Sir Edward Thorpe
with [illegible] kind regards.

MEMOIRS

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For the Hundredth Year of the Literary and Philosophical Society of Manchester (1881)

A CENTENARY
OF
SCIENCE IN MANCHESTER

(*IN A SERIES OF NOTES*)

BY

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PREFACE.

Centenary of the Literary and Philosophical Society of Manchester.

When the Society was near its Centenary it seemed good to the members that I should be requested to write some account of its doings. I said that I could not give time to write a history : it was well known that I was much occupied. I was told, however, to do just as much or as little as it suited, since no one seemed inclined to take up the subject. I should have preferred to see the work done by one who had lived from his earliest years in Manchester, and whose romance of life was associated with the neighbourhood, as then the treatment might have suited more readers. My deepest local interests are still in Scotland, although most of my life has been spent here ; still I have of course no small pleasure in tracing the course of ideas in chemistry, and in looking at general progress amongst us and everywhere.

There are men now living who could tell much of the early members, and this volume may call them forth. I pretend only to give the origin of the Society and a sketch of its main work, and that to a large extent in the language of the writers, so that much of the book is made up of quotations from their sayings, to which I have at times amused myself by making replies as if taking part in a conversation. I have often looked to the red-book of the late Alderman Shuttleworth as a store of interesting matter. As a boy he paddled about Medlock Bridge, in Oxford Road, not knowing that it was a skew-bridge, a kind which was said to have been invented long afterwards ; and he climbed up trees in St. Ann Square for birds' nests, as I have heard him say. There are many persons in Manchester well able to search and to obtain much information : I must be excused if I avoid almost all personal history, making a slight exception in honour of our founder, and in two or three cases where information did not cost research.

The names of a few living men have been mentioned, but no account has been given either of their lives or their labours, with an exception where the atomic theory was treated, since I hold that the work of Dr. Joule was a continuation of Dalton's; and the works of Dalton and Joule have given, and must continue to give, the main honour, and that is not a small one, due to the Society. Of Dr. Joule, whose chief discovery has here been spoken of, too slightly I believe, and who is the great successor of Dalton, and must stand as a prominent figure in any society of which he is a member, I would gladly have said more. Dr. Dalton filled up very fully a large portion of the first part of our history, and Dr. Joule has stood, and stands, the main figure in the second. We can claim only a part of the honour arising from Mr. Sturgeon's labours, since he came here after much of his work was done.

I must especially thank Dr. James Bottomley for the trouble he has taken. A committee was appointed to assist me, but a committee cannot write a book.

I regret that I have been unable to devote more time and energy to the work; it may appear ungracious not to have given it my whole heart. Had I the hope of a life as long as that of the Society, the result might have been more than these notes.

There have been, mainly, two objects in the volume: first, to give a fair specimen of the spirit of the Society and its work; and secondly, to show that it has done very valuable work for humanity.

I should be glad if a third should be attained. The Society has made Manchester a scientific centre for a whole century, and has done much to dispose it to seek a University, and given it a right to demand one—a right that has been conceded; but at no time has it ever received the slightest assistance from without, and the world has allowed the scientific men within the circle to do their own work unaided. Of this no complaint has been made; but now, from some change not to be discussed, it is considered that investigators require external aid; and I think it fair to say—and I do so without consulting with the Society—that the giving public would do well to consider the claims of this institution. The Society requires money for several purposes, and the account of its work is poor if I have not shown that from its beginning it has had among its leading men such as might be expected to be among the foremost to make good use of that kind of assistance. The chief demand at present comes to us from a want of room; our books are increasing, and we can neither afford them sufficient shelter nor engage the services of one who can give enough of his time. Hitherto the work, and that not small, has been done entirely by honorary or voluntary labour, and Mr. Bailey and Mr. Windsor have done much, whilst we now claim very greedily a large share of Mr. Nicholson's time.

There is another point of even greater importance. Our fees are two guineas per annum, besides an equal sum for entrance. This sum is sufficient to exclude many of the younger scientific men. It ought to be our aim rather to encourage such. Besides this, it would be much more honourable to be a member of a scientific society if no payment were requisite beyond scientific contributions, and I should be glad if we could rather show an example of electing many ordinary members without waiting till they sought for admission, in addition to honorary members elected as at present, looking rather to the intellectual gain than the help to be derived from the revenue. Of the younger men who are inclined to be original workers, we might wisely add a considerable number, and the community would receive more direct benefit from our work, and take more interest in it. I should be glad to see the Society able to aid those who show themselves able to originate ideas and ready to work them out.

In any case it would be better if we could afford to lower the subscription. I have always had an objection to the policy we have maintained, but the difficulty has been to inaugurate a more liberal one.

R. ANGUS SMITH.

MANCHESTER : *May* 9, 1882.

NOTE.—I have to thank my young assistant, Mr. Frank Scudder, for making a complete list of all the members and officers of the Society for the whole period of its existence, also an Index.

