purpose of each expenditure, and of the results reached by it.

These suggestions involve no reflection upon the eminent citizens who form the board of regents of the institution. We are sure that none will grasp the situation more readily than they when once it is brought to their attention. We feel that they are abundantly able to judge of the good policy of expending almost the entire income of the fund entrusted to them in eking out the appropriations made by congress for the National Museum and other local objects. If the claim is made that the Smithsonian Institution is in touch with the science of the world by its system of international exchanges, and with the people of the country through its annual reports, they are abundantly able to see that the prosecution of the first is a source of gain to the institution, and that its annual reports, being printed by Congress, cost the institution far less than the profit upon exchanges, so that the entire income is still available for other objects. We believe that the more carefully the able members of the board of regents consider this subject, in the light of past experiences and present conditions, the more fully they will appreciate the force of the considerations we have suggested.

*THE ACADEMY OF SCIENCES.**

TWENTY-THREE centuries ago, when the first and fairest flowers of civilization were in blossom, Plato and his friends met together in an Athenian garden to talk of the things that appeared to them to be beautiful, good and true. The garden was called 'The Academy,' and the word has ever since maintained the high traditions of its origin, uniting the ideas of friendly social intercourse and the search for truth. The philosophy of Plato was passed on to his disciples, so that we read of fourth and fifth academies; it was transplanted to Rome, where Cicero named his country house 'The Academy,' and to Alexandria, where mystical neo-platonism long resisted the dogmatic rationalism of the church.

As part of the Italian renaissance, when civilization was once more young, vigorous and beautiful, as in the Greek period, the word 'academy' was revived and used to name a society of scholars. Cosimo dei Medici, the Elder, established at Florence in the fifteenth century a *Platonic Academy,* and academies of letters by the hundred flourished in Italy during the sixteenth century. In 1560 there was established at Naples by the versatile Giambattista della Porta the first academy of sciences—*Academia Secretorum Naturæ*—to which only those were admitted who had contributed to the advancement of science or medicine. The academy at Naples was suppressed on the accusation that it practised the black arts; but soon afterwards there was established at Rome, with Galileo as one of its members, the *Accademia dei Lincei,* which was later revived and is now one of the great national academies.

The mere word 'academy' is of course unimportant; societies of scholars are not always called academies, nor are all academies societies of scholars. The beginnings of associations for the advancement of knowledge are to be found in savage tribes, developing with the state of civilization, usually in the form of guilds of priests, until we reach the Greek period, whence we date our philosophy and our science. The culture of Greece was carried to Alexandria, where Ptolemy Soter, supposed to be the son of Alexander the Great, estab-

* Address of the president of the New York Academy of Sciences, read on December 15, 1902.

lished the beginning of the μουσεῖον, based on the four corner-stones of science and culture, the university, the academy, the library and the museum; and this institution maintained its prestige for centuries. We have here an association of scholars that surpasses anything to be found in Greece or Rome, and one indeed that approaches an ideal more nearly than any existing institution. Supported by the government, we find men of science living together and working together, a system of lectures, a library of 600,000 titles and the like. To these conditions we may attribute the work of Aristarchus, Eratosthenes, Hipparchus, Ptolemy, Archimedes, Euclid, Herophilus and others, who in many ways established the principles of science. Similar if less important centers of learning arose in Bagdad, Damascus and elsewhere; and there was a series of Arabian astronomers, physicians and mathematicians, who never permitted the torch of learning to become extinct, until it was merged in the dawning light of modern science.

