Since experimental science has assumed such a commanding influence on all our affairs, so that we run the risk of great perils if we take no account of it, and leave its uses to others, let us say less well disposed than ourselves, and, on the other hand, have opportunities of great benefit if we use it rightly, it becomes a first duty to direct our steps accordingly. Just as in former times schools and colleges were founded to train men for the service of church and state, in ways which were appropriate to that high end, so now we have to see to it that the men are produced by our educational systems who can appreciate and act up to a new state of affairs. This can be done without jettisoning any of the fine instruction which has been a proud feature of our older systems.

I think that this is not essentially a matter of the rearrangement of school time tables, or the building of scientific laboratories, though such tactical methods must have their due consideration. This is a personal matter, as has been the case with every great human movement. We have not to force the use of new tools, but to encourage and develop a new appreciation and a new attitude. Our best method, as ever before, lies in our own actions. If we, in the continually increasing contacts of scientists with public affairs, can show that we have something of great value to contribute, and that we give it freely, placing our individual interests below those of a greater purpose; if we try to understand the motives and principles of those whom we meet who may not see our vision just as we may fail to appreciate theirs, then by so doing we have the best chance of bringing about the changes that we desire. It is the personal contact of the scientist, especially with those who are charged with duties to the nation, that is the moving force. That is where these new associations of science with government may mean so much, and shall mean it, if our devotion can achieve its purpose.

This afternoon I leave the presidential chair. I have deeply appreciated the honor that has been paid to me by my election to it, and I want to thank with all my heart the officers of the society, the members of council and the permanent officials who have helped me to fulfil its duties.

THE ROYAL SOCIETY[1]

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THE purpose of the "Record of the Royal Society" is "to provide a compendium of information, largely historical, regarding the rise and progress, the organization and work of the Royal Society." This purpose is admirably achieved in the present revised and enlarged fourth edition of the work. The book comprises a brief history of the society, notes on the charters and statutes, full information about the benefactors of the society, its funds, research professorships, fellowships and studentships, its library, portraits, busts and other property, its committees, publications and relations with the government. In appendices the various charters and statutes of the society are printed and also complete lists of patrons and officers, of medalists and lecturers and finally of fellows arranged both chronologically and alphabetically. Accordingly, this is both a book of reference and an account, brief, but documented as few histories can be documented, of the formation, the development and the functions of a national academy of science.

The Royal Society of London for the Promotion of Natural Knowledge is in many respects the most interesting of all such academies. It is the oldest surviving academy that has had a continuous existence. In the second half of the seventeenth century it was one of three which accomplished the first effective organization of scientific work and of scientific workers, and to-day, though its activities are different from its early activities, they are still as important as ever to the sciences and probably much more important—at least directly—to the state and to society at large.

It is convenient to divide the history of the Royal Society into three periods: the seventeenth century, the next century and a half, and lastly the time from the middle of the nineteenth century to the present day. On the whole, the composition of the society, its activities and its functions have varied widely in these three periods. The first and third are the times of vigorous activity.

The present "Record" begins with the statement that "the foundation of the Royal Society was one of the earliest practical fruits of the philosophical labours of Francis Bacon," and so it was in a measure that is to-day hardly appreciated. Sprat may be cited in support of this judgment. He wrote in his "History of the Royal Society" in 1667:[2]

[1] "The Record of the Royal Society of London for the Promotion of Natural Knowledge." Fourth edition, London, printed for the Royal Society by Morrison and Gibb, Ltd., Edinburgh. 1940. Price, 21/–.

[2] Tho. Sprat, "The History of the Royal Society of London, For the Improving of Natural Knowledge," London, 1667, pp. 35–36.

In [Bacon's] Books there are every where scattered the best arguments, that can be produc'd for the defence of Experimental Philosophy; and the best directions, that are needful to promote it. All which he has already adorn'd with so much Art; that if my desires could have prevail'd with some excellent Friends of mine, who engag'd me to this Work: there should have been no other Preface to the *History* of the *Royal Society*, but some of his Writings.

