THE ORIGIN AND DEVELOPMENT OF THE ROYAL SOCIETY OF LONDON

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THE seventeenth century was the age of scientific revival. It was veritably an era of discovery. The dawn of the era was a century or so earlier, but it was not until the seventeenth century that progress in science became rapid. Already in 1540, Copernicus, by postulating that the sun was the centre of our planetary system, had set aside the hypotheses of Ptolemy—not that these were "wrong" or "untrue", only that they were less adequate than the latter theory, which admitted a more complete generalization of the motions of the heavenly bodies. On the biological side the distinguished Belgian anatomist, Vesalius, had broken loose from authority, and instead of referring his students to the masters of antiquity, Aristotle, Hippocrates and Galen, bade them go and dissect the human body and see for themselves what was to be found there. Apart, however, from astronomy among the physical sciences and anatomy among the biological, it is generally true that the revival in science lagged a century or more behind the awakening to a new sense of values in literature and art.

There was one, however, who, though not a scientific discoverer, undoubtedly had an early influence in the scientific renaissance. This was Francis Bacon, and it is to his eternal credit that he used his great influence in stressing the importance of scientific knowledge and inculcating the adoption of the inductive method in the pursuit of scientific truth. "There is", he said, "a new unexplored Kingdom of Knowledge within the reach and grasp of man if he will be humble enough, and patient enough, and truthful enough to occupy it", and he exhorted his contemporaries to explore it "for the Glory of God and for the relief of man's estate". Bacon was born in the middle of the sixteenth century, but it was not until the reign of James I that he reached the zenith of his power. Harvey says of him that he wrote on science "like a Lord Chancellor". This was presumably intended as a reproach; nevertheless it was a sign of the times that one holding so high a position should have written on science at all.

Early in the seventeenth century Galileo was employing his newly invented telescope to reinforce the truths discovered by Copernicus, and by the aid of this instrument Jupiter's moons, Saturn's rings, and the inequalities of the moon's surface were first observed by man. The thermometer, the barometer, the air-pump and the compound microscope all came into existence soon afterwards, and were in constant use by scientific and other observers in the middle of the seventeenth century. The "magic lantern", described by Pepys as having "pictures in glass to make strange things appear on a wall, very pretty", was invented a little later.

The advances made in mathematics were equally remarkable. At the end of the sixteenth century decimals were already in use, and algebra, as a mathematical instrument, had been developed with the same notation as that employed to-day. As early as 1614 Napier of Merchiston had made the discovery of logarithms, and shortly afterwards tables of these were drawn up and published.

Turning to the biological side, the earliest as well as the most outstanding of British investigators at the beginning of the seventeenth century was William Harvey who discovered the circulation of the blood. The tercentenary of this event has been celebrated this year, for it was in 1628 that Harvey published his *Exercitatio de Cordis motu*, but there is no doubt that he had already demonstrated his views to the College of Physicians as well as others at an earlier date. Harvey's priority in this discovery has been disputed by the Italian School who assign the credit to Cesalpinus, but most authorities regard this physiologist as having but imperfectly comprehended the systemic circulation, and having seen it "darkly through Galenical glasses". There is no doubt that his British contemporaries, as well as others, assigned the credit of the full discovery to Harvey. In the words of Dryden:

> The circulating streams once thought but pools of blood
> (Whither life's fuel for the body flowed),
> From dark oblivion Harvey's name shall save.

The men who have so far been mentioned were the forerunners of those who formed the group that founded the Royal Society. Of the latter the best known for their intellectual attainments are probably Robert Boyle, the chemist, Robert Hooke, the physicist, John Evelyn, the famous diarist, John Wallis and John Wilkins, distinguished mathematicians, Bishop Seth Ward, Sir Kenelm Digby, Sir Christopher Wren, Sir William Petty and Dr. Goddard.

The Hon. Robert Boyle, brother of the Earl of Cork, has been well described as the "father of chemistry". He was the first to

distinguish a mixture from a chemical compound, and to define the meaning of an element. He was the first also to make hydrogen gas in the laboratory. In addition, he concerned himself with the weight, pressure and elasticity of air and the phenomena of respiration, and he invented the air-pump. But he had other interests as well, being learned in ancient and foreign languages, into some of which he translated the Bible. Thus he was not only a man of science but also a man of letters, besides being a courtier and popular in society. That he should have been all these is the more remarkable since he suffered from chronic ill-health and weak eyes.

