

par A. R.

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George SARTON

# The New Humanism

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Extrait d'*ISIS*, n° 16, Vol. VI (1) 1924

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BRUXELLES

Société Anonyme M. WEISSENBRUCH, Imprimeur du Roi

ÉDITEUR

49, rue du Poinçon, 49

1924

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## Preface to Volume VI

Upon the initiative of a number of scholars, a History of Science Society has been recently founded in America. Its purpose is to promote the study of the History of Science, and more particularly to support the publication of *Isis*, which has become its official organ. This is very gratifying, especially because as long as *Isis* remained a private undertaking, its existence was naturally precarious. This existence is now assured. *Isis* may slumber yet, but die — never! The patronage of the Society will stimulate its editor and other contributors to do their best to improve *Isis*, to increase its value as a tool, to enhance its scientific prestige.

The Society will be predominantly, but not exclusively, American. Indeed, it is hoped that every student of the history of science will eventually join it. One volume of *Isis* will henceforth appear each year and be sent gratis to the members of the Society. Members will also be able to buy previous volumes at a lower price (*i. e.*, five dollars per volume, instead of six). It should be noted, however, that the supply of vol. I and II is running very low, especially of vol. I which will soon be unobtainable.

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Bona fide inhabitants and institutions of those European countries whose currency is temporarily depreciated (that is, all of them except the United Kingdom, the Netherlands, Sweden, and Switzerland) will be able to obtain *Isis* at half price (*i. e.*, sixty Belgian francs) by application to the Secretary, M. L. GUINET, 30, Av. H. de Brouckère, Auderghem, Bruxelles, Belgium.

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It is interesting to place on record how the History of Science Society was founded. On December 4, 1923, Professor DAVID EUGENE SMITH sent a personal appeal to a group of some 45 representative scientists and scholars of the United States and Canada, explaining the need of such a Society, and asking them, if they approved of his suggestion, to become members of an organizing committee. Most of them gave at once their assent in such unmis-

takable terms, that whatever doubts existed as to the advisability of creating a new society were swept aside. It was now clear that the creation of a History of Science Society was not a personal fancy but a latent need of our time requiring only some outside stimulation to blossom out. The favorable reception given to this generous initiative is probably due in large part to the fact that an increasing number of men of science and scholars do suffer from the intellectual disaggregation caused by the very progress of specialized research and feel more and more strongly the need of reunion and of fellowship in a common task.

The History of Science Society was actually founded on Saturday, January 12, 1924, when the members of the organizing committee living in or near Boston, together with DAVID EUGENE SMITH and GEORGE SARTON, met at 2 P. M. at the house of the American Academy of Sciences and discussed the formal steps to be taken to complete the organization. Among other things it was decided at that meeting that the History of Science Society would coöperate as much as possible with Section L of the American Association for the Advancement of Science, but would not identify itself too closely with it. It is clear that the Society cannot succeed in bringing together various groups of men if it takes sides with any one of them. It will thus be expedient for the Society to hold some but not all of its annual meetings at the same time as the American Association for the Advancement of Science; it will be desirable to synchronize some annual meetings with other groups, for example, the American Historical Association or the American Medical Association.

As soon as the Council of the Society is duly constituted it will appoint a Committee on Publication which will share with the present Editor the responsibility and labor of editing *Isis*.

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The first appeal sent on December 4, 1923, was confidential. The second appeal, mailed to a few hundred addresses towards the end of January, 1924, was in the form of a printed circular, the text of which follows :

The undersigned members of a group selected from a large number of those who are interested in the history of science feel that it is desirable to organize a society for the encouragement of the study of the subject and for the assurance of the permanency and the adequate financial support of the international publication *Isis*, now so ably edited by Dr. GEORGE SARTON.

This periodical is devoted to the history of science in its broadest aspect and has, for the past few years, been published by the editor under circumstances that would have deterred most other men. The first five volumes, in which some ninety scholars collaborated, contain 3,116 pages, 70 papers, 527 reviews, and 9,196 bibliographic notes relative to the various aspects of

the history and philosophy of the several leading sciences. The subscription price is six dollars a year, but it is proposed to place the annual dues of the Society at five dollars, to make *Isis* the official journal, and to send it gratis to members. By participating in the work of the Society, therefore, we assist in advancing the general cause in which we are all interested, we encourage the work of Section L of the American Association for the Advancement of Science, and we aid in maintaining and in assuring the future of a journal that is recognized at home and abroad as a powerful factor in stimulating the study of the history of science.

Although the world has so many societies of various kinds that a new one may seem to most of us superfluous, nevertheless the support of *Isis* (which cannot at present be accomplished in any other way that seems open), joined to a movement in which so many scholars are interested and to which such a distinguished scholar as Dr. SARTON is devoting his life, affords an opportunity which it is believed will be welcomed in the Americas and else where. Indeed, the hope which has been expressed of an endowment for *Isis* can probably be realized only in case there is an organization of this kind to assure an interest in the undertaking.

It may also be observed that the proposed Society will be the first, on any large scale, to afford a common meeting ground for scientists, historians, and philosophers. Indeed, the study of the history of science seems to provide the only feasible method for bridging the widening gap between the men of science on the one hand and the men of letters on the other.

In case the number of foundation members warrants the organizing committee in proceeding, it is proposed that it elect a president, two vice-presidents, a secretary, a treasurer, and a council, the latter to consist of colleagues in the Society who are interested in the history of science in general and of the several sciences in particular and to represent as wide a geographic distribution as possible. These officers and council members will then be asked to perfect the organization by preparing a constitution, to formally elect foundation members, to arrange for the immediate continuance of *Isis*, and to serve during the calendar year of 1924.

We hope that you will allow your name to be placed in the list of foundation members, the payment of dues to be made upon notice of the organization of the Society. A blank for your convenience in replying is inclosed herewith.

#### Organizing Committee\* :

RAYMOND C. ARCHIBALD, hist. of mathematics, Providence, R. I.  
 FREDERICK BARRY, hist. of science, New York, N. Y.  
 FREDERICK E. BRASCH, sec., section L, A. A. A. S., Washington, D. C.  
 JAMES H. BREASTED, Egyptologist, Chicago, Ill.

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\* The circular contained only the names of the members, these names being sufficiently known in America. However, as European mathematicians or astronomers may not know American historians, or European orientalisists may be unacquainted with American men of science, even with the leading ones, I have thought it worth while to indicate the field of study and the residence of each. This will illustrate the scientific and geographic comprehensiveness of the Committee.

ERNEST W. BROWN, astromathematician, New Haven, Conn.  
 GEORGE LINCOLN BURR, historian, Ithaca, N. Y.  
 FLORIAN CAJORI, hist. of mathematics, Berkeley, Calif.  
 HENRY CREW, histor. of physics, Evanston, Ill.  
 HARVEY CUSHING, surgeon, hist. of medicine, Boston, Mass.  
 JOHN DEWEY, philosopher, New York, N. Y.  
 SIMON FLEXNER, bacteriologist, New York, N. Y.  
 FIELDING H. GARRISON, hist. of medicine, Manila, P. I.  
 GEORGE ELLERY HALE, astronomer, Pasadena, Calif.  
 CHARLES H. HASKINS, historian, Cambridge, Mass.  
 L. J. HENDERSON, physiologist, hist. of science, Cambridge, Mass.  
 ELLWOOD HENDRICK, chemist, New York, N. Y.  
 ARTHUR JOHN HOPKINS, hist. of alchemy, Amherst, Mass.  
 DAVID STARR JORDAN, ichthyologist, Stanford, Calif.  
 LOUIS C. KARPINSKI, hist. of mathematics, Ann Arbor, Mich.  
 ARNOLD C. KLEBS, hist. of medicine, Nyon, Switzerland.  
 BERTHOLD LAUFER, Sinologue, Chicago, Ill.  
 WALTER LIBBY, hist. of science, Pittsburgh, Pa.  
 WILLIAM A. LOCY, hist. of biology, Evanston, Ill.  
 DUNCAN B. MACDONALD, Arabist, Hartford, Conn.  
 J. PLAYFAIR McMURRICH, anatomist, Toronto, Ontario.  
 JOHN C. MERRIAM, palaeontologist, Washington, D. C.  
 R. A. MILLIKAN, physicist, Pasadena, Calif.  
 GEORGE F. MOORE, hist. of religion, Cambridge, Mass.  
 FRANCIS R. PACKARD, hist. of medicine, New York, N. Y.  
 VICTOR ROBINSON, hist. of medicine, New York, N. Y.  
 DAVID EUGENE SMITH, hist. of mathematics, New York, N. Y.  
 EDGARD F. SMITH, hist. of chemistry, Philadelphia, Pa.  
 PRESERVED SMITH, historian, Cambridge, Mass.  
 EDWARD C. STREETER, hist. of medicine, Boston, Mass.  
 LYNN THORNDIKE, mediaevalist, Cleveland, O.  
 H. W. TYLER, hist. of science, Cambridge, Mass.  
 J. H. WOODS, Sanskritist, Cambridge, Mass.

Correspondance may, for the present, be addressed to

Professor DAVID EUGENE SMITH,  
 525, West 120th St.,  
 New York City.