Yet after much further discriminating praise Sprat goes on to remark:

But yet his *Philosophical Works* do shew, that a single, and busie hand can never grasp all this whole Design, of which we treat. His Rules were admirable: yet his *History* not so faithful, as might have been wish'd in many places, he seems rather to take all that comes, then to choose; and to heap, rather, then to register.

So it is evident that the movement of thought in England had already discriminated between the best of Bacon's ideas and the rest of them. There must have been wide consideration and discussion of these ideas, for the "New Atlantis," first published in 1627, had appeared in ten editions forty-three years later.

Men banded themselves together in England, as in Italy and France, at this time not only under the influence of ideas but also under the influence of real needs. Association is necessary for the transmission of skills, prompt information about the work of others is necessary to men who are studying natural phenomena, in the absence of journals correspondence carried on as effectively as possible is widely called for, and all this gives rise to spontaneous association and to a recognition of the importance of corporate action. Ingenious men quickly recognize and strongly feel such needs. Boyle, Wilkins, Wallis, Evelyn, Hooke, Wren and Petty, different as they were, were all clearly moved in such ways, and there were many others.

The first gatherings out of which the society finally arose were spontaneous and seem to have originated in the forties. There was certainly a meeting in London at Gresham College as early as 1645, and Boyle's first famous reference to the "invisible college" is of 22 October, 1646. This was a time of trouble when men were disturbed, much as they are to-day, and there is evidence that the founders resorted to these early meetings as a release from the troubles of the times. Sprat says:[3]

Their first purpose was no more, then onely the satisfaction of breathing a freer air, and of conversing in quiet one with another, without being ingag'd in the passions, and madness of that dismal Age. And from the Institution of that *Assembly*, it had been enough, if no other advantage had come, but this: That by this means there was a race of yong Men provided, against the next Age, whose minds receiving from them, their first Impressions of *sober* and *generous knowledge*, were invincibly arm'd against all the inchantments of *Enthusiasm*.

[3] *Ibid.*, p. 53.

It is not too much to see in the last phrase of this quotation another influence of Bacon through his discussion of Idols.

About 1648 or '49 the original band of the "invisible college" became divided between Oxford and London, and for a time the greatest activity was at Oxford. The design for the Royal Society was probably debated for the first time only six months after the return of Charles II, on 28 November, 1660. Its execution was promoted especially by Sir Robert Moray, a man who was president before the incorporation of the society and whose influence with the King seems to have been decisive. The first charter is of 15 July, 1662, and the president of the newly incorporated society was Lord Brouncker. The first council included also Sir Robert Moray and all the men above mentioned except only Hooke (*b.* 1635), who in November was appointed curator of experiments to the society. A second charter, providing all desired privileges, is of 22 April, 1663; a third, of no great importance, of 1669. The famous mace, a gift from the King, was ordered on 23 May, 1663. There were 119 original fellows, of whom not more than a third were men of science, the rest noblemen and gentlemen of substance and importance whose support was needed and whose concern for the society seems to have been frequently greater than that of their successors in the eighteenth century. Among the original fellows was John Winthrop, Governor of Connecticut.

Another original fellow was John Graunt, author, probably with Petty, of the "Natural and Political Observations on the Bills of Mortality." This work interested the King, who recommended[4] the election of its "judicious author . . . in whose election it was so far from being a prejudice that he was a shopkeeper of London, that his Majesty gave this particular charge to his Society, that if they found any more such tradesmen, they should be sure to admit them all without any more ado."

The early meetings of the society were devoted mainly to the demonstration of experiments, and there are records of hundreds of experiments performed by Hooke and later by the joint curator, Papin, appointed to the post in 1684. The society further showed its interest in experimentation by procuring the publication of an English translation of the famous work on experimentation that had been put out by the Accademia del Cimento of Florence.[5] But the Royal

[4] "Record of the Royal Society," 4th ed., p. 20.

[5] Essays of Natural Experiments Made in the *Accademia del Cimento*, under the Protection of the Most Serene Prince *Leopold of Tuscany. Written in* Italian *by the Secretary of that* Academy. Englished by *Richard Waller*, Fellow of the *Royal Society, London*, 1684.

