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# SUMMARY STATEMENT OF THE WORK OF THE NATIONAL RESEARCH COUNCIL—1934-1935

By Dr. ISAIAH BOWMAN

CHAIRMAN

THE more concentrated activities of the National Research Council during the past year have been in five specific fields which were considered to be of major significance at this time:

(1) Borderlands in science and the training necessary for their cultivation;

(2) The educational relationships of post-doctorate fellowships and possible sources of future support;

(3) The continuation of general support for individual grants-in-aid of research;

(4) The responsibility of scientific institutions in relation to patents that may be issued on the results of scientific research;

(5) Relationships to the scientific services of the government of advisory non-governmental scientific agencies.

For the information of the public a brief description of the work in these five fields is published at this time, as soon as practicable after the close of the fiscal year. A complete statement of Council activities during the past year, including full details of the work of the several divisions, will be published as usual in the Annual Report.

## BORDERLANDS IN SCIENCE

Repeated consideration has been given by the Administrative Committee to the advancement of research in the borderlands between traditional scientific fields. Certain borderlands, such as physical chemistry and biochemistry, are now clearly recognized and well cultivated. Others are plainly in need of cultivation. Geology, geography and biology, for instance, have relationships of special importance in studies of land

use and soil erosion. The growing applications of the physical sciences to medicine indicate the potential contributions of the basic sciences when applied cooperatively in the solution of problems requiring an uncommonly wide range of knowledge of facts, principles and techniques. The extension of the basic sciences themselves requires ever new inquiry as to the wider applications of scientific knowledge to human affairs. The greatest borderland of all is that between the physical and natural sciences on the one hand and the social sciences on the other. It seems probable that the cultivation of this great borderland will be the distinctive mark of the next epoch of advancement in organized research.

The need for utilizing knowledge from several of the conventional fields of science in the attack upon current scientific problems has been recognized repeatedly in the appointment of fellows by the fellowship boards of the Council. Among the research projects of the divisions of the Council are a number which illustrate the coordination of work in several major fields of science: studies of the effects of certain radiations upon living organisms, sponsored by the Council during the past six years; certain phases of the investigations of the Committee for Research in Problems of Sex; the preparation of the monographs assembled in "The Physics of the Earth"; the organization of the Washington Biophysical Laboratory; the investigations of the Committee on Industrial Lighting; investigations on the varied causes of deterioration of marine piling; studies pertaining to the measurement of geological time; and a concentrated attack upon drug addiction. A conference on the relationships between physics and chemistry was held by two of the divisions of the Council last year.

The encouragement of research in the borderlands of science seems to involve the specific preparation of men, the coordination of different phases of a cooperative problem of common interest, the application of methods and instruments developed in one line of research to other lines and problems, and free range in the planning of research, untrammelled by traditional restrictions and supported by a broad knowledge and deep understanding of related sciences. The history of science supplies abundant proof that the development of a new technique in one field inevitably opens up unexpected opportunities for progress in other fields.

A paper is about to be published in SCIENCE upon "Borderlands in Science"[1] which assembles the discussions, illustrations and points of view brought forward at successive meetings of the Administrative Committee. The comments of readers of the paper are invited as a basis for further discussion and report.

[1] By Dean F. K. Richtmyer, of Cornell University.

While it is felt that interest in borderland problems can not be stimulated artificially, it is believed that all research agencies would welcome an opportunity to cooperate in the effort to utilize the knowledge and methods of the basic sciences in attacks upon new and varied problems on the frontiers of knowledge.

## FELLOWSHIPS

During the past year the National Research Council has expended upon post-doctorate fellowships $221,927.73, of which about 7.8 per cent. was used for administration. These funds have supported a total of 96 fellows.

After operating for periods of from 12 to 15 years there are (December 31, 1934) 901 past fellows of these three boards, who, with the 96 fellows active during the current year, have been selected from 3,953 applicants as shown in Table I.

TABLE I

| | Past fellows | Current fellows | Total applications |
|---|---|---|---|
| Physics, chemistry and mathematics | 396 | 47 | 1,489 |
| Medical sciences | 220 | 10 | 1,117 |
| Biological sciences | 285 | 39 | 1,346 |
| Totals | **901** | **96** | **3,952** |

The Council fellows have been located at about 60 American universities. Two hundred and forty-five of the fellows have studied abroad. Last year the number of active fellows was 165. For the coming year, in view of the restriction of funds, the boards in charge of the fellowship programs have appointed a total of only 60 fellows.