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The present number of *Isis* was edited in October 1923, that is, long before the creation of the Society. It was meant to serve as a propaganda number. This explains the fact that it contains only one main article, the appeal written by the Editor at Intervale. N. H., last autumn, and no other original contributions.

Two other numbers are now printing: No. 17 (VI, 2) will contain the Fifteenth Critical Bibliography of the History and Philosophy of Science and of the History of Civilization (to December 1923); No. 18 (VI, 3) will contain original papers by E. W. GUDGER (New

York), FLORIAN CAJORI (Berkeley, Calif.), FRIEDRICH DANNEMANN (Munich), GIUSEPPE GABRIELI (Rome), E. J. HOLMYARD (Bristol), DAVID EUGENE SMITH (New York), C. SCHOY (Essen), OSWALD MENGHIN (Vienna), F. S. MARVIN (Berkhamstead), G. SARTON (Cambridge, Mass.), LYNN THORNDIKE (Cleveland, O.). It will contain also the first list of members.

The lack of means had made it impossible to publish indexes to vol. IV and V. It is proposed to complete vol. VI with a cumulative index to vol. IV, V, and VI, which will greatly increase the usefulness of the collection.

Cambridge, Mass., February 1, 1924.

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# The New Humanism

« Le passé si beau qu'il soit est moins beau que l'avenir. Il ne peut nous attarder longtemps. C'est l'avenir qui importe. Le Nouvel Humanisme est tendu vers lui »

I published another paper bearing the same title (but in French) in *Scientia*, 1918. The last sentences of that paper form the epigraph of the present one. As both papers are devoted to the explanation of the same fundamental ideas, there must needs be repetitions in the second one; I have not tried very hard to avoid them. Some changes and additions were suggested by my experience of the last five years. I ventilated them at a public lecture of the Boston meeting of the American Association for the Advancement of Science, in December 1922.

The present explanation of my aims is divided as follows: I. Principles; II. The unity of knowledge; III. The unity of mankind; IV. The history of science; V. The New Humanism. To this are added two appendixes; 1) The publication of *Isis*; 2) List of the first friends of *Isis*. The first appendix is, in fact, an urgent appeal to American scientists and scholars. Please do not fail to read it.

## I. — Principles.

The New Humanism, that is, the ideal to the defense of which *Isis* is dedicated, may be derived ultimately from the following three or four principles:

1. — *Human progress is essentially a function of the advance of positive knowledge.* — Positive knowledge should be understood in the broadest manner, so as to include what little is objectively known in the fields of religion, politics and sociology. For example, the greater religious toleration obtaining in the modern world is in some measure a result of our deeper knowledge of the religions

of other peoples; the more humane treatment of various delinquents is the noblest fruit of psychopathological investigations. It is hardly necessary to mention the gigantic improvements due to the advance of the medical and physical sciences. If the circumstances of our lives are now essentially different from those prevailing in pre-historic days, or from those which can still be found among savages, it is mainly to the progress of positive knowledge and of its applications, that we owe it. Various means of communication, each more ingenious and more marvelous than the other, have so-to-say shrunk our planet to such an extent that man can impart his thought and impress his will almost immediately from one part of it to every other. On the other hand, by their gradual revelation of the infinitely small objects of chemistry and physics and of the infinitely large objects of astronomy, men of science have magnified the universe almost beyond the reach of imagination. The wildest fancies of poets seem petty as compared with the astounding facts continuously unveiled by patient investigators.

Whatever material and intellectual progress there is can be traced back in each case to the discovery of some new secret of nature or to a deeper understanding of an old one. As to spiritual progress, that is a personal matter which is largely independent from circumstances. Many dreadful obstacles which jeopardized the felicity of millions of men are gradually removed by a better knowledge of their nature and a persistent application of scientific methods to their destruction. The chances of happiness of these people are thus materially increased. Yet it remains true that the happiness, the blessedness of each person depends primarily on his own temperament and his own innate wisdom.

2. — *The progress of each branch of science is a function of the progress of the other branches.* — This second principle expresses the essential *unity of knowledge*. It is only for the sake of expediency that we do not consider science as an indivisible whole. We are obliged to divide it into various branches each of which becomes the object of separate study; as our knowledge grows, these branches are subdivided into smaller ones, which become more and more independent, and so on indefinitely. In the same manner to understand the organization of the animal kingdom we subdivide it into branches, classes, orders, families, genera, species and varieties. However natural such classifications, they contain a great deal of

artificiality. We might compare the development of science to that of a tree. The branches can not live if they be cut off, and without them, the tree itself would soon cease to exist. This comparison is not sufficient, however, for the branches of the tree of knowledge are connected not simply by means of the trunk or of the master branches from which they originated but in many other ways. Almost every year sees the birth of a new kind of research which connects various branches of knowledge in a novel way (1). Thus the tree becomes more and more complex, yet more solidly unified; we may conceive a state of development at which each bough will be directly connected with every other. The prosperity of each branch reacts directly or indirectly upon all the others.

3. — *The progress of science is not due to the isolated efforts of a single people but to the combined efforts of all peoples* (2). — This third principle expresses the essential *unity of mankind*. I do not know of a single scientific theory which is the exclusive property of one nation, but, even if such theory could be found, it would be easy to show that it involves many other theories which were contributed by other peoples. Thus the tree of knowledge cannot be conceived as being rooted in the soil of any particular country; its roots are scattered all over the civilized world and derive some substance from almost every part of it.

It is very important to realize that the second and third principles are correlative. *Unity of knowledge and unity of mankind are but two aspects of one great truth*. Their correlativeness has been verified a great many times. Each body of scientific doctrine might be compared to a chain or to a combination of chains holding together, but of which the links are very different and cannot be interchanged. As they must follow one another in a definite order, we may imagine that they are numbered. Now the student of the history of science soon realizes that these chains have not been built, as one might perhaps expect it, link after link, in the very order in which they finally appear. Time after time it has happened that particular links or series of links were made, independently, in many places

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(1) Examples : seismology ; biometry ; astronomical spectroscopy ; oceanography ; theory of relativity.

(2) Or at least of a great many of them.

very remote from each other. Sometimes links would be missing and many years would pass before it became possible to construct the whole chain, that is, to complete the theory. A good example of this may be found in the present development of physics: the theory of quanta offers adequate explanations of such facts as resonance potentials or the constitution of the hydrogen spectrum but is still insufficient to account for many other optical facts. Pursuing our illustration we may say that some of the links of that theory are still missing. They will eventually be discovered, though nobody could tell when or where. It may be in Japan, or in France or in Australia. The pregnant fact to keep in mind is that each theory, or group of theories, each branch of science and, indeed the whole of science, are made up of a series of numbered links each of which may have been found independently from some of the others (possibly not in their order of succession) and in very distant places. Yet finally all these links constitute a chain so strong that it is exceedingly difficult to break it, though subsequent discoveries may oblige one to improve its arrangement. How could such combinations of circumstances ever happen (and they happen again and again apropos of the building up of each new theory) if science was not one single body of perfect congruency and if the men of many climes who collaborate in this grand undertaking were not actuated by the same fundamental motive?

Another set of proofs is furnished by the many cases of discoveries made independently at about the same time by various people working in different places. If such simultaneity had occurred but once or twice in the course of human evolution, we might ascribe it to chance. But it has occurred again and again; in fact, there are but few discoveries which are not the subject of endless discussion as to the respective merits of several authors. Simultaneities as frequent cannot be due to chance; they cannot but be the results of a social necessity. This necessity itself is unconceivable unless science is a structure of sufficient consistency and unless the efforts of the different provinces of mankind are naturally converging.

These considerations lend a deeper meaning to the classical comparison of mankind with one single man, immortal, whose experience and knowledge become indefinitely richer and whose unified thought we call *science*. One science, fruit of an international and ageless collaboration, one single organized body, the common treasure of

all peoples, of all races; in fact, the only patrimony upon which they all have equal rights.

I have assumed that man has a purpose; if he has no purpose, his existence is a mere farce. The reality of that purpose cannot be proved in full rigor, but it may be reasonably inferred from two sets of facts. In the first place, the general drift of human evolution, the continuous growth of science and its progressive unification; in the second place, the psycho-physiological constitution of man, his possession of a thinking machine immeasurably superior to that of other animals, his constant use of it, his intellectual aspirations, his frantic attempts to explain the mysteries of the universe and of his own existence. Obeying to the same irrepressible impulse, I may try, in my turn, to solve a problem which will remain for ever above our ken, and suggest that the specific function of man (that is, his immediate purpose, for how could these two things be different?) is to produce that kind of energy which no other creature can create but himself, intellectual energy. His purpose is to create immaterial values, such as beauty, justice, truth. Above all, truth, for it can easily be shown that beauty and justice derive from it. True relations are necessarily harmonious and beautiful (the beauty of nature is unsurpassed); they cannot be unfair. On the other hand, however seductive lies or other deceits may be, we cannot conceive anything beautiful, truly and permanently beautiful, which is made of them; we cannot imagine justice built upon untruth, or purity upon impurity.