Society never went as far as the Cimento in excluding speculation. The subjects of both experiments and papers during the early years of the society were extremely varied. There was much that was important and also much that was trivial. This may be attributed to the undifferentiated nature of the science of that day, to the freshness and curiosity of the spirit of the seventeenth century "Virtuosi," and to the strong interest of many of the founders of the society in the applications of science and in *useful* knowledge. This, again, is perhaps partly owing to the influence of Bacon.

The voluminous correspondence of the society, conducted by the industrious secretary, Oldenburg, was also an important feature of the meetings. This work of Oldenburg's led to an incident which once more suggests present conditions. He was born at Bremen, and in 1667 was arrested on suspicion of carrying on with foreigners political correspondence not to the liking of the King and the government. For some time he was imprisoned in the Tower of London. This event may have been responsible for the suspension of meetings of the society from the end of May to the beginning of October. The *Philosophical Transactions* were begun by Oldenburg within three years of the granting of the first charter of the society.

In its early years the society also gave the support of its imprimatur to the publication of numerous important books, including works by Evelyn, Hooke, Graunt, Malpighi, Wallis, Willughby, Grew, Lister, Ray, Flamsteed and Papin, and most important of all, Newton's "Philosophiae Naturalis Principia Mathematica." The society also procured the writing and publication of Sprat's "History of the Royal Society."

In early years a Repository of Rarities was built up. This later (1781) was turned over to the British Museum, which had originated in the famous collection of Sir Hans Sloane, president of the Royal Society from 1727 to 1741. The long and intimate connection of the society with the Royal Observatory at Greenwich is also of early origin. From an early date also, committees of the society took over work not unlike that performed by committees of the present day.

In the beginning the society seems to have been, on the whole, favorably regarded, though Sprat's "History" is in part a defense against the old philosophy. The poets Dryden, an original fellow, and Cowley, whose name appears on the first list of those from whom the Royal Society originated, were actively favorable; but later and for a long time there was much hostility and ridicule from men of letters, such as Addison, Swift and Pope. In attacking French academicians Voltaire was an imitator of Swift.

During the seventeenth century there were also signs of anxiety about the conflict of theology and science. The question is taken up in the "History" by Bishop Sprat, who carefully develops the thesis that there ought to be no conflict, and it may be presumed that concern for this danger led the pious Boyle to found the Boyle Lectureship, which still continues. This was the time when Evelyn published an English translation of Book I of Lucretius's *De Rerum Natura*, for which he was privately reprimanded[6] by Jeremy Taylor, and it seems nearly certain that Lucretius was then exercising great influence upon thought and that this was in part the cause of the anxiety of men like Sprat and Boyle.

During the seventeenth century and for a long time thereafter, universities were not on the whole favorable to the development of science. This fact is well illustrated by a letter of Newton's written from Cambridge on 23 February, 1684–85. Newton says:[7]

> The designe of a Philosophical Meeting here, Mr. Paget, when last with us, pusht forward, and I concurred with him, and engaged Dr. More to be of it; and others were spoke to partly by me, partly by Mr. Charles Montague; but that which chiefly dasht the business, was the want of persons willing to try experiments, . . .

It is all the more remarkable that even in the earliest years of the society a sound understanding of effective scientific procedure is both implicit in the works of the founders of the Royal Society and even clearly formulated by Hooke in his *Micrographia* (1665):[8]

> So many are the *links*, upon which the true Philosophy depends, of which, if any one be *loose*, or *weak*, the whole *chain* is in danger of being dissolv'd; it is to *begin* with the Hands and Eyes, and to *proceed* on through the Memory, to be *continued* by the Reason; nor is it to stop there, but to *come about* to the Hands and Eyes again, and so, by a *continual passage round* from one Faculty to another, it is to be maintained in life and strength, as much as the body of man is by the *circulation* of the blood through the several parts of the body, the Arms, the Feet, the Lungs, the Heart, and the Head.