The funds providing for these fellowships have been furnished by the Rockefeller Foundation and the totals, since establishment, are as follows: Physics, chemistry and mathematics, $1,677.091.22; medical sciences, $770,215.02; biological sciences, $1,168,073.54; total, $3,615,379.78. (As of December 31, 1934.)

Of this total sum $174,390.14, or about 4.8 per cent., was required for administrative expenses.

It is clear that past fellows of the Council are taking their places prominently among the scientific leaders of the country. The four awards made under the American Chemical Society for work in pure chemistry, established by Dr. A. C. Langmuir a few years ago, were won by past fellows of the Council. Of the 396 past fellows in the physical sciences, about 73 per cent. are now engaged in academic work, of whom two thirds are already of professorial grade. Of the 220 past fellows in the medical sciences, 80 per cent. are engaged in academic work; and of the 285 past fellows in the biological sciences, about 70 per cent.

Repeatedly the outstanding men in science are found to have held National Research Fellowships.

In the judgment of many leading physicists and chemists the brilliant advances in chemistry made in the United States during the past decade, and perhaps even more strikingly in physics, have been largely due to the opportunity given to superior young men to pursue advanced work in the post-doctoral period. Such results bear out the expectations of the founders of the fellowships that the finding and development of talented young men for scientific leadership means a substantial national gain.

The responsibility for maintaining these fellowships rests upon all agencies alike—the foundations, the universities, technical institutes, industry and social agencies that strive to increase national welfare through the elevation of standards of living in which scientific applications play so large a part.

## GRANTS-IN-AID

During the year 1934–35 the National Research Council has made 116 grants, totalling $50,359.50, from 250 applications. These grants were distributed according to subject as given in Table II.

TABLE II

| | No. | Amount |
|---|---|---|
| *Individual Grants:* | | |
| Physical sciences | 18 | $ 8,375.00 |
| Engineering | 1 | 1,000.00 |
| Chemistry | 11 | 5,902.50 |
| Geology and geography | 15 | 6,300.00 |
| Medical sciences | 26 | 12,600.00 |
| Biological sciences | 30 | 10,547.00 |
| Anthropology and psychology | 15 | 5,635.00 |
| Totals for individual grants | **116** | **$50,359.50** |
| *Grants to Divisions of the Council:* | | |
| Conferences | 15 | 5,525.63 |
| Cooperative projects | ... | ..... |
| Grand totals | **131** | **$55,885.13** |

For the past six years funds have been contributed to the National Research Council by the Rockefeller Foundation for the support of research through grants-in-aid. The funds now in hand will provide for the continuation of grants through the calendar years 1936 and 1937.

During the six-year period, 1929–36, 667 grants have been made to 503 individual investigators located in 138 universities and colleges and in a limited number of other educational and research institutions of the United States, including a few to independent investigators. In this way $347,074.31 has been distributed. In addition, $25,562.42 has been used for conferences (of which 41 have been held during this period) and 5 grants, totaling $15,500, have been applied to the support of several programs of coordinated investigations under the sponsorship of the divisions of the Research Council. Altogether, $41,062.42 has been used through 46 appropriations for grants for these general purposes.

The total number of grants made during the period from July 1, 1929, to June 30, 1935, is shown in Table III.

TABLE III

| | No. | Amount |
|---|---|---|
| *Individual Grants:* | | |
| Physical sciences | 97 | $ 54,270.06 |
| Engineering | 18 | 12,560.00 |
| Chemistry | 75 | 43,883.00 |
| Geology and geography | 110 | 55,171.00 |
| Medical sciences | 123 | 67,517.50 |
| Biological sciences | 144 | 64,993.00 |
| Anthropology | 53 | 27,509.75 |
| Psychology | 47 | 21,170.00 |
| Totals for individual grants | **667** | **$347,074.31** |
| *Grants to Divisions of the Council:* | | |
| Conferences | 41 | 25,562.42 |
| Cooperative projects | 5 | 15,500.00 |
| Totals | **46** | **$ 41,062.42** |
| Grand totals | **713** | **$388,136.73** |

These are but the gross statistics of grants-in-aid operations. The main result is that the grants are supplying funds in a discriminating way to research projects requiring small-scale support for technical assistance, field work or instruments. Most of the grants have been of modest amount, averaging $532.00. The total of published results now amounts to several hundred papers which have appeared in scientific journals.