One recoils from admitting that humanity has no purpose but to exist and to perpetuate its existence. Nor can its purpose be to fight, kill and devour one another, nor even to create material wealth, nor to provide more comfort and luxury. All these activities are means not ends; the real purpose is the creation of new values, intellectual values; the gradual unveiling and unfolding of the harmony of nature, the development and organization of what we call art and science. All other activities are subordinated to this great purpose of the race. It should not be forgotten that however trivial this conclusion may seem to the readers of *Isis*, it is nevertheless absolutely opposed to the accepted views. According to the vast majority of men, including a plenty of so-called educated people, the creation of beauty and truth, art and science, are luxuries; artists and scientists are parasites and the more so in proportion of their very disinterestedness and of the difficulty of marketing the fruits

of their work; they may be encouraged, however, even as we cultivate unproductive flowers, they may be petted and honored even as champion dogs or race horses. According to me, on the contrary, artists and scientists are the true creators, the guardians of human ideals; it is they two accomplish the destinities of the race, who justify its existence; the other men are simply making this accomplishment possible; the masters of industry and business, the great financiers are not in any sense the leaders of humanity but its chief stewards.

How can such a deep misunderstanding obtain and persist? How can people disagree so completely on the fundamental value of their activities? This is simply due to the fact that they do not consider these activities with reference to the same extent of time. Most people care for nothing but the present and the most immediate parts of the past and the future: yesterday, to-day, to-morrow. Their historical horizon is limited to three or four generations. They would measure every achievement with respect to the length of their own life. Their attempts to refer events to such a ridiculously small standard can but lead to absurd conclusions. From that point of view, it is clear that the material needs are by far the most important and that material prosperity cannot but be the main goal. When life is so short, art and science are undoubtedly extravagances. *Primum vivere*. But as soon as our horizon extends further back into the past or further ahead into the future, the utter fugitiveness and secondariness of all our material needs, of all our everyday problems, appear in full light. Essential as these needs be for the moment, they are too futile to be self-sufficient; they cannot be aims, but means to an end. For example, my next meal is very important; if some accident would delay it too long, it would soon engross my mind; yet no sooner have I partaken of it, it is not even worth a remembrance. My life's work is much less urgent; if I stopped a while doing it, I would not suffer any harm but if I stopped altogether, my life would cease to have a meaning; I might as well be dead. Or to illustrate my point in another way, suppose you asked me which organ of our body is the most important. I could not answer without knowing your time standard. Do you think mainly of now, then what could be more important than our vegetative organs? For one must live first, and if one's life is suspended nothing else matters. The slightest injury to one's stomach or to one's kidneys jeopardizes

one's happiness and soon reduces one to inefficiency; while people with no brains may be very happy and their idiotic performances may receive considerable applause. But as soon as we think of the future the problem takes an entirely different aspect. For if we used our brains to a good purpose we may live for ever, while nobody will ever care to know whether our stomach was right or not, or how much we enjoyed our meals. The same paradox would apply as well to groups of people, or to nations, as to individuals. From the standpoint of to-day their material needs are foremost and their greatest men are those who satisfy these needs in the most efficient manner. But if we contemplate them from a greater distance, the perspective changes altogether. Who cares to know the great business men and the financiers of Greece or Rome or of the Renaissance? Their very names are forgotten. The very few of them who escaped oblivion, did so only because they patronized the disinterested activity of scholars, artists and scientists, — men whom they probably treated as pets or servants. Yet in spite of the high regard which mankind has for those who minister successfully to its material needs, as soon as they are dead and its judgment is no longer influenced by these needs, it throws them back into the background and calls their servants — artists and scientists — into the center of the stage. The sober judgment of mankind thus confirms our assumption: the few men who enrich its spiritual life are its true representatives in the light of eternity. Are we not right then in believing that it is they, and no others, who fulfill its destiny?

This enables us finally to solve another paradox: how can one reconcile the unity of mankind, which I postulated, with a chronic state of distrust, of discord and war, alas! but too obvious? Quite simply: the unity is hidden but deep-seated; the disunity, widespread but superficial. The unity is felt and expressed primarily by the few men of all nations whose aims are not selfish, or provincial, nationalistic, racial or sectarian in any other way, but largely human, the very few men upon whom has devolved the fulfillment of mankind's purpose; the disunity, the antagonism of interests, is felt and expressed by an overwhelming majority of other men. These realize intensely that their interests are different from those of the men who live in the other villages, or across the border, or who have joined another party, or who worship at another church. Jealous love of their own brethren; contempt, distrust or even hatred

of all other men is one of the emotional sources of their life, one of the stimulants of their activity. These strange feelings are reënforced by what little historical knowledge they may have. Indeed historical learning and teaching has dealt thus far largely with the most obvious and noisy part of human evolution, but the least important. In spite of many appearances to the contrary, man's essential purpose is not a struggle for existence or for supremacy, not a devastating scramble for the material goods of this world, but a generous and fruitful emulation in the creation and the diffusion of spiritual values. Now this creation takes place to a large extent secretly, for it is not accomplished by crowds, nor by pompous dignitaries officiating in the eyes of the people, but by individuals often poor and unknown, who carry on their sacred task in mean garrets, in wretched laboratories, or in other obscure corners scattered all over the civilized world, without hardly any regard for political boundaries, social or religious distinctions. « The wind bloweth where it listeth. » (1) The secrecy of their work is enhanced by the fact that it goes on in spite of the catastrophies, wars and revolutions which retain the whole attention of the people. Wars and revolutions are not essentially different from natural catastrophies such as earthquakes, volcanic eruptions, floods or epidemics; they are almost as impersonal and incontrollable. For most men these great catastrophies are by far the most important events, and this is natural enough, since their welfare is dreadfully affected by them. GALILEO'S or NEWTON'S discoveries do not raise the price of food or shelter, at least not with sufficient suddenness to be perceptible. For us on the contrary, these discoveries which must sooner or later transform man's outlook and so-to-say magnify both the universe and himself, are the cardinal events of the world's history. All the catastrophies caused either by the untamed forces of nature or by the irrepressible folly of men, are nothing but accidents. They interrupt and upset man's essential activity but however formidable, they do not and cannot dominate it. This is summed up in what I might call our fourth principle: *The essential history of mankind is largely secret.* Visible history is nothing but the local scenery, the everchanging and capricious background of this invisible history which, alone, is truly œcumenical and progressive. From our point of view peoples and nations, even

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(1) The Gospel according to St. John. III, 8.

as men, are not to be judged by the power or the wealth they have attained, nor by the amount of perishable goods which they produce, but only by their imperishable contributions to the whole of humanity.

## II. — *The unity of knowledge.*

Many scientists and scholars fail to grasp the unity of knowledge because their innate lopsidedness or the very trend of their research has gradually driven them to restrict their attention to one very special branch of science. Little by little they loose contact with other branches and finally they become unable to understand the relation of their own studies to the whole of knowledge. This condition is particularly ominous, when they have specialized too early without having first tried to know at least the elements of the other branches. Such people are but too often prone to deny a unity, which has ceased to exist for them, and, because of their own failure to master a small department of science (1), to assert the impossibility of embracing the whole of it.

The very fact that the vast majority of scientists are excessively specialized, causes encyclopedic knowledge to become more and more needed. The very few men who attempt to compass such knowledge are the true guardians of the scientific spirit. Without their centripetal activity, the smaller branches might thrive just as well, the number of scientific facts and concepts might go on increasing indefinitely, but the tree of science would slowly wither and die. Encyclopedic knowledge is undoubtedly necessary. It is also possible, even as it is possible to draw a map of the world, based upon the analytical efforts of thousands of geographers. Of course such knowledge is not meant to replace the more detailed knowledge attained by specialists, but simply to evidence the relations of each part to every other part and to the whole, to unify and to organize. It would be absurd to expect even the best encyclopedist to know as much biology as a biologist or as much physics as a physicist, yet much of the criticism adressed to them is based upon such an unfair expectation. There is but little excuse, however, for the occurrence

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(1) They naturally fail to master it because of their ignorance of other departments, because of the very narrowness of their knowledge.

of scientific mistakes in their publications, for they can and should avail themselves of the more intimate knowledge of specialists. In brief, specialists and encyclopedists, or analytic and synthetic scientists, are equally necessary; their activities are correlative and complementary. They are all of them, the servants of science. They must not let distrust and faultfinding separate them; they should rather recognize their mutual dependency and respect and help one another.

One of the fundamental problems to be solved by the encyclopedist is the classification of sciences. As soon as the number of objects to be considered in any investigation ceases to be small, the very infirmity of our mind obliges us to divide them into groups, and these, if necessary, into smaller groups, and so on. Thus he who would survey the progress of science must needs classify scientific facts and theories as naturally and logically as possible. The encyclopedist classifies concepts even as the entomologist classifies insects. The activity of the former is just as scientific as that of the latter, for a clear concept is as tangible an object as a beetle. We should not forget, however, that such classification is necessarily artificial, far more artificial indeed than our classification of plants or animals. The very evolution of science classifies already a good amount of it, for the concepts investigated by each specialist form so-to-say a natural group. However, it is soon found that these groups are not exclusive but trespass upon each other's domain in many ways. The problem is thus to choose among the various groups those which are fundamental and to subordinate the others to them as well as possible. My image of the tree helps us to realize how this can be done. The main branches which derive directly from the trunk represent the fundamental subdivisions; after that we can recognize secondary branches or branches of the second order, branches of the third order, of the fourth order, etc.

