

the character of their work, and they should be members of the commission.

2°. To approve in detail the methods of expenditure of the appropriations.

3°. To recommend such measures as they deem necessary to the efficiency of the bureaus under their supervision. It should, however, be understood that this commission is not charged with purely administrative responsibility. It prescribes what shall be done, and recommends any measures necessary to secure that object, but does not concern itself with administrative details.

We submit the following as a suggestion for the formation and *personnel* of such a commission:—

The commission shall consist of, 1°, the president of the National academy of sciences; 2°, the secretary of the Smithsonian institution; 3° and 4°, two civilians of high scientific reputation, not otherwise in the government service, to be appointed by the president of the United States for the term of six years; 5°, one officer of the corps of engineers of the army; 6°, one professor of mathematics in the navy, skilled in astronomy, — these two to be designated by the president of the United States for a term of six years, — who, with, 7°, the superintendent of the coast and geodetic survey; 8°, the director of the geological survey; and, 9°, the officer in charge of the meteorological service, — shall constitute the commission of ——. The secretary of the —— department shall be *ex-officio* president of the commission.

The members of the commission, for their services as such, shall each be paid by the United States compensation in the sum of —— dollars per annum. Their necessary transportation and travelling expenses shall be provided for as are those of officers of the army and navy when travelling on public business or duty, to be paid out of the appropriations for the services under their supervision.

The commission shall meet in Washington, D.C., for the transaction of business, not less than four times a year; but the president of the commission may convene it whenever in his judgment the exigencies of the service require a meeting.

The commission shall be attached to the office of the secretary of the department of ——, and under his superintendence shall exercise a general control over the plans of work of the coast and geodetic survey, the geological survey, and the meteorological service, and shall have the charge and custody of all the archives, books, documents, drawings, models, returns, apparatus, instruments, and all other things appertaining to the commission.

The estimates of the heads of these bureaus or offices shall pass through the commission for revision and approval; and, after the annual appropriations have been made, no money shall be expended under them, except after revision and approval by the commission of projects submitted by these bureaus in compliance with such projects.

If at any time public money is being spent by any of these bureaus, not in accordance with the views of the commission, the commission shall notify the proper auditor of the fact.

### THE ADMINISTRATION OF THE SCIENTIFIC WORK OF THE GENERAL GOVERNMENT.<sup>1</sup>

IN response to your oral request at the session of yesterday to present to the commission my "opinions relating to the organization of the scientific work of the government on a comprehensive plan, by which the work can be more thoroughly co-ordinated, more systematically prosecuted, and more economically administered, than at present," I beg leave to make the following statement:—

The scientific works prosecuted under the general government of the United States, and in like manner prosecuted by other nations, may broadly, but with sufficient accuracy, be classed under two heads. In the first class are constructive works, such as the erection of public buildings, the improvement of rivers and harbors, and the construction of light-houses. In all of the operations of this class, in order that the work may be properly executed, scientific principles and methods must be observed; but such works chiefly involve problems of applied science. The second class of operations in which the government of the United States, like all other civilized nations, is engaged, involve in their nature original investigation. They are designed, in large part, to furnish needed information to the people; and they not only involve questions of applied science, but, that the purpose for which they are prosecuted may be properly accomplished, new facts and principles must be discovered. Such institutions are the geological survey, the coast and geodetic survey, the signal-service or meteorological bureau, the fish-commission, the national museum, the hydrographic bureau, and the national observatory. The functions of such bureaus cannot properly be performed without scientific research, and their value depends upon the wisdom and efficiency of the methods of investigation pursued. It is to this second class, of purely scientific institutions, designed for and necessarily comprehending original research for the purpose of giving information to the people, that I confine my remarks.

The operations of such institutions are exceedingly complex, and, from their very nature, cannot be antecedently planned and executed according to such original plan. At every step of the work, plans must necessarily be modified, as necessitated or suggested by discovered facts. It is therefore impossible by law to organize such operations; and, more, it is impossible for the directors or superintendents of such work to lay out plans of operations which shall be a full guide to their assistants. A clear conception of the object to be attained, and a comprehensive knowledge of the principles to be used in the guidance of research, are necessary; and beyond that, from time to time, as facts are discovered, and the avenues of investigation are opened, the work is directed in its details. It will thus be seen that it is

<sup>1</sup> From the testimony of Major J. W. POWELL, director of the U. S. geological survey, before a joint committee of both houses of congress.

impossible to directly restrict or control these scientific operations by law. The general purpose of the work may be formulated in the statutes, and the operations may be limited by the appropriations made therefor, and this is as far as the statute itself can properly go; for, if the operations themselves could be formulated in law, the facts would already be known, and the investigation would be unnecessary. It being impossible by statute to control or restrict the lines of investigation, as above shown, there is yet a control of the official personal organization which can properly be exercised by statutory provision; and a further control, superior to the immediate organization prosecuting the work, may be properly exercised in relation to the financial operations in the payment of employees, and in the purchase, use, and custody of public property, and the supervision of accounts.