The Society is not in the smallest degree responsible for any opinion given in this volume. I am told of some grave errors (I believe about the Warrington and Manchester Academies) ; but as the same gentleman who complains refuses to point them out, I must leave them for others to correct, if they are worth correcting.

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SCIENCE IN MANCHESTER,

FOR THE FIRST CENTENARY OF THE

LITERARY AND PHILOSOPHICAL SOCIETY,

APRIL 1881.

CHAPTER I.

GENERAL.

WE have lived as a society for a hundred years, and seen the early years of Steam, Electricity, and Chemistry; we have heard our own words repeated by metals that had learnt our language, and the sound of our own voices carried forward by a beam of light as if we were at last having some promise of communicating with beings of other worlds and of other ages long gone by. It is natural at such a stage that we should look round and consider what we have done to assist the world in this great advance, and to seek to know if we have deserved to live in such an age.

We are quite aware that we have been in a county which has shown us little sympathy by any of its acts, and that we are looked on as some old deserted church in a great city, or as a community united by an interest in a region of fancy or of thought, but not of action, and scarcely conversant with the world around them. But it will not be difficult to show that these opinions are far from being correct, that thoughts have gone out from this society piercing far into the future, and that some have been sent here by nature from distant space ; and that instead of neglecting the world around them our members have been keen in detecting its requirements, and some of them far-sighted beyond the rest of men in seeing improvements. We have paid of late little attention to the historic past ; our past has been chiefly in geological eras.

We must not be considered arrogant if we claim for our members to have finished two great stages of a course of thought with which the world long toiled, begun east of Greece and keenly contested and grown old, although unsettled in the times when the Greek intellect was most powerful ; and more than that, to have carried it beyond the farthest point which by them was seen or hoped for. We allude to questions regarding the constitution of matter, which is now generally considered proved to consist of definite particles forming at least one stage of existence, although it may be that these particles themselves are differently formed, leading us to the still unsettled portion of the atomic theory, a division unknown to the ancients. We have finished one part, we have cleared the ground for discussing the other. One of our members may be said to have established the great science of chemistry on this basis of the atom. He carried our thoughts beyond the stage of definite volume and went to the immediate consequences of its existence, namely constancy and exactness of composition in chemical substances, and we may say in all matter.

Another of our members has led the world from atomic equivalents in chemical combinations to the equivalents of heat and other forces of the universe. Do not wonder then if we consider such men portions of that great race of thinkers which includes many of the finest names from Leucippus and Epicurus to Lucretius, and onwards to Newton and modern science; we certainly may claim for them to be more than a link in the chain of thought, although we may be obliged to leave unlifted the very weight and precious burden itself which the chain was intended to bring up from the deep well of truth.

It is well for us to see the relation in which we have stood to the progress of mankind; but whilst we speak as if the town in which we live had little conscious sympathy with us, we must not suppose ourselves independent of it, or forget the strange rules of social progress, or the effects which great communities have upon individual efforts, unconsciously exercised by the majority and producing results the origin of which is quite unknown either to them or to the minority. This great subject we may leave for a time to the readers of Lewes and of Herbert Spencer, ourselves however being convinced that the modes of communication are more observable in society than in the individual man, whose life comes out of an infinite darkness. Whilst few of the great community around this Society gave us any of its thoughts and none gave us any of its wealth, it is certain that without its activity the society would not have lived; but as a living being sends out its energies to form a finger, a foot, or a brain, each of which may exist without either of the others, so in some more or less clear way the community of South Lancashire urged the thoughts which led to the establishment of the Literary and Philosophical Society of Manchester. The formal origin however is well known, and has no more of the mysterious than all nature shows ; it is explained in the first volume of the Society's Memoirs, and will be repeated here in due time.

Notwithstanding this, the growth of such an institution, standing out by itself in provincial England, is a phenomenon which requires attention, because the city contained only 27,246[1] inhabitants in 1773, when the Society was collecting its strength but had not yet assumed a name. We have many cities as large in our times, but we have few with the vigour of early Manchester, and that apparent prevision and real confidence in the future which men feel to be equal to a powerful argument and one that wins when reason fails.

We remember being told of certain difficulties in managing the workers of a mill at Oldham, and it was asked why not have bought or built a mill at some other place, since you knew how difficult it was to begin at that town ? The reply was a typical one, 'The peculiar thread spun at Oldham can be spun nowhere else at present, because generations have grown into the habit.' And so the life of a place becomes characteristic because the early inhabitants had their peculiarities ; in the same way, when a little village of last century with an unusual sound of a letter or a word becomes in the course of less than a century a large city, it is observed that every one is subdued by the peculiarity of the early typical individuals, and follows the same occupation with the same speech and manners, and notably the same pronunciation of one specially marked letter.