The records of Roman history are chiefly of wars and politics; but its institutions still dominate the world. The names of Pliny, Galen and Lucretius prove that science was cultivated. It is said that there were twenty-eight public libraries in Rome in the fourth century; and the schools of the Roman Empire never became extinct. Rome was the center whence first empire and then the church spread civilization throughout Europe. The removal of the seat of empire to Byzantium, the ever recurring invasions of the barbarians from the north, and the tenets of the christian church are supposed to have extinguished learning and culture; and the period from the decline of the Roman empire to the revival of learning in Italy is called the dark ages. But perhaps these centuries are only dark in so far as they are obscured from our sight. It may seem absurd for an amateur in history to make an assertion contrary to the common views; but the scientific man, saturated with the doctrine of evolution, is loth to accept a spontaneous generation of culture at the period of the late Italian renaissance. Students of medieval history are indeed beginning to date back this period of awakening to the thirteenth or even to the eleventh century; but there appears to be much evidence for a gradual extension of civilization and culture throughout Europe from the sixth to the eleventh centuries.

It is a long way from the love passages of the Phædrus to those of the Vita Nuova, from the fawn of Praxiteles to the madonna of Giotto, from the Phrygian mysteries to the order of St. Francis. The christian church is said to have been inimical to culture and science, but to it we owe the establishment of monasteries, schools and libraries throughout Europe. It is natural that the civilizations of Athens and of Rome should have become merged in the surrounding peoples. We might as well wonder why Shakespeare did not give rise to a line of poets, as to wonder why the Athens of Pericles was not permanent. When Rome came in contact with the peoples of the north, an average resulted which was in the end an extension of civilization. The barbarians who overran Italy and sacked Rome were themselves converted to christianity, and the traditions of culture were carried beyond the Rhine and the English Channel.

Boetius, whose birth coincided with the fall of the western empire, wrote on science as well as on philosophy. From his death, in 525, education and learning were in the hands of the church. Gregory the Great, pope from 590 to 604, encouraged primary education; and monasteries, being at once schools, libraries and academies of learned men, were established everywhere under the early popes. Bede, born about

673, wrote on astronomy and medicine. At his school at Jarrow in Northumbria there were 600 monks in attendance besides strangers from a distance. Alcuin, born about the year that Bede died, went from the directorship of the school at York to establish the palace school for Charles the Great, making the court of the emperor more nearly an academy of sciences and letters than has happened elsewhere in history. Alfred the Great in the following century also cultivated letters at his court, and himself wrote on scientific as well as on literary subjects. He established schools throughout his dominion, including an academy at Oxford.

The traditions attributing the University of Paris to Charles and Oxford University to Alfred are discredited; but the schools they supported and established certainly did not become extinct, but developed into the medieval universities. The curriculum of the monastic and cathedral schools may appear narrow and trivial—the well-known seven arts, the elementary trivium—grammar, rhetoric and dialectic, and the more advanced quadrivium—music, arithmetic, geometry and astronomy; but if we compare it with the curriculum of the American or English college of a few years ago we should cast no stones. Indeed, when we try to picture the state of affairs, the invasions of the Northmen and Saracens, the wars and pillages, we can but admire the spirit that maintained schools and libraries in the monasteries, the academies of sciences and arts of the time. The Roman Church, the Holy Roman Empire, civic life and independence and finally the universities were the offspring of the so-called dark ages.

The medical school of Salerno, whose beginnings are traced to the ninth century, seems to have descended directly from the Greco-Roman period. It was secular in character, extending its privileges to Jews and women. It is of interest to scientific men that the first university should have been a school of medicine, but it must be admitted that it did not contribute considerably to the advancement of science—at Alexandria the living human body was dissected, at Salerno Latin hexameters were written on the urine—nor has its imperfectly known organization the interest for us that attaches to the universities of Bologna and Paris.

The medieval university is certainly one of the most notable institutions known to history. It appears almost incredible that 10,000 students from all parts of Europe should have frequented Bologna, when traveling was as expensive, difficult and dangerous as was the case in the thirteenth century. The guilds or trades unions of the students and teachers represent a kind of organization that is of peculiar interest to those of us who are concerned with the conduct of modern scientific societies. The present period is marked by combinations of labor and of capital, such as have not previously existed, but the guilds of the middle ages had a more complete organization, and the universities of scholars have no modern counterpart. It seems to me that we men of science suffer both in position and in character from the dependence to which we submit, and that we could with advantage learn from the *studium generale* of the middle ages.