I beg permission to set forth certain facts, which, I think, should be used as a guide in the establishment of such official organization and superior control. In the first place, the investigations prosecuted by all of these scientific institutions are in their nature inter-related and interdependent. The success of one is dependent, to a large extent, upon the success of the others; and, if at any time in the correlated investigations prosecuted by the general government any one branch fails in its department, the other branches suffer therefrom to a greater or less extent.

Foreexample: geodetic operations carried on throughout the world, and having for their purpose the determination of the figure of the earth, were for a long time prosecuted by refined trigonometric methods; but, as the work progressed, the problem was found to be more complex than was at first supposed, and elaborate gravity determinations were added to trigonometric methods. And it has quite lately been discovered that trigonometric and gravity methods must yet be supplemented by the determination of the geologic structure of lands, especially of mountains and mountain systems. Thus it has been found that the geographer cannot accomplish his work without appealing to the geologist for his knowledge. On the other hand, it has been found in the study of structural geology—and by that is meant the plan upon which the rocks composing the lands of a country are arranged—that it cannot be clearly understood and explained without the facts of geodesy. Sound geologic research, therefore, must progress hand in hand with sound geodetic research.

Again: in the prosecution of geodetic research, the parties thus engaged determine the exact position in latitude, longitude, and altitude, of many points upon the surface of the earth. In the prosecution of a geologic survey of the same territory, these same points must also be known; but, more than that, their number must be vastly multiplied, so that a map may be constructed setting forth the latitude, longitude, and altitude of all portions of the country surveyed. Where the geodetic survey establishes but hundreds of points, the geologic survey must have millions of points established.

Again: the points to be used in the geodetic survey

must necessarily be selected for that purpose. A general reconnaissance of the country over which such a survey is carried must be made, and the materials collected for at least a skeleton map. Thus it is that a skeleton map is necessary for a geodetic survey, and a completed map for the geologic survey. In like manner it can be shown that the relations between geodetic and geologic work are manifold, and, still further, that the geodetic work and the geologic work have a great variety of connections with the other scientific works prosecuted by the general government. It would require a volume to set forth all these relations, and to show how completely the success of one is dependent upon the success of all.

It will thus be seen that the official organizations for these institutions should be co-ordinated, that they may work together and aid each other; and, further, as each is interested to a greater or less extent in the operations of the other, the organization should be such that one shall not be compelled to do that which is the proper function of another, and that no one shall be permitted to encroach upon the functions of another. As long as the several scientific commissions and bureaus of the general government are distributed through all the departments of the government,—one in the war department, another in the navy, another in the interior, another in the treasury, etc.,—each bureau must necessarily, to a large extent, be autonomous: they must be self-governed, for it is a practical impossibility for any secretary of a general department to make such a study of the methods of scientific research as would warrant him in attempting their control. Hence these institutions have in the past been to a great degree autonomous, and must, under the same plan, continue to be.

If the statements thus briefly made are correct, it follows that the first guiding principle to the proper official organization of the scientific work is as follows: *The scientific institutions of the government should be placed under one general management.*

Again: as a necessity, scientific investigation must be controlled by the facts discovered from year to year, and from month to month, and from day to day. The operations of investigation, therefore, can only be controlled by the men who are actually performing the work. For example: the director of the geological survey cannot possibly lay out the work for his assistants in detail. He can only set forth in a general way the object to be reached, the general methods to be pursued; and such plans must be held open to revision from time to time as the facts discovered by the investigators themselves may demand. He must therefore hold himself always in communication with his assistants, and ever be ready to entertain their suggestions; and there is always a probability that he will err more in the direction of rejecting wise suggestions than accepting unwise plans.