Grants-in-aid make possible the continuation of the research of grantees at their home institutions, encourage the individual through a special form of recognition, and bring to the fore investigations and investigators of high merit. The support of research by special grants is a long and well-recognized method of fostering creative work, especially in institutions that have no free funds for the support of research which may reach the point of emergency.

## PATENT POLICY

The patent policy of the National Research Council, since its initial definition in 1924, has been to make available the patentable results of scientific work sponsored by the Council without profit and for the free use of the public. As the custodian of trust funds intended to support scientific research for public benefit the Council has not wished to profit, even in the bookkeeping sense, from any of its operations. During recent years many other institutions have been studying the same problem. New types of patents have developed and the patent system has come to be relied upon more and more as a standardizing and controlling agency.

In order to pool the experience of institutions that deal with patent matters, and secure broad and detailed discussion, a conference was held last March under the auspices of the Council. As a result of this conference and of further study on the part of a special committee of the Council, the patent policy of the

Council has been closely reexamined and a committee will pursue the subject still further in the immediate future and in the light of accumulating experience. Besides safeguarding the interests of the public, the Council desires to secure the full and prompt publication of the results of research, conducted under the auspices of the Council or through its committees and fellows, with provision for the recognition of the rights of cooperating agencies and of special conditions which may indicate the method of treating patentable results case by case.

Out of the discussion of the past year has come the suggestion that a central agency might be established in the United States which could serve universities and research institutions by administering for them such patents as it may seem desirable to take out. More competent and experienced handling of patent cases might result and individual institutions be saved a considerable administrative expense and effort. The results of scientific work would thereby be protected also from socially harmful exploitation.

### Governmental Relationships

The work of the Science Advisory Board, in its second year of operation as a committee of the Council, has demonstrated the extraordinary service which the scientists of the country can render government where suitable opportunities are afforded. Instead of having its usefulness limited to the submission of reports upon random requests for aid and advice from the scientific bureaus of the government or the congress, the board has been able, through the approval of the President of the United States and through the cooperation of the several heads of departments, to study and report upon scientific problems in a coordinated way. It has been demonstrated that there exists a need for a permanent service of this comprehensive type.

Happily, steps have already been taken to make permanent the valuable features of the past two years' experience of the board by providing new agencies within the framework of the National Academy of Sciences and in line with its charter obligations. No one interested in the progress of science can fail to realize the importance of maintaining strong scientific bureaus in the Federal Government; and our citizens have the right to expect that the organized agencies of science, and especially the National Academy and the National Research Council with their permanent endowments and high prestige, shall exert themselves unremittingly and effectively to accomplish this purpose. The second report of the Science Advisory Board, to be issued within a few weeks, is worth close study by every scientist who maintains a lively sense of responsibility as a citizen. The limitations of space forbid an extended statement in this place on the accomplishments of the board.

### Biological Abstracts

*Biological Abstracts* has been issued since 1926, and by December, 1935, the ninth volume will have been completed. Volume VIII for 1934 contained 21,469 items. During the past eight years references have been published to 188,139 books and articles, most of them with abstracts. A large corps of collaborators, including about 300 sectional and topical editors, has furnished material. Correspondents are located in all the scientifically productive countries of the world. The material abstracted is gleaned from about 5,000 journals. Altogether, a most efficient and far-reaching system has been built up for reporting the content of biological contributions from the whole world with the keenest attention to economies consistent with making a reliable and thorough survey. A new form of comprehensive index by author, subject and taxonomic classification has been devised especially adapted to botany, zoology and the allied sciences, and a means has been provided for the coordination of contributions in the fields of biology to a degree which has never before been attained.

The publication of *Biological Abstracts* has been sponsored by the Union of American Biological Societies and the funds administered through the National Research Council. The editorial expenses have been met from appropriations made by the Rockefeller Foundation, which now total $658,000. The printing expenses have been met from subscriptions and a limited amount of advertising.