Robert Hooke collaborated with Boyle in the construction of the air pump, and himself invented a number of physical instruments. He put forward in an imperfect form the undulatory theory of light and a theory of optical interference. He was the author of a book entitled *Micrographia* in which the value of the microscope as an instrument of scientific research was developed. Besides this he did much original scientific work. Shrunken and deformed in shape and somewhat dishevelled in appearance, he was in striking contrast with his aristocratic friend and patron Boyle. Pepys says of him, "he is the most, and promises the least, of any man in the world that I ever saw."

John Evelyn was a man of versatile genius. He not only knew several foreign languages and was a considerable traveller, visiting many of the private continental museums (for in those days there were no public ones) and concerning himself with the various objects of nature and art collected therein, but he also studied medicine at Padua and chemistry at Paris, and devoted much time in his own garden to botany and horticulture, in which subjects he made original contributions. His Diary contains many references to the Royal Society of which he several times refused the Presidentship.

John Wallis was another man of great versatility. Educated at Emmanuel College, Cambridge, he was appointed by Cromwell Savilian Professor of Geometry at Oxford. Like so many of his contemporaries, he was learned in languages. He was one of the first to accept and to proclaim Harvey's views on the systemic circulation. He was author of the *Arithmetica Infinitorum* which contained the rudiments of the differential calculus; it is said also that this work suggested the binomial theory of Newton. Wallis used his powers on behalf of a succession of Governments and contrived to keep on good terms with all.

Dr. John Wilkins, Warden of Wadham, and afterwards Bishop of Chester, filled also high offices in the Universities. Amongst

much other work in mathematics and mechanics, he forecasted the practicability of both submarine and aerial navigation.

Seth Ward, Bishop of Exeter and subsequently of Salisbury, was another accomplished man who for a time held the Savilian Chair of Astronomy at Oxford. He was more renowned, however, for his work on behalf of the Church and charity than for his contributions to scientific knowledge. He was a great preacher, no inconsiderable benefactor—he restored Exeter Cathedral and founded the Seth Ward Almhouses at Salisbury, besides doing much other useful and charitable work. Later he became well known among men of science for his theory of perpetual motion.

Sir Kenelm Digby was a man of a different type. He had an undoubted interest in science, but little critical faculty. He was conversant with alchemy and astronomy, was a great conversationalist, and was apt to misinterpret and exaggerate the results of his experiments; nevertheless he had considerable influence which he used on behalf of science. He took part also in public affairs and theological controversy. It is said he was the first to recognize the part played by "vital air", that is oxygen, in the respiration of plants.

Sir Christopher Wren is probably best known as the architect of St. Paul's Cathedral and of Chelsea and Greenwich Hospitals, but he was also a man of great scientific attainments. He was not only an astronomer (being at one time Professor at Oxford) and a mathematician (applying his knowledge practically in dynamics), but also an anatomist and physiologist. He investigated the structure of insects with the microscope, and produced excellent drawings of what he saw. In 1680 he became President of the Royal Society.

Sir William Petty was likewise a man of exceptionally wide interests. He was one of the first exponents of political economy. He was also a surveyor, and constructed a map of Ireland which Evelyn said was the most exact that ever yet was made of any country. Moreover, he invented and produced various mechanical contrivances such as a double-keeled vessel and "a wheel to ride upon". It is known further that he had medical interests, and was once instrumental in reviving an unfortunate woman who had been unjustly but ineffectively hanged for infanticide. It is recorded that he put her to bed with a "warm woman" after her body had been given to her friends for burial, subsequently bleeding her and administering alternately clysters and nourishment. On her recovery Petty and his friends procured her pardon, raised a subscription for her, and finally married her off to a worthy man by

whom she had several children. The case aroused considerable interest at the time, and is illustrative of Petty's benevolence. Evelyn says of Petty he never knew "such another genius". "There is not another Latine poet living when he gives himself that diversion, nor is his excellence less in Council and prudent matters of state, but he is so exceeding nice in considering and examining all possible contingencies, that he adventures at nothing which is not demonstration." The following lines, written by Petty to his daughter, perhaps illustrate another side to his character:—

> My pretty little Pusling and my daughter An,
> That shall be a Countess if her Pappa can:
> If her Pappa cannot, then I make no doubt
> But my little Pusling will be content without.
> If my little Pusling prove but an ugly carron,
> Then she must be content to get but a baron;
> But if her fortune be so low as to get but a knight,
> Then I trow her cake is dough.