It is thus that, to a large extent, the plans of the work prosecuted by an organization for scientific research must originate with the experts and specialists who are themselves engaged in the investigation; and

the most important function which the director of such an institution has to perform, lies in the selection of the proper men, — the specialists who have a genius for research. From the very nature of the work performed, the plan of operations to a large extent must come up from the individuals who are doing the work, and can only to a limited extent originate with the director. Out of the multitude of plans and ideas thus suggested by a corps of specialists engaged in original research, the superintendent or director selects such as he thinks wise, and is successful in his work to the degree in which he has a comprehensive knowledge of the subject.

If the above considerations are correct, the second guiding principle for controlling scientific work of the government is as follows: *The several bureaus engaged in research should be left free to prosecute such research in all its details, without dictation from superior authority in respect to the methods of research to be used.*

I beg to call the attention of the commission to certain statements of the committee of the National academy of sciences, which constitute a part of the record of the proceedings of this commission. These statements are as follows:—

Your committee states only the general sentiment and wish of men of science when it says that its members believe the time is near when the country will demand the institution of a branch of the executive government devoted especially to the direction and control of all the purely scientific work of the government. In this day the pursuit of science itself is, visibly to all men of education, directly connected with the promotion of the general welfare. . . . The members of your committee are conscious that placing these bureaus under one department would not necessarily result in the proper co-ordination of their work, because the head of such department would probably find it impracticable to enter into the consideration of all details necessary to that purpose. It appears to us that the evils already pointed out require, in any case, the organization of a permanent commission to prescribe a general policy for each of these bureaus. The functions of this commission would be,—

1°. To examine, improve, and approve the plans of work proposed by the several bureaus, and to revise their estimates in accordance with such plan. The performance of this duty would require consultation with their chiefs, generally and separately, respecting the character of their work; and they should be members of the commission.

2°. To approve in detail the methods of expenditure of the appropriations.

3°. To recommend such measures as they deem necessary to the efficiency of the bureaus under their supervision. It should, however, be understood that this commission is not charged with purely administrative responsibility.

It prescribes what shall be done, and recommends any measures necessary to secure that object, but does not concern itself with administrative details.

It will be seen from this extract that the learned members of the national academy constituting that committee, fully recognize the importance of a unified administration of the scientific bureaus. The same committee further expresses the opinion that a

department of science is desirable; but, fearing that such a department cannot be organized at the present time, a commission is recommended, to be composed of a secretary of one of the departments of the government, the president of the National academy of sciences, the directors or superintendents of the scientific bureaus, a professor of mathematics from the naval observatory, an officer of the engineer corps, and two citizens of the United States, eminent as scientific men, to be appointed by the president.

Sympathizing fully with the general tenor of the recommendations of the academy, I wish to present certain reasons for objecting to the constitution of the board of commissioners as recommended by that committee. The objection to such a board is twofold. In the first place, it would be composed of incongruous elements. A board composed of civil and military officers would, it is believed, be inharmonious, from the fact that military and civil methods of administration are entirely diverse, and proceed upon diametrically opposed theories. The military officer plans and commands: the civil officer hears, weighs, and decides.

In the second place, the board, as thus recommended, would be impracticable in its relations to the departments under which the several scientific bureaus are placed. Officers subordinate to the secretary of war, and officers subordinate to other secretaries, together with officers having no other connection with the government but as members of this board, would have the practical control of the work, so far as it could properly be controlled; and the secretaries themselves would simply be channels through which instructions to the bureau officers would be transmitted.

This, it is feared, would be irksome to executive officers composing the cabinet of the president. It is a matter of record in the proceedings of this commission, that Professor Newcomb of the navy department, and Gen. Comstock of the army, withdrew from the committee of the national academy at the request of their superior officers, the secretaries of those departments. It is presumable that this action was taken because the military secretaries did not desire to have their subordinates deliberate upon questions of policy affecting the conduct of the secretaries themselves; and this was entirely natural and proper, from a military stand-point, where superior officers plan and command, and inferior officers obey and execute. In a civil department of the government it would have been entirely in the course of things, and in no respect a violation of official proprieties, for subordinate officers to present plans, even of general policy, to their superiors.

Having thus briefly commented upon the plan of the academy committee, I beg permission to suggest a plan which would not involve the same difficulties. There is, in the organization of the general government, an existing body of officers competent to co-ordinate the scientific work, with an organization peculiarly fitted to supervise the general plans, and yet leave the officers of the several scientific bureaus free to carry on the details of operations by scientific methods, as they are developed from time to time. I

refer to the regents of the Smithsonian institution. These regents are composed of the chief justice, the vice-president, three members of the senate, and three members of the house of representatives, and six citizens. These regents are appointed as follows:—

The regents to be selected shall be appointed as follows: the members of the senate, by the president thereof; the members of the house, by the speaker thereof; and the six other persons, by joint resolution of the senate and house of representatives.