The centers at Bologna and Paris developed almost simultaneously. Bologna was primarily a law school and Paris a theological school. The former was more strictly professional, and its students were mostly men of maturity, already holding positions in the church or state. The universities of students, representing different nationalities, obtained control and imposed their authority on the masters and on the city. The school at Paris was less professional in the sense that theology and

philosophy were the liberal studies of the age. There was at Paris from the time of Abelard a vast number of teachers gathered together from all quarters; and the formation of a university of masters was followed in the thirteenth century by the complex organization of nations and faculties.

Migrations from Bologna established universities throughout Italy, while the influence of Paris led to the universities of Oxford and Cambridge, of Prague and of the various French cities. Science in the modern sense of the word did not play an important part in the medieval university; but Roger Bacon, born in 1214, was intimately associated with Oxford and Paris, and doubtless found encouragement as well as persecution at these universities. The promise of Bacon was not fulfilled for more than two centuries; but there was a slow growth of science at the universities. Copernicus found masters at Cracow, Bologna and Padua and was himself professor at Rome. Kepler and Galileo filled chairs at universities; they bring us to the period of the organization of academies of sciences.

Francis Bacon in his *New Atlantis,* published in 1627, pictures Solomon's House as an ideal academy of sciences. I have already referred to the establishment of actual academies of sciences in Italy during the sixteenth century. They were originally clubs of scientific men or men interested in science who met together to discuss and perform experiments. Like the early universities the academies were at first independent of the state; but they subsequently received charters and appropriations of money. In the sixteenth and the first part of the seventeenth century academies of sciences were founded throughout Europe. The period was marked by extraordinary scientific progress which was greatly stimulated by the interchange of ideas made possible by the academies. The state of science was such that each member could understand and take interest in the work of all the others. Intellectual curiosity was widespread, catholic and naïve.

The Royal Society of London and the Academy of Sciences of Paris arose at about the same time and under similar circumstances. At Paris a club counting among its members, Descartes, Gassendi and Pascal met at a private house for some thirty years, until an academy of sciences was finally organized by Colbert on the model of the Académie Française established earlier under the auspices of Richelieu. The seven original members included Huyghens, who was called to Paris. They received pensions from the king and grants for instruments. The academy was reconstituted in 1699 with fifteen active members, three each in geometry, astronomy, mechanics, anatomy and chemistry. The academy of sciences became part of the Institute of France in 1795; at which time it was divided into ten sections in each of which were six members and six associates in the provinces, the sections being: (1) mathematics, (2) mechanics, (3) astronomy, (4) experimental physics, (5) chemistry, (6) natural history and mineralogy, (7) botany, (8) anatomy, (9) medicine and surgery, and (10) agriculture. An eleventh section—geography and navigation—was added in 1803 with three members. As constituted since 1833, the Institute of France contains five academies: (1) Française, (2) Inscriptions et belles-lettres, (3) Sciences, (4) Beaux-arts and (5) Sciences morales et politiques. The academy of sciences contains eight members and the other academies forty. Each receives a pension. As we all know, the intellectual life of France has been centered largely at Paris and in the academies.

The Royal Society of London resulted from a club that held meetings as early as 1645; it was finally organized in 1660 and

chartered in 1662. The membership was larger and less exclusive than in the case of the Paris Academy, and there has not been a division into sections. Under the existing statutes fifteen fellows are elected annually, and the membership numbers about 450. The fellows do not receive pensions as in the continental academies, but pay dues. The society, however, administers a government fund for research (£4,000 annually), and has in many ways cooperated with the government. There has been this year established a British Academy for the Promotion of Historical, Philosophical and Philological Studies.

The Accademia del Cimento, begun in Florence in 1657, and the Collegium Curiosum begun in Altorff, Franconia, in 1672, are types of the scientific clubs of the time. Somewhat later academies were established in various centers—the Berlin Academy in accordance with the plan of Leibnitz in 1700 and the St. Petersburg Academy by Peter the Great in 1724. The members receive salaries from the government; at St. Petersburg these are liberal, so that at one time eminent foreigners, such as Nicholas and Daniel Bernoulli, were attracted to St. Petersburg by membership. Similar academies were established in the capitals and other cities of the continent—at Stockholm, Copenhagen, Munich, Madrid and elsewhere. These imperial and royal academies were patronized by kings and princes and were part of the court life of the time.