This gives one also a way of estimating the importance of a new scientific discovery. A scientific discovery is either the detection of a new fact, or the establishment of a new relation between old facts and their rearrangement. In either case it can be symbolized on our tree by a new twig or by one of the intersecting lines already described. The importance of the discovery is then easily deduced from the position of the twig: if it is placed at the periphery of the foliage it is not likely to be very significant because it will affect but a few of

the smallest branches; if, on the contrary, it is located near the center of the tree on one of the primary branches its importance is probably considerable for it may influence and transform an enormous province of science.

Each new concept introduces a new branch of science. This enables one to build up a primary classification which is, in spite of some artificiality, of great service. For example, the concept of space opens the field of geometry; the concept of number that of arithmetic and analysis. Add to those the concept of time, and we can construct mechanics. Various other concepts, less fundamental, lead to the development of the physical sciences: astronomy, physics, chemistry, etc. New fundamental concepts, such as life and mind are needed to introduce the new departments of knowledge which we call biology, psychology, sociology. The utility of that classification, which is so well known that my little sketch of it is quite sufficient, is based upon the fact that it makes possible the arrangement of the main provinces of science according to the number of fundamental concepts which form the core of each. Thus mathematics are based on only two of these fundamental concepts; mechanics on three; biology on four; psychology and sociology on at least five. This classification suggests that the relations between these provinces are not by any means equal; their dependencies are not reciprocal. This is amply confirmed by a deeper study of the subject. For example, a physicist must know mathematics, but it is not essential for a mathematician to know physics; a biologist should have some knowledge of mathematics, physics, chemistry, but a physicist may to a large extent ignore biology. It follows from this that the encyclopedist should be primarily a mathematician. If not, his synthesis can never be truly profound and complete; he can never embrace the whole tree of knowledge but must be content with a few of its primary branches. To use another illustration, we may liken the encyclopedist unto a man climbing a mountain in order to have a general view of a large country. It is clear enough that the survey of each man will depend upon the sum and quality of his knowledge, but irrespectively of that, only the mathematician will be able to reach the very top. The chemist, knowing but little or no mathematics will have to stop at some distance below; his horizon will be smaller. The biologist, ignorant of mathematics and physics, will begin to be impeded much lower still; the physician

without real scientific education, will not be able to climb at all. It is this very condition of affairs, so distressing to those who are the victims of it, which causes so many biologists and naturalists to distrust the possibility of encyclopedic knowledge. Such knowledge is indeed hopelessly beyond their own reach; they are utterly unable to see the scientific theories in their true perspective and, as they do not realize the true reason of their failure, they believe that everybody is bound to fail even as they do.

Encyclopedic knowledge is necessarily limited with regard to the innumerable details and applications of each discipline, — this does not matter inasmuch as it is not meant to replace but simply to coördinate special knowledge, — but it cannot safely be restricted as far as the theories themselves are concerned. That is, the encyclopedist must have as deep an understanding as possible of the cardinal facts, the crucial problems and the main theories of each science; if not, his knowledge is worthless and his efforts are doomed to remain sterile. He must be able to contemplate the whole fabric of science, not from below but from above, from as high a point of view as the development of knowledge permits, or else, he is utterly unfit to accomplish his task. It is necessary to insist on this, because this point, obvious as it is, is frequently misunderstood. Thus any kind of uncharted information, if it be sufficiently massive; any random accumulation of facts, even the most superficial; any sort of intellectual *olla podrida*, is apt to be mistaken for true encyclopedic knowledge (1). It is because of such misunderstandings that the latter has but too often fallen into disrepute. Encyclopedic knowledge has no more right to be superficial than any other sort of knowledge; its value is a function of its depth and solidity. Any kind of knowledge implies a selection and classification of facts; the selection and classification of the encyclopedist are not the same as those of the specialist; they are made on a different scale, but

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(1) It is true, the word encyclopedia and its derivatives have lost their original meaning, because the existence of various important works, entitled Encyclopedias, reminds us of a collection of information arranged in alphabetic order. Such order is, of course, exceedingly convenient but equally artificial. Let me say, once for all, that when I speak of encyclopedic knowledge, I never mean dictionary knowledge (which is, in some ways, an extreme instance of disintegrated knowledge) but on the contrary, as the etymology suggests, organized and unified knowledge.

to have any worth they must be made with at least as much accuracy and intelligence. The aim of encyclopedic endeavors is to unify and deepen our knowledge; incidentally they simplify it, but this simplification is essentially different from that aimed at and obtained by popularizers. Encyclopedic knowledge is not by any means elementary knowledge, though it is not necessarily of exceptional difficulty. It is synthetic, organic, classified, unified and simplified knowledge.

One very valuable result of one's efforts to attain such knowledge is the keener realization of one's ignorance, or to put it otherwise, of the approximative and provisional nature, the essential relativity, of science. To be sure, the scientific knowledge already available is marvellous enough. The laws of nature are subjects for infinite wonder, but is their gradual discovery by man not even more wonderful? Among the innumerable splendors of nature, none are more sublime than those created by the human mind. However, each addition to our knowledge as it broadens our intellectual horizon, extends our contact with the mysterious unknown, the infinite darkness which is beyond. There are far more mysteries in the world for the man of science, especially for him who is of the encyclopedic type, than for the ignorant, but they are not mixed up indiscriminately with the rest of his thought; he knows where they are for he is painfully aware of the gaps and of the imperfection of his knowledge.

The attitude of the philosophical scientist of to-day is thus materially different from that of the positivist of a century ago. It is still a positivism, because constant pains are taken to separate very sharply the things that we know positively from the others and to build our philosophy primarily upon them, but it is a positivism tempered by greater humility and charity.

I feel more and more deeply that the very core of what I would call a scientific education is the insistence upon truth. The greatest number of people have no clear idea of it. The education imparted by literary people does not inculcate the value of truth, because most of their statements are of necessity purely qualitative. It is equally correct, for example, to say « this man is good », or « this man is bad », because any man is good in some respects and bad in others, and because such statements are not amenable to a rigorous verification. It is only in the laboratory — for real life is far too

complex — that one can learn the real signification of truth. Unfortunately a great number of experimenters are so specialized that their truths, however accurate within their little domain, are incomplete. The discovery of truth implies at once the critical use of good methods, a sufficient broadness of outlook and boundless generosity. But everything in life seems to conspire against the truth-loving attitude, which is the essence of the real scientific spirit. Not only does the usual literary education discourage it, but many conditions of everyday life run directly against it. For example, the Roman maxim « *caveat emptor* » is still as apposite to the commercial standards of our day as to those of two thousand years ago. A seller is not supposed to volunteer information discrediting his merchandise even if his silence is, in fact, a deceit. And what shall we say of the legal training which molds the characters of so many of our leading men? No lawyer, no politician is expected to mention facts which do not favor his cause. In forensic practice this does perhaps not matter so much, for the judge knows that each litigant tells only one side of the story and that the truth must be somewhere between. But think of the havoc which is made when such methods are transferred from the forum to the study, when only one party is heard and there is no judge! Yet such is the influence of juridical education that most men deem themselves sufficiently honest if they do not tell positive lies. They constantly distinguish between useful truths, which it is well to state, and unuseful, self-damaging truths, which it is not dishonorable to withhold; they are apparently unaware that, under such conditions, the real truth can but seldom be known. There is very little difference, indeed, between half-truths and half-lies. No wonder then that it is almost impossible to obtain accurate information on political and social affairs. Even scientists are not free from such reproaches (the war has given us repeated proofs of it), because they themselves have received no scientific education and because their outlook is often very narrow. The consequences of all this are simply frightful. For example, the combination of some ethical knowledge with this legal conception of truth is the very recipe of moral and religious hypocrisy. Many people get rid instinctively of all the facts which do not tally with their prejudices; it is as if their mind was protected by a semipermeable membrane letting the agreeable truths in and leaving the disagreeable ones out. From the scientific point of

view this is nothing but intellectual dishonesty, but they call it optimism.

The saying of NIZOLIO (1) in his *Antibarbarus* that scholasticism is the capital enemy of truth, must be understood in a similar way. For every kind of scholasticism, whether it be Christian, Jewish, Muslim, Buddhist, Vedantist or Neo-Confucianist, is the deductive development of a limited set of observations and experiments; the neat formulation of an authoritative and final doctrine. The small amount of truth upon which it is based is gradually diluted into a mass of arguments more and more remote from nature; it degenerates very soon into a rigid system, which, in spite of all the truth it may contain, is fundamentally erroneous.

These remarks on truth may seem to take us away from our subject, but they do not. The burden of this chapter, indeed, is to insist upon the necessity of encyclopedic knowledge. I have tried to show that knowledge, to be truly valuable, must be sufficiently comprehensive and congruent. Science is not simply an aggregation of isolated facts, however pregnant these may be; it is an organized concatenation of them; not a final one, but on the contrary, one constantly subject to addition and revision. The scientific spirit is essentially the love of truth, — not the selected and unverifiable truths of literary men, not the fragmentary truths of lopsided scientists, not the unchangeable truths of the scholastics — but all the truth available, whether it be useful or not, pleasant or unpleasant. Incomplete truth is no truth at all. In many cases it can hardly be distinguished from downright falsehood. The main purpose of a scientific education would be to explain the methods of reaching the truth, all the truth within one's grasp, and to inculcate the habit of needing and telling it. It would teach people not to be satisfied with less and to feel as humiliated if they withheld the unfavorable aspect of their case as if they had deliberately falsified the facts involved. Encyclopedic knowledge is the aim; critical observation and experiments, unreserved disclosure of the results, are the methods.