Newton was president from 1703 until his death in 1727, but already the ardor of the early years of the society had cooled and there followed a long period that is relatively unimportant. During this period the proportion of men of science among the fellows was always small, and on the whole men of great scientific distinction were few. Notable exceptions in the eighteenth century were Hales, Bradley, Cavendish, Watt, Priestley, the elder Herschel, John Hunter and two Americans, Franklin and Rumford, whose initiative, versatility and practical abilities remind one of Wren and Petty rather than of their own eight-

[6] Letter, 16 April, 1656.

[7] C. R. Weld, "A History of the Royal Society," London, 1848, Vol. 1, p. 305.

[8] Preface.

eenth century English contemporaries. Possibly there is some significance for the social historian in the origin of such men in the later period and in a remote colony.

In the second half of the eighteenth century the government began to make a practice, which has become highly important, of referring scientific questions to the Council of the Royal Society for consideration and advice. One early question gave rise to a famous controversy concerning lightning rods, and in the year 1777 the affair degenerated into a political quarrel. Pointed lightning rods were the invention of Franklin, who had become a rebel. Benjamin Wilson advocated blunted conductors, and the partisans of pointed conductors were regarded as friends and supporters of the Americans. The affair seems to have resulted finally in the resignation of the president, Sir John Pringle, who had said to the King in supporting pointed rods: "I cannot reverse the laws and operations of nature." There is a story, not well founded but widely believed, that the King replied: "Perhaps, Sir John, you had better resign." At all events, Pringle did resign and was succeeded by Sir Joseph Banks, whose long presidency, in some respects almost monarchical, continued from 1778 to 1820.

Earlier in the lightning rod controversy, the council found it necessary to take the position that the society as a whole did not give an opinion, but that:[9]

> The procedure was that a Committee of the most eminent of the Fellows of the Society cognizant of the subjects concerned was appointed by the Council, and their report when adopted by the Council was transmitted as their recommendation. This procedure has always been observed and is still in use.

Judging by long experience, such a practice seems to-day necessary, alike in the interest of the society and of the state. In the long run it may well be an indispensable condition for the independence of an academy of science, for it is competent individuals, not societies, who can objectively weigh and appraise evidence.

A further development was the appointment of fellows of the society by departments of the state to serve on councils and committees where scientific matters must be considered or reviewed. In more recent years such activities of the society and of its members have taken on the very greatest importance.

The Linnean Society was founded in 1788, the Geological Society in 1807, the Astronomical Society in 1820. At first these new societies were regarded as secessions from the Royal Society and were strongly opposed by Sir Joseph Banks. In due course, however, it became clear that this movement, like the establishment of journals devoted to specialties, was indispensable and that it did not lead to a weakening of the Royal Society but only to a modification, and in some respects to a strengthening, of its activities.

In 1743 a dining club was established among the fellows, which since 1795 has been known as the Royal Society Club. This club survives in full activity. It has had its ups and downs, and from 1847 for some decades its functions were in part usurped by the Philosophical Club, made up of a body of reformers. Long before the end of the nineteenth century, these reformers had accomplished their purpose, and in 1901 the two clubs were amalgamated.

The early years of the nineteenth century were a period of transition marked by not a little dissatisfaction among the scientific fellows of the society. In the year 1830, "Of the 662 Fellows who then formed the Society only 104 had contributed at least one communication which had been published in the 'Philosophical Transactions.'" It was in this year that Babbage published his "Decline of the State of Science in England," which was chiefly directed against the Royal Society. He had been associated with Peacock and the younger Herschel in an attempt to introduce Continental mathematics into the University of Cambridge, one of his efforts having been the proposal to form a society for promoting "the Principles of pure *d*'ism [*d* is Leibniz's symbol] in opposition to the *dot*-age of the university [*dots* are Newton's notation]." It was also in this year that a serious effort, in which Faraday seems to have taken a hand, was made to elect Herschel president, but in the end the Duke of Sussex received 119 votes and Herschel 111.

At length, in 1846, it was decided:[10]

> . . . that the election of candidates for the Fellowship should be held once annually and in May; that the number which the Council should select and recommend for action each year should not exceed fifteen.

It is said that:

> This was probably one of the most important, if not the most important, change in the administration of the Society which had been made since its foundation, for the result was to change it within a generation from a body of well-educated and cultivated men, of whom probably only one-third or rather more could be classed as men of science, to a scientific institution of the highest rank.