The American Philosophical Society, modeled by Franklin on the Royal Society, had its beginnings at Philadelphia in 1743; and the American Academy of Arts and Sciences, modeled by Adams on the Paris Academy, was established at Boston in 1780. Both institutions were originally of national scope and still maintain this character to a certain extent. Academies more local in character were subsequently established in different cities, the Connecticut Academy of Arts and Sciences, founded at New Haven in 1799, being the oldest of these. Our own academy of sciences was organized in 1817 as the Lyceum of Natural History in the City of New York. The National Academy of Sciences was incorporated by congress in 1863. It was born into a world that has changed, and we may hope progressed, since the golden age of academies. The differentiation of the sciences, the dispersal of our men of science over a wide area and the general trend of democratic institutions are not favorable to the academy of the type that flourished in the seventeenth and eighteenth centuries.

The nineteenth century witnessed an extraordinary development of scientific activity throughout the world. Each science has had its great leaders who have established new fundamental principles and new lines of investigation, while the workers in the ranks are now a great army. I have had occasion during the past year to compile a biographical catalogue of the living men of science of the United States. On my preliminary list there are eight thousand who have published scientific papers, with a few exceptions, admitted because they are engaged in teaching or other scientific work of some importance. I estimate that the scientific men of the world number about 50,000, not counting those physicians, engineers and others who do not directly contribute to the advancement of science, nor those who are engaged in historical, philological and other studies, not commonly included in the natural and exact sciences.

Under these circumstances scientific organization has been compelled to adjust itself to new conditions. The two great developments have been the establishment of large national associations holding mi-

gratory meetings and of spècial societies for the several sciences. The German Congress of Scientific Men and Physicians was established in 1828 and the British Association for the Advancement of Science in 1831. There are similar associations in other European countries, in Australasia and in South America. Our own association was established in 1848, being a continuation of the Association of American Geologists and Naturalists, founded in 1840.

The Linnean Society for zoology and botany was founded in London in 1788 and received a royal charter in 1802. The Geological Society of London was established in 1807, and the Royal Astronomical Society in 1820. These societies were offshoots from the Royal Society, and were a necessary result of the differentiation of science and the increase in the number of men of science. At the time, however, they were supposed to weaken the Royal Society, its president Sir Joseph Banks, saying, 'All these new-fangled associations will finally dismantle the Royal Society, and not leave the old lady a rag to cover her.'

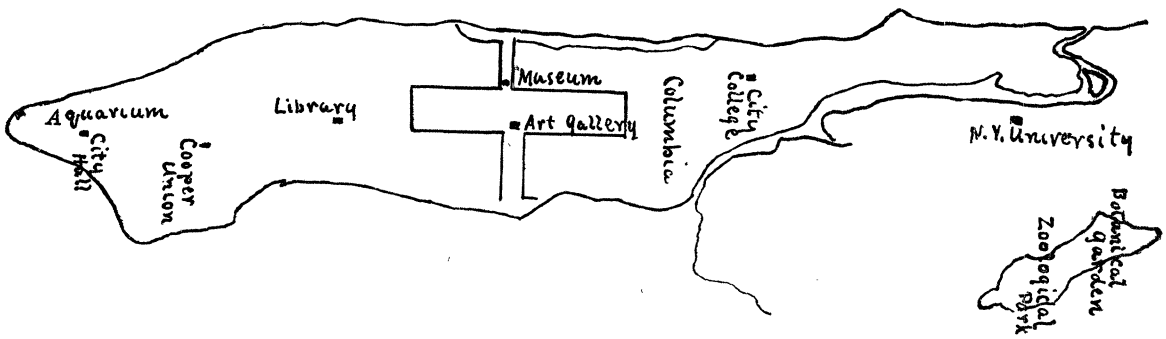
The scattering of scientific men in this country delayed the establishment of special societies. The American Association was divided into two sections in 1875 and into nine sections in 1882. The American Chemical Society was established in 1876, and we now have national societies for the principal sciences—mathematics, physics, chemistry, astronomy, geology, botany, morphology, ornithology, anatomy, physiology, bacteriology, pathology, psychology and anthropology.