This body of regents appoints a secretary of the Smithsonian institution, who is its executive officer. If such of the scientific bureaus as should properly have a civil organization were placed under the direction of the regents of the Smithsonian institution, perhaps the best possible administration of the scientific work of the government would thereby be secured; and the learning and administrative ability of the present secretary of that institution would furnish abundant assurance that the organization of these departments under a common head, would, at its inception, be thorough and wise.

The history of the Smithsonian institution, with its governing board constituted as above, is the best warrant that could be given for a wise administration of the scientific operations of the general government. The first secretary of that institution, Professor Henry, was one of the great scholars of his time; and, under his administration, the affairs of the institution were conducted so as to meet with the approbation alike of the congress of the United States, the learned men of the country, and the people at large. His successor, Professor Baird, one of the leading scholars of the world, has conducted the operations of the institution as assistant secretary, and subsequently as secretary, in such a manner that the government of the United States has intrusted to him much larger and wider duties in the administration of the fish-commission and the national museum. It will thus be seen that the board of regents would constitute an able and efficient supervisory body; and it may always be expected that the executive officer of that board would be a man thoroughly competent to execute such a trust.

I next come to the consideration of the subject as to what bureaus should be placed under this common organization. Two of the bureaus already mentioned are now under the Smithsonian institution; namely, the fish-commission and the national museum. The geological survey could be very properly added to the number. Its relations to the national museum are very intimate. All of its collections of rocks, ores, minerals, and fossils, are deposited therein; and its laboratories for the study of these collections, chemical, physical, and paleontological, are also in the national museum, as they must necessarily be connected with the collections. This relation between the geological survey and the national museum is not by virtue of organic law, but solely by convention between the secretary of the Smithsonian institution, and the director of the geological

survey, and is a special courtesy to the geological survey, extended by the secretary of the Smithsonian institution. In like manner the geological survey has intimate relations with the fish-commission. In that commission it is necessary to employ a corps of biologists. The paleontologists of the geological survey also constitute a corps of biologists. The biologists of the fish-commission study the living forms in the existing bodies of water on and around this continent; the biologists of the geological survey study the fossil forms of the same region, some of which still exist, others of which have become extinct; and the biologic work of the two departments is so intimate, that at times the biologists of the fish-commission perform work for the geologists of the survey, and at other times the biologists of the survey perform work for the fish-commission and the national museum. It is very clear, therefore, that the geological survey could appropriately be placed under the same management as the fish-commission and the national museum.

The coast and geodetic survey must first be considered in its relations to certain other departments of scientific work. The committee of the academy recommend the establishment of "a physical observatory to investigate the laws of solar and terrestrial radiation, and their application to meteorology, with such other investigations in exact science as the government might assign to it." And they also recommend that the functions of the bureau of weights and measures, now performed by the coast-survey, be extended so as to include electrical measures, and that the whole be transferred to the new bureau recommended. The coast and geodetic survey already has under its charge the bureau of weights and measures. It is also engaged in magnetic researches, and could appropriately undertake electrical researches, and also the researches relating to solar and terrestrial radiation. I do not think that it would be best to create a new organization for the purposes thus indicated, but that it would be the part of wisdom to enlarge the functions of the present organization of the coast and geodetic survey to accomplish the desired purpose.

I have already mentioned that the national observatory is one of the institutions engaged in original research of such a character that it should form one of the co-ordinated bureaus, but it would not be necessary to transfer it as an independent bureau. It might properly be consolidated with the coast and geodetic survey. Under such a plan, this survey would have for its functions geodetic investigations, the methods of which are in part astronomical. It would also have the gravity investigations, and the investigations relating to solar and terrestrial radiation, which are also in part astronomical. It would also have the magnetic and electrical investigations. All of these lines of research are intimately related and profoundly interdependent.