The number 15 was adhered to until 1930. From 1930–37 the number of candidates elected on the recommendation of the council was 17. Since 1937 it has been 20.

This action has had a marked effect not only upon the choice of candidates but upon the size of the so-

[9] "Record of the Royal Society," 4th ed., p. 47.

[10] *Ibid.*, p. 58.

ciety. From the year 1700 until about 1850 the increase in the number of fellows, almost linear, was from just over 100 to more than 750. During the ensuing 30 years the number fell continuously to less than 500. Since that time it has always been between the limits 450 and 500.

The ratio of this number to the number of inhabitants of the country is greater than 1/100,000. The corresponding ratio for the United States is less than 1/300,000. Indeed, the fellows of the Royal Society are somewhat more numerous than the members of the National Academy of Sciences, and are likely to become even more so. Such differences between the two bodies can hardly lack importance. It must be remarked, however, that other circumstances, such as habits and traditions and the possible frequency of meetings, may well go far to determine the optimum size of an academy. At all events, it may be said that a membership of the Royal Society both relatively and absolutely large has proved to be advantageous. On the other hand, the Académie des Sciences of the Institut de France is both relatively small and absolutely very small indeed, and this is rather widely regarded both in France and elsewhere as a disadvantage. Yet a century ago it was perhaps not so regarded.

Like all other academies whose members are chosen from the whole field of science, the Royal Society is troubled by the problem of making its ordinary meetings generally interesting. This is a difficulty which hardly existed in the early years of the society, but which arose long ago with the increasing specialization of men of science and which seems likely to continue. It rests upon the awkward fact that there is little satisfaction in listening to a paper that you do not understand on a subject in which you are not interested. In respect of this difficulty, the small extent of the country and the possibility of frequent meeting are perhaps disadvantages.

The present state of the society is well known and is fully documented in the present "Record." The Royal Society has become a central body of men of science, long since relieved of the tasks that have been taken over by the many special scientific societies, charged with many responsibilities but detached from politics and from special interests of all kinds. The duties of the society as the established and traditional adviser of the government on all scientific questions have steadily increased. Its concern for international affairs, at least in times of peace, has greatly developed, and during the present century new responsibilities in the administration of funds for research have arisen. In the year 1900 the value of the research funds of the society was £42,000; in 1937 it had grown to £636,000. There are now six research professorships financed by the council of the society and also a number of research fellowships and studentships.

To-day the Royal Society is an indispensable and efficient part of the organization of a complex modern state. To what does it owe its strength and its usefulness? First, it is a truly representative body. For nearly a century the council has in fact had the last word in the selection of new fellows. Of late years the practice has been that special committees sift the candidates, but the council still makes the final selection and is said to determine a certain small proportion of the nominations independently of all committees. Thus the council can see to it that all subjects are fairly represented in the membership of the society and that men whose work falls outside the recognized special sciences are not forgotten. There is perhaps no really good way of recruiting an academy, and under any system some men are bound to be overlooked or rejected until they have passed their prime. But the system of election to the Royal Society has long worked well and the highest scientific competency of the nation is always well represented in the Royal Society.

Secondly, the council is also charged with almost all administrative and executive duties and authority. It is a working body, a body small enough for effective deliberation which can meet frequently and which, partly for that reason, possesses and preserves a tradition of responsibility. This condition, to be sure, also depends upon the smallness of the country and upon the fact that in general the members of the council live in or near London. In particular, Cambridge is not far from London, and the importance of Trinity College, Cambridge, in the activities of the Royal Society is very noteworthy. During the present century more than half the presidents of the Royal Society—the elder Rayleigh, J. J. Thomson, Rutherford, Hopkins and W. H. Bragg—have been fellows of Trinity, and during the same period more than one third of all officers of the society have been fellows or scholars of the same college.