She became the Countess of Kerry.

Dr. Goddard was Gresham Professor of Physic and at one time Warden of Merton College, Oxford. He had a laboratory which he placed at the service of the Society.

Such were some of the men who met together at frequent intervals to perform scientific experiments, to demonstrate scientific instruments, apparatus and specimens, and to discuss experimental philosophy. Sometimes one of them gave a discourse, and this was followed by a discussion. Weekly meetings were held in London as early as 1645, and there is evidence that these gatherings represented the "Invisible College" referred to by Boyle in various letters in 1646 and 1647. They appear to have been held at first mostly in the rooms of Dr. Goddard, in Wood Street, but sometimes in the Bull-head Tavern in Cheapside. Bishop Spratt, author of the History of the Royal Society and himself an original Fellow, tells us, however, that it was "at Oxford, in Dr. Wilkins his lodgings, in Wadham College, which was then the place of Resort for Vertuous, and Learned men, that the first meetings were made, which laid the foundation of all this that follow'd. The University had at that time many Members of its own who had begun a free way of reasoning; and was also frequented by some Gentlemen, of Philosophical Minds, whom the misfortunes of the Kingdom, and the security and ease of a retirement amongst Gown-men, had drawn thither."

It was not until about the year 1658 that the majority of these men came to London and with some addition to their numbers met together regularly, usually at Gresham College.

In 1660 the first Journal-book of the budding Society was opened with a memorandum recording that, following the usual custom of most of them, the Lord Brouncker, Mr. Boyle, Mr Bruce, Sir Robert Moray, Dr. Wilkins, Dr. Goddard, and others met together at Gresham College to hear Mr. Wren's lecture; "and after the lecture was ended, they did, according to the usual manner, withdraw for mutual converse. Where amongst other matters that were discoursed of, something was offered about the designe and founding a Colledge for the promoting of Physico-Mathematicall Experimentall Learning." At these meetings certain rules and regulations were drawn up, as well as a list of persons who were thought suitable for joining the Society.

A week after the last of these meetings word was brought by Sir Robert Moray that the King (Charles II) approved their scheme and purpose, and expressed a desire to join the Society himself. Moreover, it soon became evident that a number of prominent noblemen and gentlemen who were interested in experimental philosophy were willing to follow the King's example. For, in the meantime, the study of science had become fashionable. The King himself, Pepys tells us, had his little "elaboratory, in his closet, a pretty place." There, amongst other works, he dissected bodies, sometimes in the company of distinguished surgeons. Pepys tells a story on the authority of Edward Pickering, the King's messenger, "of a child being dropped at the ball at Court, and that the King had it in his closet a week after, and had dissected it; and making great sport of it, and said that in his opinion it must have been a month and three hours old; and that, whatever others think, he hath the greatest loss, (it being a boy, as he says,) that hath lost a subject by the business." We know also that Charles had a naturalist's interest in animals, and we read of him walking in the gardens of Whitehall in the early morning accompanied by an attendant who carried bags of grain to feed the wildfowl that the King had introduced there. It is interesting to note that ever since that time pelicans and other water birds have been a feature of St. James's Park, which was then the King's garden. Charles attended some of the meetings of the Society, and himself took part in the experiments with his own hands.

Amongst others who joined the Society in the same year were the Duke of York, afterwards James II, the Duke of Brunswick, and Prince Rupert. The latter had no small talent for chemistry, and invented a new method for making gunpowder. He was also the preserver of the temporarily lost art of mezzotint, which had probably been explained to him at an earlier date by the inventor,

Ludwig von Siegen, and which Rupert demonstrated subsequently to Evelyn. The Duke of Albemarle (General Monk) entered the Society at the same time.

Another famous member of the nobility who was interested in experimental science was George Villiers, Duke of Buckingham. The versatile genius of this remarkable man is commemorated in Dryden's well-known lines:—

> A man so various, that he seemed to be
> Not one, but all mankind's epitome;
> Stiff in opinions—always in the wrong—
> Was everything by starts, but nothing long;
> Who, in the course of one revolving moon,
> Was chemist, fiddler, statesman, and buffoon;
> Then, all for women, painting, fiddling, drinking,
> Besides a thousand freaks that died in thinking.