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(1) As quoted by RENAN in his *AVERROËS* (second and later editions, p. IV, 393). The Italian humanist MARIO NIZOLIO taught at Parma and later at Sabbioneta, where he died c. 1576.

### III. — *The unity of mankind.*

I explained in the first chapter that unity of knowledge and unity of mankind are correlative notions. It is easy to show that the scientific organization of the world and its internationalization are also correlative; either one must necessarily drag the other in its train. For one thing, science — at least that part of it which has already become classical — is the common thought of the whole world; it is the organized body of all the facts and theories from which almost all arbitrariness has been excluded, upon which enlightened people are unanimously agreed and which is placed temporarily beyond the range of discussion. The domain of classical science is the privileged domain of internationalism, for it is already the common patrimony of all men. Moreover science constitutes the very axis of human advance and furnishes the very principles and the fundamental methods of social organization. The progress of knowledge and of intercourse introduces continually new social ties; the solidarity and interdependence of men grow almost automatically together with the multiplicity and the precision of these ties; this solidarity becomes more and more an organic need of our life. The unconscious efforts of all peaceful men, strengthened by the conscious endeavors of a few scientists and organizers, are thus slowly preparing a higher sort of international brotherhood.

The unity of mankind is proved by their common purpose, the creation of spiritual values, mainly the development of science (1). The nobility of man is constituted by this common purpose, by this immense and endless collaboration, by the memory of past accomplishments all pointed in the same direction, by the very treasure of beauty and knowledge accumulated by his ancestors. The collaboration of all the peoples of all times is effected primarily by

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(1) The fact that the different races of men have not been equally productive is no objection to this, for they are nevertheless collaborating in the same great task. The contributions of women have been on the whole considerably smaller than those of men; yet when we speak of men, we always include women. Moreover the race which has been hitherto chiefly responsible for the development of positive science might be annihilated, — for example, if no method is found to stop internecine aberrations. The fulfilment of mankind's destiny would then devolve upon other races.

a few men of genius, who may appear almost anywhere, but also by the division of analytic labor between a great number of other men, patient and conscientious scholars, well trained observers and experimenters. Indeed the systematic exploration and description of the universe can be accomplished only by an international coöperation involving many thousands of investigators. Besides, each great discovery, each new synthesis, may necessitate a tremendous amount of fresh inquiries, which cannot be successfully carried out unless all nations do their share of them.

I must especially insist upon the collaboration of East and West, because it is but too often overlooked or misunderstood. Most historians are so dominated by occidental prejudices that they can hardly imagine any other civilization than the one resulting from the double stream of Greco-Roman and Judæo-Christian traditions; at any rate they behave as if no other civilization were worth considering. One might grant that the greatest number of scientific facts and theories have been discovered by the Mediterranean nations and by the Christian peoples of Western Europe, yet a good many others have been revealed by other peoples — Jewish, Iranian, Muslim, Hindu, Chinese, Japanese — and there is no way of measuring the respective values of their contributions. One must needs recognize that human civilization is not exclusively occidental, not by any means. Moreover the very fact that the civilizations which developed in the Mediterranean basin and in Central and Eastern Asia were largely independent, renders their comparison extremely instructive. This comparison affords another proof of the essential unity of mankind, for the fundamental problems of East and West are the same, and the solutions, however dissimilar, have yet many points of contact (1). Finally an immense cultural progress would be brought

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(1) The independent and dissimilar evolutions, East and West, joined to the necessity of confronting them, makes it practically impossible to divide the past into a certain number of historical periods as most historians do, for Eastern and Western periods do not tally. Therefore in the *Critical Bibliography of Isis*, the past is subdivided primarily in centuries, which enables (and indeed obliges) the reader to make a comparative survey of East and West for each century. This decimal subdivision is very artificial (no natural one is possible) but very convenient, because a century covering about three or four generations, represents the maximal range of direct personal influence. The century period is neither too long nor too short; it harmonizes well with the length of human life.

to pass if it were possible to combine the highest ideals of East and West. We have as much to learn from them as they from us, but we will never learn anything unless we approach one another with open hearts and true humility (1).

The sympathetic study and the understanding of the thoughts and ways of other peoples is a vital necessity for every man. If he neglects it, he soon becomes provincial and loses his sense of proportion. Such necessity is nowhere more urgent than in the newer civilized countries of the world, such as the American Republics or the British Dominions. The civilization of these countries is indeed incomparably less independent from that of Europe, than the Roman civilization was from the Greek, or the Japanese from the Chinese. When I hear the flippant criticisms of Europe into which some Americans like to indulge, I cannot help thinking of children insulting their mother.

The true internationalism toward which the unity of knowledge and the unity of mankind are steadily driving us, will constitute an immense progress. This progress will be largely due to the development of positive knowledge and scientific methods. It is hardly necessary to add that this internationalism, expressing the common mission of mankind, is essentially different from that futile and sterile cosmopolitanism, which would ignore or belittle national characteristics. It does not in the least attempt to supersede the smaller groups of humanity but strives rather to complete and strengthen them by a supreme organization embracing them all. The slow constitution of nations and the development of that noble loyalty of every citizen to his mother country did not destroy the family unit but on the contrary fostered and protected it, by putting some new vigor and sanctity into it. The only thing which the higher duty of patriotism did destroy was the fiendish hostility of rival families. Their differences were merged into a larger union and assuaged by a common loyalty to the whole country. In the same way international ideals do not aim at the destruction of any national or racial quality but simply at the dissolution of international

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(1) A very valuable attempt to compare the philosophical developments of Europe, India and China has been made recently by PAUL MASSON-OURSSEL. *La philosophie comparée*. Paris 1923 (reviewed below).

hatreds. National loyalties must be gradually harmonized into a higher loyalty to the common purpose of mankind.

It is important to observe that loyalty to truth would almost suffice to realize this immense step forward. If everybody placed the love of truth and justice even above the love of his family or of his country, there would be no reason to fear the disintegration of humanity by a new civil war. Nor could any country be the loser by this, for what could it hope to win by falsehood or injustice? Even as no honest man would care to obtain advantages for himself or his family by misrepresentation, no honest country would attempt to magnify itself by force or fraud at the expense of other countries. If the truth standard of politicians and diplomatists was the scientific standard instead of the legal or commercial, our international ideal would be accomplished without any difficulty.

In the meanwhile, whatever happens at the surface, the essential unity of mankind is a reality which will be attested in the future as it has been in the past by a small elite of scientists. These will pursue their sacred task, undisturbed — even as bees pursue theirs — in spite of wars and other cataclysms. Thus, thanks to them, the secret advance of mankind may go on indefinitely.

#### IV. — *The history of science.*

From the technical point of view, the point of view of everyday life, no knowledge is worth considering but the very latest. From the philosophical point of view, on the contrary, the consideration of the latest stage of knowledge is absolutely insufficient. Because of the essential relativity and incompleteness of science we cannot fully understand it unless we see it flow and develop. Science is not a being but a becoming. Fixed knowledge is dead knowledge; we are interested primarily in live knowledge. We are very anxious to get acquainted with the latest theories, but that alone cannot possibly satisfy our curiosity; we must know their ancestry as well, we must be able to retrace their evolution from the very beginnings until their present state. Thus it is indispensable to study the history of science.

You remember my representation of knowledge by a tree. This helped us to conceive the possibility of a natural classification of sciences. In the case of living beings too, a classification to be

adequate must tally with the facts of family relationship and descent. These facts are established mainly by paleontological and embryological, that is, by historical methods. Even so, an adequate classification of sciences involves historical investigations. The only safe way of unravelling it, is to study carefully the development of the different branches of science from the earliest times step by step until to-day. Purely deductive classifications, which do not take the facts of ancient science into account, are of no value whatsoever. Similar investigations are necessary to solve satisfactorily every scientific problem which is not restricted to utilitarian and immediate applications.

On the other hand, from what I have said in the previous chapter of the scientific nature of the internationalization of the world, it follows that it is not possible to study the development of human organization (not simply the organization of knowledge but of society) without continual reference to the history of science. The history of science is, indeed, the skeleton of the history of civilization. In particular, those who would understand the advance of internationalism and further it, must needs study the history of science; there is, in my opinion, no better way of giving to their activity the philosophical foundation which it lacks but too often. The sublime recital of man's intellectual progress throughout the ages, would fire their enthusiasm, stimulate their devotion, increase the convergence and the efficiency of their endeavors.

Whether our interest be primarily philosophical or sociological, as soon as we realize that our knowledge of nature and of man cannot be complete or sufficient unless we combine historical with scientific information, the history of science becomes so-to-say the keystone of the whole structure of education.