The production of *Biological Abstracts* has depended very greatly upon the contribution, made without charge, of the abstracting services of its editors and special reviewers. It is the only large abstracting journal which does not pay honoraria for its abstracts. A system for obtaining authors' abstracts has been put into effect which involves a number of the English language journals both in this country and abroad. A repeated and careful study of printing costs indicates that it is cheaper to print *Biological Abstracts* for all fields of biology in a single volume than to subdivide the material for issue in sections by fields. It has been found that individual biologists who have ready access to files of the *Abstracts* in their institutional libraries are making increasing use of the annual index issues of the *Abstracts* as an effective key to the literature in their fields.

With the increasing interdependence of science, of which the multiplication of problems in the borderlands involving two or more of the classical disciplines is one indication, the need for a systematic review of related literature has become more and more apparent.

The use of biological literature extends far beyond the limits of the special fields of zoology and botany. It is resorted to by both physicists and chemists working upon problems relating to biology, and it is, of course, fundamental in the application of biological knowledge to various branches of medicine and public health. Over 25 per cent. of the institutional subscriptions to the *Abstracts* are for medical establishments, and over 16 per cent. of the individual subscribers are engaged in medical research. The organization of the great mass of literature annually produced in all the fields of biology bears rather directly on the welfare of society.

In the fall of 1934, after several years of operation, the Union of American Biological Societies, with the consent of the Rockefeller Foundation, requested the Division of Biology and Agriculture of the National Research Council to make a study of the need and of the use which biology and the related sciences have for a periodically coordinated review of the literature in these fields and of the degree to which *Biological Abstracts* is meeting this need. The younger men and the more active investigators regard *Biological Abstracts* with high appreciation, while those who are more strongly established in their professions seem to make less use of it. Also, those located at large institutions with extensive libraries seem to find less need for the *Abstracts* than investigators located at smaller institutions. In sum, 88 per cent. of those replying to a questionnaire that was designed to test the work of the journal regarded it highly, and most zoologists, botanists and geneticists who replied rate it as indispensable.

### International Scientific Unions

The National Research Council has renewed its efforts during the past year to arrange for the payment through governmental appropriation of the dues of the United States in the International Council of Scientific Unions and several affiliated unions to which the council has adhered. The total of these obligations would amount to about $6,700 at present rates of exchange. The Council regards it important that these relations be maintained, but unless governmental provision can be made for them there seems to be no possibility of meeting the financial obligations involved. No one who has participated in the work of the unions, and of the congresses held under their auspices, can fail to be interested in the outcome of this form of international cooperation.

### Medical Sciences

In the fields of the medical sciences mention may be made of four enterprises: (1) research on problems of sex; (2) investigations upon narcotic drugs; (3) a survey of research in the United States on the gonococcus and gonococcal infections; and (4) a world survey of tropical diseases and facilities for studying them.

*Sex Research:* Work sponsored by the Research Council during the past fourteen years upon problems of sex has yielded over 700 published papers on the part of a score of investigators who have collaborated on these problems. A total of about $810,000, provided by the Rockefeller Foundation, has been expended upon them. Perhaps the most important result of this work is the development, during the past decade, at a number of institutions throughout the country, of laboratories competent in personnel and equipment to carry these and related investigations further.

While continuing to support various projects in the general biology of sex, the committee now purposes to devote its chief efforts to relatively neglected areas of its field of interest, such as neurophysiology, psychobiology and psychopathology. With fairly comprehensive knowledge now at hand concerning the medical phases of this subject, it is becoming increasingly important to be able to produce the hormones of sex synthetically by inexpensive processes in order to apply this knowledge in medical practice, and the Council's committee is addressing itself to the encouragement of research in this direction.

*Narcotics Research:* Within the past year significant results have begun to appear from the work conducted at the University of Virginia upon the chemistry of narcotic drugs, and at the University of Michigan upon the physiological effects of the narcotic alkaloids produced synthetically at the University of Virginia. These research centers have made themselves highly specialized and efficient agencies of experimentation in their respective fields. Knowledge of the chemistry of narcotic alkaloids and of the physiological effects of these substances has been greatly advanced by their coordinated effort.