The Duke amused himself with chemistry, and for some years, according to Burnet, "he thought he was very near the finding of the philosopher's stone". He set up glass works at Lambeth and took out a patent for glass making. Both he and Dryden were original Fellows of the Society, and if they met, as they almost certainly must have done at some of the earlier meetings, it is interesting to speculate on what they said to each other.

Among the original 55 Fellows of the Society there were two other distinguished men of science who remain to be mentioned. These are Francis Glisson and Francis Willughby. Glisson was Regius Professor of Physic at Cambridge, and the author of a book on rickets. He is best known to students of medicine for his work on the liver, and for giving his name to 'Glisson capsule'. Willughby, another Cambridge man, was a naturalist and did much original work in zoology paying attention not merely to external characteristics, but also to the internal anatomy of the species he described. His three great treatises on Birds, Fishes, and Insects were completed and edited by John Ray.

Although the object of the Society was "the improving of Natural Knowledge by experiments", in its early days other branches of learning were freely represented. Cowley, the poet, was one of the original group who promoted the formation of the Society, but owing to his retirement to the country he was never actually enrolled. Among the original Fellows, however, poetry was well represented by Denham and Waller, as well as by Dryden, as already mentioned. Edward, Earl of Clarendon, the famous author of the *History of the Rebellion*, was admitted a Fellow in 1664-5;

a month after the King had subscribed his name, and Samuel Pepys, the diarist, joined a week later.

Although Pepys had little real scientific knowledge or genius, he possessed an insatiable curiosity, and the discoveries of the age were ever a source of interest to him. Moreover he delighted in the society of scientific men. These qualities, together with a business aptitude, a power of organization and a high personal character inspired him to take a leading part in the development of the Society, of which he became President in 1684. The constant references to the Royal Society in Peyps's Diary throw much light upon the way in which scientific studies were regarded and the interest they aroused at the period in which he wrote.

On February the 15th, 1664-5, we find the following entry in the Diary:—"Thence with Creed to Gresham College, where I had been by Mr. Povy the last week proposed to be admitted a member; and was this day admitted, by signing a book and being taken by the hand by the President, my Lord Brouncker, and some words of admittance said to me. But it is a most acceptable thing to hear their discourse, and see their experiments; which were this day on fire, and how it goes out in a place where the ayre is not free, and sooner out where the ayre is exhausted, which they showed by an engine on purpose. After this being done, they to the Crown Tavern, behind the Change, and there my Lord and most of the company to a club supper; Sir P. Neale, Sir R. Murrey, Dr. Clerke, Dr. Whistler, Dr. Goddard, and others, of the most eminent worth. Above all, Mr. Boyle was at the meeting, and above him Mr. Hooke....Here excellent discourse till ten at night, and then home." On another occasion Pepys records an experiment on a kitten which was nearly killed by the air being withdrawn by means of the newly invented air pump, and then revived immediately by air being let in, "this air being made by putting together a liquor and some body that ferments." He describes also experiments on animals with poisons, particularly with the Florence poison, which was probably white arsenic. The action of opium was likewise investigated by injecting it into the hind legs of a dog which "presently fell asleep". Great attention was paid to the transfusion of blood. In one experiment Pepys describes how the blood of a dog was let into the body of another dog. "The first died upon the place, and the other very well, and likely to do well".

The seventeenth century was an age of taverns, and Pepys records his impressions of the convivial gatherings which took place, after the official meetings of the Society, at the Bull-head, or the Crown behind the Exchange, or the King's Head tavern by Chancery

Lane, where the company ate and drank and continued their discussions. These meetings formed the beginning of "The Royal Society Club" ,which continues to exist as a dining club at the present day.

Of many of the original Fellows very little is known. Bishop Spratt says they were for the most part "Gentlemen, free and unconfined, who, by the freedom of their education, the plenty of their estate, and the usual generosity of noble blood, may be well supposed to be most averse from sordid considerations." It is interesting to note that in the list of the original Fellows, all excepting such as belonged to the nobility or clergy, or had the designation of doctor, are described as "Esquire", with the one exception of Robert Hooke, who is entered as "Mister". It is recorded that King Charles, being greatly impressed with the work of one, John Graunt, author of "Natural and political Observations on the Bills of Mortality", and a London tradesman, gave "particular charge to the Society that if they found any more such tradesmen, they should be sure to admit them all without any more ado."