Unfortunately this is not generally understood either by historians or by scientists. Their lack of understanding, however painful, is not surprising. It is clear that historians who know nothing of science or scientists whose conception of historical methods is of the crudest kind, cannot appreciate the expediency or even the possibility of harmonizing their respective points of view. Either group is contemptuous of the other and deems its own task self-sufficient. Although some change towards a wiser attitude is already perceptible, the great majority of historians are still unaware of the very gravity of their ignorance. It has not yet dawned upon them that only such men who

can really grasp the meaning of human progress and can analyse its internal structure are truly qualified to explain the past. The attitude of most scientists does not prove much more enlightenment. Many of them will go out their way to express their contempt of historical work, thus revealing their deep ignorance of it. They believe apparently that history is still in its literary stage: they do not realize that the historical methods of to-day deserve to be called scientific to the same extent as many methods used by naturalists; they forget also that the methods which they themselves are using have not always been as rational and rigorous as they now are. The methods of every discipline improve gradually; the organization of some sciences grows faster than that of others but they all have very humble beginnings. It may be objected that historical research leaves no room for experimentation, but the same can be said of many branches of natural history; there remains in every case ample opportunity for critical observation and comparison. The main difficulty is caused by the uniqueness of historical facts; they happen once and are never exactly repeated. Yet comparisons are still possible between facts of a similar kind, and there is no danger in this if full allowance is made for every dissimilarity. Granted that historical knowledge is of its nature less accurate than that obtainable in other descriptive sciences, it would be very foolish to despise it on that account. The aims of the scientist and of the scholar are identical: to reach the truth — positive, objective truth — as much of it as can be attained. The smallness of one's knowledge is no disgrace if no more be within one's reach and if one remain keenly aware of its limitation.

Many men of science lack historical spirit, that is, they are not able to see the past in its true perspective. They will say, for example, that the development of science before the xix<sup>th</sup> century, or before the xvi<sup>th</sup>, is not worth knowing because it is too rudimentary. They forget that to compare medieval science with our own, is absurd and unjust. We have succeeded in reaching the present level because we stand on the shoulders of people who had reached a lower level before; if these people had not done their part of the ascent, others or we ourselves would have had to do it. To pass sentence over early science from the point of view of our own is as unfair as to refer children actions to grownups standards. To appreciate justly previous stages in the development of science,

we must not compare the knowledge of a certain period with our own but rather with that of the preceding period; we must ask ourselves whether these people knew more or less than their fathers, whether their endeavors, no matter how modest, were made in the right direction. Our present knowledge will have to be judged some time in the same way (1).

The main reason of the lack of interest in the history of science is the separation of the intellectual elite into two rival groups. This separation itself is largely caused and at any rate aggravated, by the fact that education has not kept pace with knowledge. In spite of the tremendous progress of science, a truly scientific education is not yet organized anywhere.

To come back once more to the tree of knowledge, the studies which I advocate in order to reconcile the historical with the scientific spirit, would be of two different kinds. One may investigate the state of knowledge and civilization at a definite period, that is, one may study transversal sections of the tree. The whole history of science might be conceived as a complete series of such sections. Or else, one may study the development of a branch or group of branches from its roots to its youngest twigs. This corresponds to the history of particular sciences. Studies of the second kind are fairly numerous, especially with regard to mathematics, mechanics, astronomy, chemistry, geology and medicine. Studies of the first kind, though their cultural value is considerably greater, are on the contrary very rare. One might say that knowledge and

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(1) MACAULAY expressed similar views in his essay on Sir JAMES MACKINTOSH'S History of the Revolution in England in 1668, London 1834 : «As we would have our descendants judge us, so ought we to judge our fathers. In order to form a correct estimate of their merits, we ought to place ourselves in their situation, to put out of our minds for a time, all that knowledge which they, however eager in the pursuit of truth, could not have, and which we, however negligent we may have been, could not help having. It was not merely difficult but absolutely impossible, for the best and greatest of men, two hundred years ago, to be what a very commonplace person in our days may easily be, and indeed must necessarily be. But it is too much that the benefactors of mankind, after having been reviled by the dunces of their own generation for going too far, should be reviled by the dunces of the next generation for not going far enough. »

civilization have not yet been completely and carefully mapped for any period, excepting perhaps the golden age of Greece (2).

To give a clearer idea of the extent of our studies, I will indicate two other historical surveys which would complete them : the history of art and the history of religion. But it should be noted that to parallel the history of science, as I understand it, the history of religion should include all religions and the history of art, all the fine and applied arts and the belles-lettres of every nation. Even as the historian of science explains the progress of positive knowledge and of its applications, the historian of religion would explain the development and purification of beliefs, the historian of art, the elaboration of dreams. The three histories put together would constitute a perfect mirror of the gradual expansion of man's thought. The history of science would be, of course, the central history, for it would be, among these three, the only one evidencing a continual accumulation and improvement. In spite of a few momentary regressions, the history of science is, indeed, essentially a tale of progress, of conquest; the progress is slow but sure, the conquests are inalienable; man cannot tell another tale of such greatness. It is unique. This is especially obvious if the history of thought is truly encyclopedic and œcumenic, for peoples or races may degenerate or disappear, or some branches of science may be temporarily neglected, but if one takes a broad view of the whole tree of knowledge, deriving its substance from the whole world, the growth may be sometimes irregular, it is never interrupted.

#### V. — *The New Humanism.*

The greatest difference between the history of science, as I understand it, and general history, as most historians understand it, is that the latter does not allow us to draw any definite conclusions, while the former leads directly to a new philosophy. The history of science cannot be an end in itself, but a means to a higher end : a deeper understanding of science, of nature, of life. It is possible that there is no logic in the course of political events and that it is vain to speculate on the calamities of the past, but there is certainly a logic, a very rigorous one, in the development of knowledge, — for this

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(1) Even then contemporary achievements of other peoples have been neglected.

development is progressive and cumulative. General history is largely a history of passions — the passions of single men or larger groups — and have human passions varied materially in the course of time? It is true, it includes also the history of institutions. This part of it is considerably more instructive and forms a sort of transition to our studies, for the development of institutions is obviously a function of the progress of knowledge.

The philosophy to which the history of science leads is what I have called the *New Humanism*. It embodies all the ideas set forth in the previous chapters; its principles are the very principles which I explained at the beginning. The unity and the organization of science are evidenced by the study of its history. The same study explains and proves the progress and the unity of mankind.

The name of this philosophy is justified by the fact that it implies a humanization of science, a combination of the scientific and humanistic spirit. I call it New Humanism with reference to the older humanism of the Renaissance to which it cannot improperly be compared. The old humanism was a revival of the ancient knowledge and wisdom fallen into neglect during the Middle Ages, its integration with the rest of contemporary culture; it drew its strength and inspiration from the vast treasure of Greek and Latin literature. In the same way, the New Humanism is a revival of the knowledge patiently elaborated and accumulated for many centuries by men of science, but neglected and despised by men of letters and educators, — its integration with the rest of our culture; its main spring is the history of science. It undertakes to bring together for the first time, scientists, historians, philosophers, sociologists; to coördinate and harmonize their points of view; to broaden their horizon without lessening the accuracy of their thought; to make the accomplishment of their higher task easier in spite of the increasing wealth of knowledge.

I said that the Renaissance was a resurrection of ancient wisdom. This statement is correct but needs qualification. The humanists and even more the contemporary men of science who turned to antiquity for fresh inspiration, did so as freemen, having a will of their own. Their reverence for the past was deep but critical. The main characteristic of the Renaissance, indeed, was its individualism, its refusal to submit blindly to authorities. It was essentially anti-scholastic. Even so, the New Humanism recognizes scholasticism as its arch-enemy.

Such movement is becoming more and more necessary for many reasons. In the first place, the intellectual laziness of most men, the ignorance and pedantism of educators, a load of knowledge, growing beyond the power of endurance of many, ancestral terrors and superstitions ever lurking, all these circumstances conspire to revive or to fortify scholastic tendencies. Then, as I have said above (but the matter bears repetition), the separation of the elite into groups unable to understand one another is ominous. It jeopardizes at once the unity of science and the unity of mankind. Men without scientific knowledge are totally unfit to explain the progress of humanity. Uneducated scientists, — men with short memories and no sense of perspective — are bound to be lopsided, narrow-minded, unimaginative; they are constitutionally unable to have a clear and deep understanding of science, not to speak of history. The best fruits of their own studies are lost to them. Investigations carried on along very special lines without reference to the work of one's fellowmen must produce in the end a sort of scientific Pharisaism, a worthless and stupid idolatry of facts, a system of meaningless conventions and unconscious prejudices. All these dangers are considerably increased by the fact that, as science is developing all the time, more and more of it will pervade our life (whether we like it or not) and eventually, when the inertia of schoolmen is overcome, our education. Science is our greatest treasure but it must needs be humanized or it will do more harm than good.

The New Humanism is a compromise between idealism and knowledge. I do not know which is worse, idealism without knowledge or knowledge without idealism, yet in the present circumstances we are but too often obliged to choose between the two evils. We need ideals to guide our steps toward the future, but they cannot possibly be fulfilled if we are not aware of the obstacles to overcome, of the paths to be followed, of the dangers that lie in them. Even the ideals themselves cannot be clearly conceived if one is not sufficiently familiar with all the knowledge available in one's time. Nothing can be more demoralizing than unreasonable ideals.

We might say also that the humanization of science is a compromise between the claims of the future and those of the past. Many are the poets and philosophers, who, realizing deeply the evils caused by the very progress of civilization, have dreamed of reestablishing the purity, the simplicity and other idealized condi-

tions of former times. But that is a false ideal or one which is wrongly formulated. We must interrogate the past in order to obtain a better understanding of our sacred patrimony, of our present position, of ourselves; we must contemplate it for the sake of its beauty and nobility; yea we must revere it, but a return to it such as RUSKIN, TOLSTOI, TAGORE and others have preached, is truly impossible. Humanity cannot go backwards any more than a grown man can recover the innocence and carelessness of his childhood.

