and less frequently by repetitions of the word *Chen*. I make this assertion subject to further alteration and improvement, as I have not examined the buildings themselves, being obliged to depend upon bad photographs and still worse wood-cuts.

The hieroglyphs and ikonomatic ornamentations of Palenque, *Chi-chen-itza*, Labna, Tikul, Lorillard City, and Copan, judging by photographs taken at these places, seem to be allied to one another, but those of *Uxmal* are more archaic, with the exception of Copan.

The plan I have adopted in my analysis of the various components of a 'glyph, those standing for the sounds of the names of the things represented, is based upon the idea that the Maya script, both hieratic and demotic, is similar to the higher grade of picture-writing suggested by M. Aubin, in his analysis of the name *Itz-co-atl*,— represented by the conventional sign for water, obsidian attachments to the shaft of the arrow, and a vase or pot,— which by reference to his work will more fully appear.

Proceeding upon this plan, I endeavored to analyze Landa's Key, and have found that the Maya scribe simply gave 'glyphs, whether simple or combined together, that carried out Landa's pronunciation of the Spanish alphabet, by means of characters which stood for the sounds of the names of these letters.

The hieroglyph of a tarantula or centipede, figured in the Troano plates — a claw pinching a rope attached to the foot of a deer-like animal, and also a hand attached to the same insect-like figure in the act of pinching — suggested the various curved 'glyphs of the verb C^{h}*i* (Maya, to bite), which are, I believe, in connection with the parrot 'glyph, *Moo*, a part of the primitive elements of the Maya alphabet. From this I have obtained Chá, Chā (or Che), Chi, Cho, Chu, and from the *Moo* (parrot) 'glyph has been obtained a, e, i, o, u. This system has been applied successfully to the rendering of the components of the day-signs of the Troano manuscript and those of the Chilan Balaam of Káua, using Dr. Brinton's plates for the work — those published in his essay upon the books of "Chilan Balaam," pages 16 and 17.

In several cases certain 'glyphs, such as that of *Ikilcab*, *Cauac*, and *Itzamna*, have suggested meanings so clearly expressed that the words were easily found in the vacubulary of the Abbe Brasseur de Bourbourg, and had such a strong resemblance to objects and 'glyphs carried by the figures to which they belonged, that I venture to think the alphabet which I have arranged will eventually work successfully. It is based upon studies of the hieratic script made while at the Ecole de Beaux Arts in 1875–76–77, and work done on the Troano script in 1880; these researches being thrown aside and recommenced since Jan. 1, 1892.

Although Dr. Thomas and myself have proceeded in methods totally different from each other, and have never yet met to make comparisons, in quite a number of cases our methods have shown like results. I have mailed Professor D. G. Brinton, and the first-named gentleman, proof of this similarity of interpretation, and may also add that before I received a copy of Professor Thomas's "Key" I had mailed, and I venture to say both these gentlemen had received, my analysis and arrangement of the Maya signs of orientation, viz., *Chikin*, West; *Lakin*, East; *Schaman*, North; *Nohol*, South. My arrangement of these signs corresponds to that of de Rosny and Thomas. The first sign of orientation on the list was determined by the C^{h}i 'glyph.

I mention the correspondence of my work with that of Professor Thomas to show that this similarity of interpretation, referred to, cannot be the result of mere guesswork.

The aspirates and signs of repetition and the determinatives of the Maya Graphic System are most important, and I give them as Landa expresses it, and also by dotted lines in circles and curves. The phonetic value of the curve in the Maya alphabet is one of its strongest elements. Most of the characters in the key I have arranged are based on it and other natural suggestions of animate and inanimate nature—