New York city and members of our academy have done their share in establishing and supporting these societies. The Torrey Botanical Club, begun in 1870, was the first of the special societies. The Chemical Society was established in this city and has its headquarters here. The American Mathematical Society began as the New York Mathematical Society and still has its main center in New York, as has also the American Physical Society. The secretaries of the American Physiological Society and of the American Psychological Association are officers of our academy, and the secretary of the American Geological Society was formerly one of our most active members. The societies for civil, mining, mechanical and electrical engineering have their headquarters in New York city.

Apart from scientific societies this city has, during the past fifteen years, witnessed an unusual, perhaps unparalleled, development of its scientific and educational institutions. Columbia University has become one of the dozen great universities of the world. Its new grounds and buildings, costing $8,000,000, are but a symbol of its educational position. New York University, with its beautiful new site and buildings, has grown in equal proportion. The City College is erecting new buildings, and high schools have been established. Our libraries have been consolidated, the building for the great public library is in course of erection and numerous branch libraries have been founded. The American Museum of Natural History has more than quadrupled the value of its buildings and collections, and the Metropolitan Museum of Art has equally increased its galleries and endowment. The Botanical Garden, the Zoological Park and the Aquarium have arisen as by miracle. Hospitals, asylums and all kinds of public institutions have increased even more rapidly than the wealth of the city. In spite of Tammany Hall, in spite of reform administrations, our public, educational and scientific institutions have developed in a way that has

perhaps never been equaled hitherto or elsewhere.

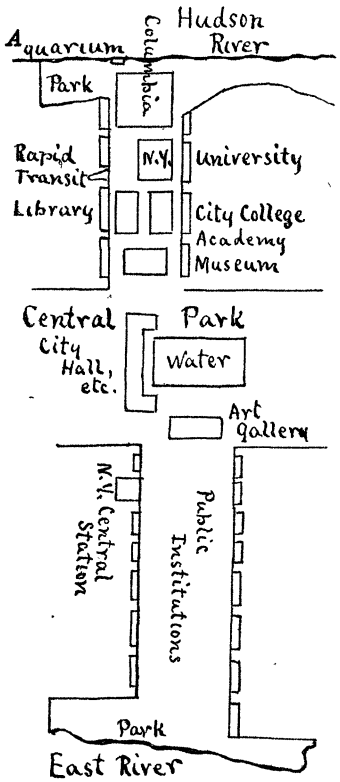
In this marvelous development there are two failures that we must all regret—one for which it is not easy to find words. The site of the park and buildings would of course have been above the thoroughfares, and all the buildings would have been within five minutes ride on an underground railway.



the stationary condition of our Academy of Sciences, the other the dispersal of our institutions over such an area as to detract greatly from their usefulness. All the way from the Battery to the Bronx—some twenty miles as the trolley car goes—separated by almost impassable streets and overshadowed by tenements and apartment houses, our institutions may be found, or at least looked for. Fifteen years ago the city had a great opportunity, but no leader being at hand it was lost. The situation of some of our scientific institutions is shown on the one chart; what might have been is shown on the other.