Knowledge is one but its sources are many. Follow them and you will find that they can be reduced finally to two: nature and history. Either is necessary; neither is sufficient. The New Humanism is an emphatical recognition of that fact. Scientific and historical knowledge are equally indispensable; neither can completely enlighten us without the other. The New Humanism is an endeavor to preserve the best traditions of the past, to integrate them with our newer discoveries; to temper our knowledge with grateful memories and, so-to-say, to atone for the intellectual progress which it is our destiny to accomplish (sometimes faster it seems, than we deserve) by an increased devotion and more humility. The scientists of to-day whose privilege it is to contemplate the whole past and to dominate nature from the summit of modern science, must not be unworthy of their exalted position. No phase of human experience must be foreign to them; they must redeem their knowledge and the tremendous power it confers by humanity and love. They it is who will transmit the sacred treasures of our ancestors to our children. They must look back with gratitude and veneration towards the past, yet go forwards. Whatever salvation there be, is forwards not backwards. The past, however beautiful, is less beautiful than the future... The New Humanism derives its main inspiration from the past, yet it is turned towards the future.

George SARTON.

*Intervale, New Hampshire.*  
*September, 1923.*

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## APPENDIX I.

*The publication of « Isis ».**(An urgent appeal to American scholars.)*

I started the publication of *Isis*, ten years ago, in 1912-1913, to collect materials for the history of science and to explain and promote the very ideals to which this essay is devoted. I had then but little experience and my knowledge was considerably smaller than it is now. Without the encouragement of many of the leading men of science of the world (1), I would never have dared so bold an undertaking. By the middle of 1914, when the war broke out, *Isis* was fairly well launched. When I resumed the publication in 1919, after many tribulations, many of the former subscribers could not be reached any more: some were dead, others were ruined, others still had turned to other subjects. The work of propaganda was to be done all over again. Yet the European market was largely destroyed and I was myself impoverished. My income was now almost exclusively derived from my labor and, owing to the very high cost of living and to various accidents, I was obliged to live from hand to mouth. In spite of the devoted collaboration of my wife, I could not improve my condition. Since 1919, I have spent, on the average, twenty per cent of my salary for the publication of *Isis* and for my studies.

It should be noted that the effort which I am making to promote the History of Science and the New Humanism, is unique, for *Isis* is essentially different from other reviews of general science, such as *Nature*, *Scientia*, *Science progress*, *Revue générale des Sciences*, *Die Naturwissenschaften* or *Science*, whose aim is scientific (and professional) rather than humanistic. *Isis* is perhaps nearer to *Scientia* than to any other review, yet it is very different from it, because it does not contain the many valuable essays on modern theories which are found in *Scientia*, but does contain a vast amount of information on the history of science which cannot be found

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(1) Especially of the French mathematician HENRI POINCARÉ and of the Belgian sociologist EMILE WAXWEILER, — both gone alas! — Thanks to the latter I obtained some financial help from the chemist ERNEST SOLVAY for my start.

anywhere else. *Scientia* is a review of high popularization which appeals naturally to a larger public; *Isis* is, on the contrary, a review of scientific research edited primarily to satisfy the needs of a special group of scholars. Other reviews devoted to the history of science are published in Germany (the *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften*; the *Archiv für die Geschichte der Naturwissenschaften und der Technik*) and in Italy (the *Rivista di storia delle scienze mediche e naturali*, and ALDO MIELI's excellent *Archivio di storia della scienza*), but none of these reviews is as comprehensive as *Isis*, and none is as deeply concerned with the philosophical and sociological sides of the subject, the ideals of the New Humanism.

The first five volumes of *Isis* (1) contain 70 papers (2), 327 reviews and some 9,196 bibliographic notes. The reader may be reasonably sure to find in them a critique, a brief analysis or, at the very least, a mention of every publication of any importance relative to any aspect of the history of science and subsidiarily of its philosophy and of the history of civilization.

The main papers are generally not meant to be read (except a few editorials) but to be studied. The aim of *Isis* is not by any means to entertain idle readers but to collect and publish the best information available, to coördinate the work of scholars scattered in many distant places, in brief, to organize the history of science as an independent and full-fledged discipline placed on the same level as, say, the history of art or the history of religion. For example, the editor is anxious to publish original scientific texts, that is, to provide material for later investigations. The publication of Oriental texts (or rather of translations of them) is especially important, for a large proportion of them are still unpublished and virtually unknown. The subsequent volumes of *Isis* will contain — in shâ Allâh — many translations of Arabic, Persian, Sanscrit, Chinese and Japanese texts.

Most of the original papers, I said, are not meant to be read; the reviews, on the contrary, should be read, as much as possible, by all students of our subject and the more so that these students

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(1) 3118 pages, that is, an average of 624 p. per volume.

(2) The papers are written mainly in English and French, but also in German, Italian, and Latin.

will find in them, at least in some of them, many remarks of methodological value. However the most useful part of the journal is probably the Critical Bibliography which is not paralleled in any other publication. The material collected in it and duly classified is not restricted to the history of science; some of its deals with the philosophy of science or with philosophical problems which may confront the scientist; another part deals with the history of civilization or with the history of art or the history of religion. In short, everything which may help the historian of science to obtain the information which he strictly needs, is included, but beyond that, the editor tries to give him every inducement to keep a generous view of his studies and to be, what he might and should be, a true humanist.

The classification is primarily chronological, by centuries (1). Material which cannot be classified in that way is then if possible, classified historically (2), and if that fails, systematically (3). The purpose is to oblige the reader to consider the development of mankind — not simply one province but the whole of it — in its true chronological sequence. He cannot possibly use my classification without being constantly induced to make comparisons between the achievements of various peoples of East and West. Neither can he use it at all without realizing that many branches of the tree of knowledge grew together, each one influencing the others. Thus this classification offers, so-to-say, a continual illustration of the unity of mankind and of the unity of science.

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(1) See in chapter III, the footnote justifying the centurial classification.

(2) Under the following headings : Antiquity ; Asia ; Babylonia and Assyria ; Byzantium ; China ; Egypt ; Greece ; India ; Iran ; Islam ; Israel ; Japan ; Middle Ages ; Rome.

(3) Under the following headings, briefly indicated : Anatomy ; Anthropology ; Archæology, museums and collections ; Art, art and science, iconography ; Arts and crafts ; Astronomy, geodesy, meteorology and terrestrial physics ; Bibliography and libraries ; Biology ; Botany ; Chemistry ; Economics ; Education ; Ethnology, primitive and popular science ; Geography ; Geology, mineralogy, palæontology ; History of civilization ; Language and literature ; Logic and theory of knowledge ; Mathematics ; Mechanics ; Medicine ; Morals, moral organization of society ; Pharmacy ; Philosophy ; Physics ; Physiology ; Pre-hi-tory ; Psychology ; Religion, science and religion ; Science (bibliography, history, organization, philosophy) ; Sociology, jurisprudence and positive polity ; Statistics ; Superstitions and occultism ; Technology ; Zoology ; Alia.

The editor takes special pains to publish careful reviews of all the works of real importance, — the scholarly works which are the fruit of first hand investigations as distinguished from the books which are written and produced mainly for commercial reasons. It is his ambition to provide a scholarly and intelligent critique of every scholarly work; he should not be too severely blamed if he has not yet succeeded more completely in doing it. It is certain that nothing would promote our special learning more than the publication of a careful review of each important work by the best judge. It has been regretted that it took so long before a review appeared in *Isis*. A speedier publication is certainly very desirable but the editor's very small resources restrict his freedom. Moreover accuracy and fulness are the aim, rather than speed. A delay of a year or two is of little concern for a work of lasting value and it is hardly worth while to review others.

If the editor succeeds in obtaining sufficient assistance, he proposes to increase the number of illustrations — portraits, facsimiles, maps, diagrams; he has not the means of doing it himself.

This introduces the financial question, the appeal to the reader. If the latter does not like to be « touched », it is high time for him to run away. To put it as briefly as possible, I cannot and do not expect help from those who do not understand my point of view and my aims. But am I not justified in expecting those who understand me, who use *Isis*, or if they do not use it themselves, who appreciate its usefulness, who watch me fight alone, — to come and join and help me?

How can one help? The simplest way is to subscribe to *Isis* either directly or through one's bookseller (1). Those who can afford it may order many copies to be distributed either by themselves or by the publishers according to their instructions. For example, they may order the mailing of *Isis* to the university libraries of countries whose money is debased. They can also suscribe to the advertising fund or pay directly advertisements in other journals.

Scholars who are blessed with more genius and good will than worldly goods can also help in many ways. The Critical Bibliography to be truly satisfactory requires the collaboration of a great number

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(1) The simplest way is to join the History of Science Society. See preface to this volume. (Note added at the last moment. G. S.)

of specialists. I would be especially grateful to qualified scholars who would undertake to sub-edit one of the chapters, *e. g.*, Greece, or Middle Ages, or astronomy, or botany.