The charter of incorporation granted by the King as Founder and Patron passed the Great Seal on July 15th, 1662, which date therefore is the anniversary of the foundation of the Royal Society. Next year it was followed by a second charter which confirmed and extended the privileges of the Society and decreed that those who joined it should be styled 'Fellows of the Royal Society'. It is by this charter that the Society is still virtually governed. The powers granted were, however, confirmed in 1669 by a third charter under which, in addition, the King granted certain endowments. The King also presented the Society with a silver mace, richly gilt, and this is still in constant use, being placed on a table in front of the President before every meeting. The tradition that this mace was the "bauble" removed by Cromwell from the House of Commons is now believed to be unfounded.

The charters provided that the President and Council should be elected annually on St. Andrew's day, and it was formerly the custom of the Fellows to wear a St. Andrew's cross of ribbon at this meeting, but this practice has long been discontinued, though the officers are still elected, as formerly, on the last day of November. For this reason St. Andrew came to be regarded as the patron saint of the Society. On this point John Aubrey, the antiquary, and one of the original Fellows, records a remark of Petty's that he would rather it had been St. Thomas, "for he would not believe till he had seen and put his fingers into the holes; according to the motto, *Nullius in verba*".

The Royal Society met originally in Gresham College, but in 1666 removed to Arundel House, the property of Henry Howard, afterwards Duke of Norfolk, and an important benefactor of the Society. The bulk of the magnificent library which the Duke gave to the Society afterwards passed to the British Museum, where it is maintained as a separate collection.

During the Presidency of Sir Isaac Newton the quarters of the Society were transferred to Crane Court in 1710. Sir Isaac occupied the chair for a longer time than any president with the one exception of Sir Joseph Banks. Newton was elected in 1703, and remained president until his death in 1727. This was a very fruitful period for the Royal Society and for the progress of science, due largely to the importance and fame of Newton's far-reaching discoveries.

Under the presidency of Banks, in 1780, the Society moved to quarters assigned to them by the Government in Somerset House. It was part of the president's policy to render the Fellowship more select, and the discussions on this question gave rise to much acrimony, which is described in a contemporaneous tract, but in the end Banks obtained the support of the majority of the Fellows.

The Society moved in 1857 to the quarters it now occupies on the east side of the quadrangle of Burlington House in Piccadilly.

In the early days of the Royal Society an active 'correspondence' was carried on between it and continental men of science. This correspondence—or rather selections from it—formed the beginning of the 'Philosophical Transactions'. The first number, consisting of sixteen quarto pages, appeared in March, 1665, and was drawn up by Oldenburg, the secretary to the Society. After a short time, however, the Transactions came to consist of complete papers or treatises, each by one of the Fellows or some other man of science. The 'Proceedings', which contained the shorter papers communicated, did not commence until the nineteenth century. Both sets of publications are now divided into two series, called A and B, and are respectively devoted to papers of a mathematical, physical. or chemical character and those dealing with biological subjects. In addition to these the Society has from the earliest days published separate treatises of which the most notable is probably Newton's 'Principia'.

The Royal Society has, from its commencement, been frequently consulted by successive Governments about scientific matters of national importance. The equipment of the Royal Observatory, the change in the calendar, the ventilation of prisons, the protection of buildings from lightning, the measurement of a degree of latitude, the Geodetic and Trigonometrical surveys,

various expeditions, such as those under Captain Cook, Ross, Parry, and many others, the use of coal tar, and the causation of tropical diseases, are only a few of the matters on which the Government has sought advice from the Royal Society.

The Society is officially associated with the Royal Observatory at Greenwich, the National Physical Laboratory, the Lawes Agricultural Trust, besides many other institutions, societies and schools to which it nominates governors or representatives. The administration of the annual grant made by the Government for scientific research is another of its duties, but this did not begin until 1849.