The city could have bought the blocks from the American Museum to the North River for about $10,000,000. These remaining one half park, half the part of Central Park between the American and the Metropolitan Museums might have been used as a site for public buildings without decreasing the amount of open space, while at the same time greatly increasing its value for all the purposes of a park. The plan shows what might have been done on the west side. The wasteful duplication of libraries and the rest would have been avoided, and there would have been a strengthening through cooperation

The cross arm of Central Park should



have extended to the East River, and there should have been a park along the river,

facing Blackwell's Island and corresponding to Riverside Park. Hospitals and eleemosynary institutions could have been built on this arm of the park and facing it, while the various institutions for the defective classes would have been on the islands in the East River. The cross arm of Central Park would always have been near the center of population of the city, and if it had been made a center for its intellectual and higher social life a gain would have resulted which it would scarcely be possible to overestimate. Fifteen years ago this could have been done as far as the west side is concerned with little or no expense to the city; now it would cost $30,000,000. I should gladly expend one third the yearly income of the city for the purpose; as I am helpless and harmless I suppose there is no danger that I shall be put in the institution on Ward's Island.

The atrophied condition of the New York Academy of Sciences is as lamentable as the dispersal of our scientific institutions, but fortunately it is not so irremediable. The university, the library, the museum and the academy are, as I have already said, the four corner-stones of science and culture. They should be parts of one over-institution, and should, in my opinion, be one of the chief cares and adornments of the state, being no less essential than the police or army and the courts. As the institutions of the city can not now be brought together, we must do the best we can to give the Academy the position it should have. It is immaterial whether the institution be called the New York Academy of Sciences or the Scientific Alliance of New York. We must have an institution that will coordinate the scientific work accomplished in the city. We must have a building for our meetings and other work, and should have as part of it or adjacent to it a club house. The building should be situated near the Museum of Natural History, this being without doubt the most central position. Let us get money from millionaires if we can, but it seems to me that for the honor of the city the building should be built by the city. I see no reason why it should not be part of the American Museum. The large lecture halls could be used in common, and we should need only two or three rooms of moderate size, one seating about a hundred people, for ordinary society meetings, and others for a committee room and a room for the archives and secretariats of the different societies. The libraries and any collections there may be could with advantage be merged in those of the museum. Such rooms, if part of a wing of the museum, would cost the city perhaps $100,000. Then we should collect one or two hundred thousand dollars for a club-house to be placed across the street.

A few words remain to be said in regard to the functions of an academy of sciences under the conditions that obtain at the beginning of the twentieth century. Libraries, laboratories and museums are no longer our charge. We are primarily guilds of scientific men. The organization of science in America toward which I believe we are moving is this: We shall have a national society for each of the sciences; these societies will be affiliated and will form the American Association for the Advancement of Science, which will hold migratory meetings. Winter meetings will be held in large centers where all the societies will come together, and summer meetings will be held at points of educational and other interest when the societies will scatter somewhat. The council of the American Association composed of delegates from all the societies will be our chief deliberative and legislative body. Our national societies will consist of local sec-

tions, and these sections will unite to form an academy of sciences. The men who are in one neighborhood and engaged in the same kind of work are the natural unit. They should unite on the one hand with those in other neighborhoods to form a national society; they should join on the other hand with the men of science of the same neighborhood to form an academy of sciences. This plan of organization may appear to be almost too logical for a world that is somewhat careless of logic, but it is in part already realized. It will in my opinion result as a necessary condition from the state of affairs. Our academy has already contributed to it, and it seems to me that we should continue to do consciously what we have hitherto done rather blindly.

We have two main external functions—our meetings and our publications. For both of these the men of science interested in the same subjects are the natural group. We need not increase the number of our sections; but should allow subsections for each of the sciences, letting those who are immediately concerned meet as they find it most advantageous. These groups should maintain their own autonomy, and we should not require the members to join the academy, least of all so long as our present dues are maintained. The academy should provide convenient places for meeting, arrange for joint meetings of several groups, provide general lectures of interest to more than one group, support a club-house, give receptions and exhibitions and the like.