At any rate, I do hope, that the readers who appreciate the importance of the History of Science and who believe in the New Humanism, will not let me fight alone but will subscribe to *Isis*, even if they be as poor as its editor!

One more word. The name *Isis* has puzzled many persons. I chose it ten years ago because it was short, as I might have chosen MINERVA, ATHENE, HERMES or CLIO if those names had not been preëmpted. The title of a review should be as short as possible, being explained, if necessary, by a sub-title of any length. The name *Isis* evokes in my mind the period of human civilization which is perhaps the most impressive of all, — its beginning. Has mankind ever made as great a stride forward, as when it invented the making of fire or the rudiments of language?... However I discovered too late that this same name evoked in other minds ideas of mysteries and occultism very remote from my own. I understand that some people have been attracted to *Isis* because of such ideas (they must have been very disappointed!) while others have been equally repelled. I heard of a prominent scientist declaring that a journal called *Isis* could but be superficial and that he would not even look at it. He did not realize that it would have been difficult to surpass his own superficiality!

Gentle reader, if you are interested in the History of Science and Civilization, if you believe in the New Humanism, subscribe to *Isis* (1).

G. S.

Cambridge, Mass.

October, 1923.

## APPENDIX II

### *List of the first friends of « Isis ».*

This list of the first friends of *Isis* may help to define its aims. We often judge an undertaking by the men who joined in it. The

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(1) Bona fide inhabitants of countries whose currency is temporarily depreciated may obtain special terms by applying to the Secretary of *Isis*, Mr. L. GUINËT, 30, Avenue H. de Brouckère, Auderghem, Bruxelles, Belgium.

list includes all the men who contributed to any one of the first five volumes of *Isis* and those who agreed to support it at the very beginning and whose names appeared on the covers of the early numbers. Some of the latter did not contribute any papers. However, I could not omit their names because this would have involved omitting those of the much lamented HENRI POINCARÉ and EMILÉ WAXWEILER, to whom *Isis* is so deeply beholden. The names of those early patrons who did not collaborate have been asterisked. The names of the friends who died are followed by their dates of birth and death. It is shocking to realize how many have already left us. The names of the contributors of original papers have been printed in boldface.

**Agnes Arber**, hist. of botany, Cambridge, England.

\*SVANTE ARRHENIUS, physico-chemist, Stockholm, Sweden.

\*HENRI BERR, historian, Paris, France.

**Ernst Bloch**, hist. of chemistry, Brünn, Czechoslovakia.

**John David Bond**, hist. of mathematics, Knoxville, Tenn., U. S.

**Karl Bopp**, hist. of mathematics, Heidelberg, Germany.

VERA BOUNY, mathematician, Mons, Belgium.

**Pierre Boutroux** (1880-1922), hist. of mathematics, Paris, France.

FREDERICK E. BRASCH, hist. of American science, Washington, D. C.

C. BURALI-FORTI, mathematician, Torino, Italy.

**Florian Cajori**, hist. of mathematics, Berkeley, Calif., U. S.

\*MORITZ CANTOR (1829-1920), hist. of mathematics, Heidelberg, Germany.

YUEN R. CHAO, Sinologue, Cambridge, Mass., U. S.

**J. M. Child**, hist. of mathematics, Manchester, England.

A. K. COOMARASWAMY, hist. of Hindu culture, Boston, Mass., U. S.

\*FRANZ CUMONT, hist. of antiquity, Rome, Italy.

**Waldemar Deonna**, archaeologist, Geneva, Switzerland.

J. L. E. DREYER, hist. of astronomy, Oxford, England.

\*EMILÉ DURKHEIM (1858-1917), sociologist, Paris, France.

GEORGE ENGERRAND, archaeologist, Austin, Texas, U. S.

**Antonio Favaro** (1847-1922), hist. of physics, Padova, Italy.

\*FRANZ M. FELDHAUS, hist. of technology, Berlin, Germany.

\*JOHN FERGUSON (1837-1916), hist. of chemistry, Glasgow, Scotland.

\*ARNOLD VAN GENNEP, ethnologist, Neuchatel, Switzerland.

**Aug. Georges-Berthier** (1888-1914), hist. of biology, Lyon, France.

**Edmond Goblot**, philosopher, Lyon, France.

- Icilio Guareschi (1847-1918), hist. of chemistry, Torino, Italy.  
 Léon Guinet, hist. of science, Brussels, Belgium.  
 \*SIEGMUND GÜNTHER (1848-1923), hist. of science, Munich, Germany.  
 Charles H. Haskins, historian, Cambridge, Mass., U. S.  
 \*SIR THOMAS L. HEATH, hist. of Greek math., London, England.  
 \*J. L. HEIBERG, hist. of ancient science, Copenhagen, Denmark.  
 HALLDÓR HERMANNSSON, hist. of Iceland, Ithaca, N. Y., U. S.  
 ARTHUR JOHN HOPKINS, hist. of chemistry, Amherst, Mass., U. S.  
 \*FREDERIC HOUSSAY (1860-1920), zoologist, hist. of biology, Paris, France.  
 J. W. S. Johnsson, hist. of medicine, Copenhagen, Denmark.  
 Laura Jourdain, London, England.  
 Philip E. B. Jourdain (1879-1919), hist. of mathematics and mechanics, Cambridge, England.  
 L. C. Karpinski, hist. of mathematics, Ann Arbor, Mich., U. S.  
 G. R. Kaye, hist. of Hindu math., Delhi, India.  
 Graf CARL VON KLINCKOWSTROEM, hist. of technology, Munich, Germany.  
 A. KORN, physicist, Berlin, Germany.  
 E. KREMERS, hist. of pharmacy, Madison, Wis., U. S.  
 \*KARL LAMPRECHT (1856-1915), historian, Leipzig, Germany.  
 BERTHOLD LAUFER, Sinologue, Chicago, Ill., U. S.  
 RAYMOND LENOIR, philosopher, Paris, France.  
 WALTER LIBBY, hist. of science, Pittsburgh, U. S.  
 \*JACQUES LOEB (1859-1924), biologist, New York, U. S.  
 Gino Loria, hist. of mathematics, Genova, Italy.  
 DUNCAN BLACK MACDONALD, Arabist, Hartford, Conn., U. S.  
 SILVIO MAGRINI, physicist, Bologna, Italy.  
 ROBERTO MARCOLONGO, mathematician, Naples, Italy.  
 JEAN MASCART, hist. of mathematics and astronomy, Lyon, France.  
 Paul Masson-Oursel, Sanskritist and Sinologue, Paris, France.  
 \*WALTHER MAY, hist. of biology, Karlsruhe, Germany.  
 Hélène Metzger, hist. of chemistry, Paris, France.  
 Aldo Mieli, hist. of science, Rome, Italy.  
 Yoshio Mikami, hist. of Japanese science, Tokyo, Japan.  
 Gaston Milhaud (1858-1918), hist. of science, Paris, France.  
 G. A. Miller, hist. of mathematics, Urbana, Ill.  
 \*MAX NEUBURGER, hist. of medicine, Vienna, Austria.  
 Wilhelm Ostwald, hist. of chemistry, Grossbothen, Germany.  
 \*HENRI POINCARÉ (1854-1912), mathematician, Paris, France.

- Em. Radl**, hist. of biology, Prag, Czechoslovakia.
- \***SIR WILLIAM RAMSAY** (1852-1916), chemist, hist. of chemistry, London, England.
- Praphulla Chandra Ray**, hist. of Hindu chem., Calcutta, India.
- \***ABEL REY**, hist. of science, Paris, France.
- ARNOLD REYMOND**, philosopher, Neuchatel, Switzerland.
- D. S. ROBERTSON**, Cambridge, England.
- Julius Ruska**, hist. of Muslim science, Heidelberg, Germany.
- E. S. RUSSELL**, hist. of biology, London, England.
- George Sarton**, hist. of science, Cambridge, Mass., U. S.
- LÉOPOLD DE SAUSSURE**, hist. of Chinese astron., Geneva, Switzerland.
- Carl Schoy**, hist. of Muslim astron., Essen, Germany.
- H. M. SHEFFER**, logician, Cambridge, Mass., U. S.
- Charles Singer**, hist. of biology and medicine, London, England.
- David Eugene Smith**, hist. of mathematics, New York, U. S.
- \***LUDWIG STEIN**, philosopher, Berlin, Germany.
- J. Stephenson**, hist. of Muslim science, Edinburgh, Scotland.
- EDWARD STREETER**, hist. of medicine, Boston, U. S.
- Luigi Sualì**, hist. of Hindu phil., Pavia, Italy.
- \***KARL SUDHOFF**, hist. of medicine, Leipzig, Germany.
- LYNN THORNDIKE**, Mediaevalist, Cleveland, O., U. S.
- Emile Turrière**, mathematician, Montpellier, France.
- \***EMILE WAXWEILER** (1867-1916), sociologist, Brussels, Belgium.
- Catherine Durning Whetham**, hist. of science, Cambridge, England.
- Wm. Cecil Dampier Whetham**, hist. of science, Cambridge, England.
- HEINRICH WIELEITNER**, hist. of mathematics, Augsburg, Germany,
- John Kirtland Wright**, hist. of geography, New York, U. S.
- \***H. G. ZEUTHEN** (1839-1920), hist. of mathematics, Copenhagen, Denmark.

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