It was perhaps inevitable that a society which started with such high prestige and showed so much activity should have its detractors. Evelyn describes how at the Oxford University Encaenia in 1669, Dr. South, the Public Orator, made a speech containing 'malicious and indecent reflections on the Royal Society as underminers of the University, which was very foolish and untrue as well as unseasonable'. The Society was made the subject of ridicule by Shadwell in his comedy, 'The Virtuoso', and by Butler in the satire called 'The Elephant in the Moon'. Addison in the 'Spectator' refers to Fellows of the Royal Society as belonging to the class of people who have nothing to do, but says that the formation of the Society had good effect, 'as it turned many of the great geniuses of the age to the disquisitions of natural knowledge, who, if they had engaged in politics with the same parts and application, might have set their country in a flame'. Steele in the 'Tatler' accuses the Society of being 'in a confederacy against men of polite genius, noble thought and diffusive learning', and says that when he met 'a young fellow that is an humble admirer of the sciences, but more dull than the rest of the company (he) concludes him to be a Fellow of the Royal Society.' Swift's attack on the philosophers in his 'Voyage to Laputa' is notorious. More amusing is Pope's account in the 'Dunciad' of the assembly before the Queen of Dulness of those who were to receive titles and degrees. Amongst them were the

> '. . . . . more distinguished sort
> Who study Shakespeare at the Inns of Court.
> Impale a glow-worm, or Vertu profess,
> Shine in the dignity of F. R. S.'

Attacks from within were also from time to time made upon the Society, or at any rate upon its policy. It has been already mentioned that it was the desire of Sir Joseph Banks to make election into the Society more difficult, and that after much controversy this

policy received the support of the majority of the Fellows. Nevertheless, the number of candidates elected was often very large, and in the forties of the last century it was not unusual for nearly fifty Fellows to be enrolled in a single year. The qualifications also were not high, or were of the wrong character.

Dr. Bonney, adapting the words used in criticism of a celebrated Oxford college, says there was a danger that eligibility for election should consist of a candidate being 'well born, well dressed and moderately learned in science'. Stimulated by the criticism of the newly formed 'Philosophical Club', the Society took action, and in 1847 adopted a new set of statutes providing that the Council should select annually from the candidates a list of persons, not exceeding fifteen, whom they should recommend for election, and that the number joining in any one year should be limited to these. It was understood, further, that the candidates should be chosen for scientific distinction and original contributions to knowledge. This principle of selection and limitation has existed ever since.

Women are not eligible for election as Fellows, and in the ordinary way are not even allowed to attend the meetings. There have, however, been notable exceptions, as when Queen Victoria attended to subscribe her name as Patroness in the book which contains the signatures of the Founder and of all the Fellows from the commencement. Pepys records that there was much debate as to whether the Duchess of Newcastle should be permitted to attend a meeting, 'many being against it', but eventually it was agreed to, 'and we do believe that the town will be full of ballads of it.' The following entry occurs in Evelyn's diary under date 30 May, 1667:—'To London to wait on the Duchess of Newcastle (who was a mighty pretender to learning, poetrie, and philosophie, and had in both publish'd divers bookes) to the Royal Society, whither she came in great pompe, and being received by our Lord President at the dore of our meeting roome, the mace, etc. carried before him, had several experiments shewed to her. I conducted her Grace to her coach, and return'd home.'

In addition to the fifteen Fellows who are annually nominated by the Council, Princes of the Blood are eligible for the Fellowship, and every alternate year two other persons, chosen by the Council for general merit or services to science, may be elected.

With the exception of William and Mary, and Anne, each successive sovereign has been Patron to the Society. The close connection between the Crown and the Royal Society has from the first been something considerably more than formal. The Royal Medals were instituted by George IV as an incentive to scientific

investigation, and their annual award has been continued by each of his successors. The important part played by Charles II, not only in founding the Society, but in assisting its fortunes, was duly recognized by contemporary men of learning, and this feeling, which was something more than loyalty, finds appropriate expression in Bishop Spratt's dedication of his 'History':—

> Of all the Kings of Europe, Your Majesty was the first who confirm'd this Noble Design of Experiments, by Your own Example, and by a Public Establishment. An Enterprise equal to the most renoun'd Actions of the best Princes. For, to increase the Powers of all Mankind, and to free them from the bondage of Errors, is greater Glory than to enlarge Empire, or to put Chains on the necks of Conquer'd Nations.

Readers of the Review will regret the unavoidable absence from this issue of *Topics of the Day*.—EDITOR.