In regard to publications I am somewhat heterodox. Proceedings and transactions were an important function of the academy of the eighteenth century, but there is no longer any excuse for printing researches on utterly diverse subjects in one volume, because the authors happen to be members of the same academy. We might as well make up volumes according to the cranial index of the contributors. The national society for each science should directly or indirectly have charge of the publications in that science. We need in every science: (1) A series of monographs, each of which should be published as a unit, (2) a 'Centralblatt' containing abstracts of the literature with a complete bibliography, and (3) a journal for shorter articles, general discussions, critical reviews, etc. The abstracts and bibliography should be an international undertaking, each country contributing its share. What is now printed in the annals, transactions and proceedings of our academies, should be contributed to the series or journals. In the series of psychological monographs, which I am glad to say exists, should for example be printed any monographs that are prepared by our members, and if the academy has funds for publication, it should share the expense. These monographs can be parts of our proceedings and can be given to those members who are interested. Their existence will be known to every specialist throughout the world. They will be puchased by individuals and libraries, and will ultimately become self-supporting. It is to be hoped that the academies of the country will unite in a plan of this character, and that our academy will initiate the movement.

When we review the whole subject of the history and present status of the academy of sciences we must, I think, come to the conclusion that the function of the modern academy is now modest. Libraries, museums, research laboratories, government departments and universities have developed in a way that leaves no excuse for the academy of sciences to attempt competition with them. The university in its modern form seems to me most suitable for the central

institution, and when our universities are controlled and supported by the state and when there is only one university in a region, it seems to me that the university should administer the libraries, museums, research laboratories and the like, and that the academy of sciences will be essentially a part of the university. The national and local societies for each branch of science are the natural groups for meetings and discussions and for publication. Membership in an academy as an honor, the presidency as a distinction, foreign members, medals, prizes and the like, seem to me to belong to the childhood of science. So long as we are still in this state let us rejoice in our innocence, but what is charming in the child is intolerable in the man.

Has the academy of sciences then played its part in the world? Must it, like the mastodon and elephant, give way to organisms better suited to a changed environment? I have already indicated that I believe the academy to have important if modest functions, and have stated what I think them to be. They are essentially those of a guild. We need a center in each community for organization and social intercourse. As capitalists unite in corporations and laborers in trades unions, so men of science should unite in their academies. We should not profess unselfish philanthropy, but we may reasonably claim that whatever is accomplished to improve the condition of men of science, to increase their influence or to forward their work, is of benefit to the community and for the welfare of society.

J. McKeen Cattell.
Columbia University.

---

*ANNUAL ADDRESS OF THE PRESIDENT OF THE ROYAL SOCIETY.**

President Huggins said that since the last anniversary the Society had lost by death nine Fellows and two foreign members. The deceased Fellows were Sir Joseph Gilbert, died December 23, 1901, aged 84; the Marquis of Dufferin and Ava, died February 12, aged 75; Maxwell Simpson, died February 25, aged 86; Sir Richard Temple, died March 15, aged 76; George F. Wilson, died March 28, aged 80; Sir Frederick A. Abel, died September 6, aged 75; Dr. John Hall Gladstone, died October 6, aged 75; William Henry Barlow, died November 12, aged 90; Sir William C. Roberts-Austen, K.C.B., died November 22, aged 59. The foreign members were Alfred Cornu, died April 12, aged 61; Rudolf Virchow, died September 5, aged 80. Not the Royal Society only, but mankind, he said, had sustained grievous loss by the deaths of two of the foreign members. Rudolf Virchow left a record of intellectual achievement unsurpassed in its high distinction and value, its exceptional and sustained vigor during a life unusually prolonged, and its remarkable variety. In his own country Virchow would be remembered not only as the distinguished pioneer in pathological science, but also as an influential politician and a great social and municipal reformer. He had been many times in England. He was present at the Medical Congress held in London in 1881. In the Croonian lecture, delivered before this Society in 1893, he reviewed, in his own masterly way, the progress of pathological physiology. Five years later he gave the Huxley lecture at the Charing-cross Medical School, when he took for his subject 'Recent Advances in Physiology'; Lord Lister and Sir James Paget being present to do him honor. At the celebration of his 80th birthday at Berlin, in 1901, the Royal Society was represented by Lord Lister. Virchow was born in 1821. He was elected a foreign member of the Royal Society in 1884; eight years later the Royal Society conferred upon him their highest

* From the London *Times*.