The group of collaborators at the University of Virginia has produced 264 substances, of which 120 are phenanthrene derivatives (several being similar in their chemical formation to vitamin D and the carcinogenetic factor of tar) and 144 are morphine derivatives. Ninety-three of these substances are entirely new. All these 264 substances have been tested for their physiological properties at the University of Michigan, and clinical studies are now in progress of a small selected group of such substances to determine their addiction liability and the possibility of using them in medical practice as narcotics and analgesics.

*Surveys:* The survey of research upon gonococcal infections was undertaken in cooperation with the

American Social Hygiene Association and is nearing completion. It is understood to be the first comprehensive review of research in this field that has been made either in the United States or abroad.

The survey of tropical diseases has culminated in a statistical report upon the "Geography of Diseases" which is now in process of publication as a volume of some 700 pages.

### Division of Engineering and Industrial Research

The National Research Council recognizes the advancement of science by research in industrial laboratories. The Council believes that the research work of industry should never become dissociated from the basic scientific work of the universities. The Division of Engineering and Industrial Research lends its assistance also to work on special projects, such as the coordination of investigations in the field of dielectrics, systematic studies upon the conservation and transfer of heat through various materials used in industrial processes and investigations upon the friction of fluids in pipes. For a number of years the division has supported the American Bureau of Welding in cooperation with the American Welding Society for the encouragement of investigations upon both the theory and the practice of welding.

The Highway Research Board of the Council has for thirteen years been cooperating with the U. S. Bureau of Public Roads in the coordination of research conducted by numerous state and university agencies upon the construction and maintenance of highways. In addition the board is sponsoring special cooperative investigations upon (a) the use of high elastic limit steel for concrete reinforcement, (b) the warping of concrete pavement slabs, (c) the stabilization of the curve of low-cost-type roads, and (d) studies upon highway costs as an element in regional economic improvement.

### Conclusion

This brief review pertains to a few of the Council's activities that have special interest at this time. It includes no reference to other highly interesting and valuable work of the divisions of Physical Sciences, Chemistry and Chemical Technology, Biology and Agriculture, Geology and Geography, and Educational, States and Foreign Relations. The reports of the chairmen of these divisions will appear in the next Annual report of the Council and are of such general interest to scientists that they would be summarized here were it not for the limitations of space. It is fitting that acknowledgment should be made to many for financial aid and especially to the Rockefeller Foundation and the Carnegie Corporation for their willingness, during the past year, to contribute to the general support of the Council as well as to specific projects.

# OBITUARY

## EDWARD SALISBURY DANA

THE death of Edward Salisbury Dana on the sixteenth of last June at the age of eighty-five ended a most remarkable chapter in the history of American science. He was of the third generation of a family that for more than a century and a third guided and enriched our scientific life. The record of this family is unique.

The story may be said to have commenced in 1802 when the elder President Dwight appointed Benjamin Silliman to the professorship of geology, mineralogy and chemistry in Yale College. It was Yale's first recognition of science as a part of the college curriculum. Silliman made two most important contributions to the development of science in the United States. Through his influence the first important mineral collection which came to this country, the Gibbs collection, was brought to New Haven for exhibition and later was purchased by friends of Yale for its permanent use. This collection afforded material for study and early made Yale a center for mineralogical investigation. His second great contribution was the founding in 1818 of the *American Journal of Science*. This, the oldest scientific magazine in the country, was for more than a hundred years edited and supported by the members of the Silliman-Dana family.

James Dwight Dana was a student of Silliman and in time became his scientific successor. These ties were strengthened when he married Silliman's daughter. The elder Dana was perhaps most renowned as a geologist, but it was as a mineralogist that he had his greatest influence on his son Edward's career. J. D. Dana published the first edition of the "System of Mineralogy" in 1837 when only a few years out of college. This book, which has had the greatest influence in that science of any single book published anywhere, passed through five editions under J. D. Dana's editorship, the fifth edition being dated 1868.

Edward S. Dana was born in New Haven on November 16, 1849, in the house on Hillhouse Avenue where he lived the greater part of his life and in which he died. He graduated from Yale in the class of 1870. The next two years were spent in graduate work, chiefly in mineralogy under the direction of Professor George J. Brush, of the Sheffield Scientific School. The following two years he was abroad, studying at