I come now to a consideration of the survey of the immediate coast of the United States. The primary purpose of this survey is the construction of charts to be used by mariners. This survey of the coast

proper is nearly completed, and should be finished by the present organization. When thus finished, the work of the coast-survey on land will be practically ended, but the hydrographic operations must be permanently continued. In this hydrographic work a large corps of naval officers and seamen are employed under the coast-survey; and the navy is also engaged, under the organization of the hydrographic bureau, in conducting researches of like and related character off the coast. It is evident that this hydrographic work prosecuted by the coast and geodetic survey is pre-eminently a naval work, from the fact that officers and seamen of the navy are employed in its prosecution. The officers of the navy are necessarily, and should be, the geographers of the sea. Statesmen agree, that, even in time of peace, a naval establishment must be maintained. A school is supported by the general government for the education and training of officers to command its navies. This training should be continued by practical operations at sea, not by engaging in unnecessary war, but in the navigation of the seas and the management of vessels; and, while thus engaged, the navy may be appropriately and economically employed in the study of oceanic geography. I am therefore clearly of the opinion that the hydrographic work of the coast and geodetic survey should be transferred to the hydrographic bureau of the navy. As thus organized, it would necessarily have a military administration, and could not properly be placed with the other scientific bureaus enumerated above under one common management. There would yet necessarily be relations existing between the bureau of navigation and the other scientific bureaus; but they would be of a much less fundamental character, and would be limited in scope, and the few relations thus existing could be properly adjusted by convention.

If the signal-service is to have a military organization, it would be unwise to directly associate it with bureaus with civil organizations, for reasons already stated. Should it be deemed wise to include it in the group of scientific institutions, it should then be re-organized on a civil basis.

The various lines of research enumerated in characterizing the scientific bureaus above are such as properly pertain to the functions of government in the common judgment of mankind. The warrant for this statement exists in the fact that the leading civilized governments of the world do, in fact, provide for the prosecution of such operations. The subject of the endowment of such research by government has been widely discussed by statesmen and by scholars in America and in Europe alike; and the wisdom of such endowment, and the fundamental principles that should control such work, have been again and again clearly enunciated. The actual practice of the several governments engaged in this work is to a large extent harmonious, but in some important particulars there is diversity of methods. In the British government a part of the scientific research is controlled by organizations in the executive departments: another part is controlled by scientific societies organized under royal charters, and receiv-

ing grants of money from the general government. In the German states various methods are adopted, one of the most important of which is that the universities receive grants from the general government for scientific research. This latter method largely prevails in Russia; but in all of these countries the methods adopted in the United States are steadily gaining ground, and the practice of European governments is steadily following the precedents established in the United States.

The questions submitted by act of congress to the deliberation of this commission affect profoundly all of the important industries of the land. You are to decide for the people the best methods of utilizing the results of all scientific research, as they pertain to the welfare of the people of the United States; and your action, should it be confirmed by congress, will ultimately affect the deepest interests of all the people; and the influence of your action will be exercised in promoting or retarding scientific research itself, which is the chief agency of civilization, and the results of which constitute the chief elements of civilization.

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#### THE AMERICAN SOCIETY FOR PSYCHICAL RESEARCH.

At a meeting held in Boston, Jan. 8, the organization of the society was completed. The conduct of the affairs of the society is by the constitution placed in the hands of a council of twenty-one, which consists of Prof. G. Stanley Hall of Baltimore; Mr. George S. Fullerton of Philadelphia; Dr. William James, Prof. E. C. Pickering, Prof. J. M. Peirce, of Cambridge; Mr. Coleman Sellars of Philadelphia; Major A. A. Woodhull of New York; Professor Simon Newcomb of Washington; Drs. C. S. Minot and H. P. Bowditch, and Messrs. W. H. Pickering and C. C. Jackson, of Boston; Col. T. W. Higginson and Mr. N. D. C. Hodges, of Cambridge; Prof. George F. Barker of Philadelphia; Mr. S. H. Scudder and Prof. C. C. Everett, of Cambridge; Mr. Morefield Storey of Boston; Professor John Trowbridge of Cambridge; Mr. William Watson of Boston; and Professor Alpheus Hyatt of Cambridge. Professor Newcomb has been chosen by the council as president of the society, and Profs. Hal, Fullerton, E. C. Pickering and Drs. Bowditch and Minot, as vice-presidents; Mr. Watson, treasurer; and Mr. N. D. C. Hodges, secretary.

After the organization was completed, Professor Pickering, who was in the chair, referred briefly to the work of the committee on organization, which has had the matter in charge since last fall, and said that the details of organization would bear a small part in the work of the society; that there was now need of co-operation among all members in order that there might be some fruitful investigations carried on. He urged all members to look about among their friends for suitable subjects; Professor Pickering's opinion being that it would be much safer and more satisfactory to experiment on people of good standing, who might exhibit powers of mind-reading, or