Thirdly, the society is respected. Englishmen at large think of it as a great national institution, and they think of it often. It is kept before their minds by its many important public services, by the dignity of its ancient establishment and honorable record, and even perhaps by the magic of the familiar letters F.R.S. All young men of science aspire to membership. In England this is a strong and conscious ambition among the young men, an ambition probably much more general, stronger and more conscious than the ambition of young Americans to become members of the National Academy of Sciences. Such ambition is a source of strength to the society and to science in general.

Above all, the Royal Society is independent. Thus

it can freely promote natural knowledge and fearlessly, without prejudice, select committees qualified to give expert advice and opinions and able to do so disinterestedly. Not very long ago such freedom and independence were taken for granted. But a time has now come when we may well ponder them. By studying the Royal Society as described in its official "Record," much may be learned of the conditions governing the effective organization of men of science and their disinterested service to society.

OBITUARY

CARL L. ALSBERG

THE passing of Carl L. Alsberg on October 31, 1940, represents indeed a loss, not only to the world of science, but even more so to those who had the privilege of knowing and working with him. That his loss will be felt in many different quarters is due, in large part, to the extraordinary breadth of his interests and an all-embracing curiosity which led him into ever newer fields. His life was one of many transitions and to each new task he brought, not only the wealth of great experience, but also a rare originality of thought and quickness of perception.

Born in New York City in 1877, his early education was not along conventional lines but took place entirely at home under the supervision of his mother, a woman of unusual intelligence, and his father, who was a chemist. While still quite young, he entered Columbia University, from which he obtained an A.B. degree at the age of nineteen. His early interest was in biochemistry, probably traceable to the influence of his father, and as training for his chosen field he studied medicine, taking an M.D. degree from Columbia in 1900. Thereafter followed three years of scientific study and research at the Universities of Strassburg and Berlin, and upon his return to the United States he was appointed assistant in physical chemistry at Harvard University. His association with that institution in various capacities lasted until 1908, at which time he entered the service of the Bureau of Plant Industry in the United States Department of Agriculture as chemical biologist. In 1912 he was selected to head the Bureau of Chemistry in the Department of Agriculture and served as bureau chief for nine years, during which time he developed a keen interest in problems of governmental policy and administration.

On the founding of the Food Research Institute at Stanford University in 1921, he accepted appointment as one of the three original directors, his fellow directors being Dr. Alonzo Taylor and Dr. Joseph S. Davis. With his removal to the West Coast, Dr. Alsberg soon became deeply interested in problems of the Pacific area, in particular those of food supply and their effect upon the population of the Far East and North America. The result was his very active participation in the Institute of Pacific Relations, and for years he served, not only as trustee, but also as chairman of the International Research Committee of that body. He was, in addition, a member of the Committee on Pacific Investigations, Division of Foreign Relations, of the National Research Council, and a member of the Pacific Coast Regional Committee of the Social Science Research Council.

It was at the Food Research Institute that Dr. Alsberg first took an active interest in economics, an interest stimulated by his close association with others concerned primarily with the economics of food supply. As a result, his energies were given a new direction, to which a lengthy list of publications on various economic phases of the food industry can attest. He was in particular attracted by problems of food production and commodity regulation, and in recent years devoted much time to the study of these questions in relation to wheat and fats and oils.

On the whole, the years at Stanford represented a transition between the natural scientist and the social scientist, and with his appointment in 1938 as director of the Giannini Foundation and professor of agricultural economics at the University of California, this new development was completed. Due to his own experience, Dr. Alsberg was always deeply concerned with the relationship between the physical and the social sciences. His years of service to the former had confirmed his belief in the great worth of the natural sciences, not only *per se,* but as a discipline for the scholar. He was especially fascinated by the problem of adapting the methods of research employed in the natural sciences to research in the social sciences and emphasized the value of scientific methods in his teaching.

To give a list of Dr. Alsberg's publications and the many organizations in which he was active would require much space. Above all, it would give no genuine picture of his truly great contribution to science and to society, for much of this lies hidden in the encouragement and stimulus he has given to others. Never one to be sparing of his help, his suggestions and advice have led to the inauguration and completion of many works of scholarship and research, and even invention, which otherwise might not have seen the light of day. For this he claimed no credit but the satisfaction of seeing a good piece of work well done.