It matters not if people come from a different country, their children become initiated into the peculiarities of this

[1] Percival's Works, vol. iv.

spot, taught by the children of the place, which children are more powerful teachers than the wisest men or tenderest mothers, and so we have a burr in one place and aspirated vowels in another. Thus too, Manchester has in its modes of thinking grown by concretions so constant and regular that it resembles more the great crystal produced in a mass of incongruous matter; simply because there was in solution sufficient of its own kind to prefer the original shape of the small accidental parent crystal, and to leave all the incongruity behind it whilst it grew in size and in precision of character more fully than the germ crystal itself, which however still kept leading the type. In following out the comparison we may wonder, exactly as young and even old chemists do, how much of the incongruous matter there really was to the small amount crystallised, so we must wonder how few in a great city cared for the Society, how many were suited for the peculiar trade and commerce of the place, how many business men were to be found in it, whilst few of them in a whole century have cared for science by itself. No society has been more entirely dependent on the men who at the time formed its attending members. Whilst out of a great community these members must be considered few, of these few those who have attended have been, as is always the case, fewer; and of these again the active have been only a small part; but not the less there has been a law in the recesses of humanity which has caused the influence of the community to concentrate itself, first into the Society, and then through particular members, into the theory of chemistry, equivalents of atoms and their connection with mechanical force, the knowledge of which must influence mankind for ever.

CHAPTER II.

ANCESTRY OF THE SOCIETY.

Warrington Academy.

THE remote ancestry of the Literary and Philosophical Society itself passed through Warrington, and it may be unnecessary to trace farther back the lines of its descent. An academy for a small body of religionists was founded in that town in the year 1757, and several men of eminence took part in its classes. Friends of the scheme were present from Birmingham, Manchester, Liverpool, Gatacre, Chowbent, and Bolton.

An interesting account of the academy of Warrington and its pupils as well as teachers by the Rev. William Turner was published in 1814, and republished in the 'Warrington Guardian' by William Beamont, Esq., of Orford Hall. We are there informed of all the teaching staff, and of the influence which each exercised in the small community. The academy was projected by the Rev. John Seddon,[1] son of Mr. Seddon of Hereford, and was established for 'Protestant dissenters.' It does not seem to have been intended for Unitarians specially, and the writer is informed that if it became connected with the latter it was an accidental development. In that account we are told of Dr. John Aikin the younger, who has long been known to boys as having, along with his sister Mrs.

[1] Mr. Seddon was educated at Kendal and Glasgow.

Barbauld, written the work called 'Evenings at Home;' but in his many literary works he also taught men, and Mrs. Barbauld, with her feeling poems, almost upsets the Oldham theory.

Dr. Enfield's life belongs also to the nation; we must not forget him as one of those who taught at Warrington, although he came from Sudbury in Suffolk. Dr. Reinhold Forster and the Rev. Gilbert Wakefield need only be mentioned as showing the rank of men who were teaching in this small academy at Warrington, even although the Rev. Dr. Enfield taught theology to one pupil. Roscoe, of Italian fame, as a young man visited the place, and was on friendly terms with the teachers; and another friend and visitor was the benevolent Howard.

The president of this academy, which might if it had persevered have risen to fame, was the Honourable Hugh Lord Willoughby of Parham, a zealous dissenter; and the first tutor in Divinity was the Rev. John Taylor, D.D. When the academy opened on October 20, 1757, the name of Thomas Percival stood first on the list of students.

Amongst the teachers who conducted the academy we find one who has often been taken for Jean Paul Marat, the victim of Charlotte Corday. The following note by Mr. Turner has given rise to inquiries, which seem to render the criminal portion impossible.[1] 'It is known that he (Marat) was in England about this time, and published in London a philosophical essay on the connection between the body and the soul of man. He is said to have written a book on man and the mutual influence of soul and body, and to have had it published in Amsterdam in 1775. Mara, as his name is spelt in the minutes of the academy, very soon left Warrington, whence

[1] See *Appendix* A.

he went to Oxford, robbed the Ashmolean Museum, escaped to Ireland, was apprehended in Dublin, tried and convicted in Oxford under the name of Le Maitre, and sentenced to the hulks at Woolwich. There one of his old pupils at Warrington, a native of Bristol, saw him. He was afterwards a bookseller in Bristol, and failed, was confined in the gaol of that city, but released by the society there for the relief of prisoners confined for small sums. One of that society who had personally relieved him in Bristol gaol afterwards saw him in the National Assembly in 1792.'

From the account given of the social life at Warrington it must have been a very pleasing one for a time; the usual envy and jealousy seem not to have troubled the nerves of the teachers, and malice seems not to have guided their tongues. How painfully these vices infect the teachers in colleges or universities we have seen or heard of in this country and on the Continent. But literature is exciting, and the love of fame produces sometimes sad results, as our magazines tell us with their strange discussions. We never heard of Shakespeare speaking evil of an actor, although some played much better than he did according to opinions, and might in a narrow mind have caused envy and malice. After all, the remark is too common, and complaints of the irascibility of poets and actors, or any other authors, scientific not excluded, are endless. But we must keep to Warrington.

Dr. John Aikin the elder was one of these teachers, a name honoured everywhere in England, and he and his daughter, Mrs. Barbauld, have the affectionate regard of most educated Englishmen, whilst we cannot but wonder, when looking at the list of his works, at the great width of thought and of purpose which characterised his extensive labours. His work is now old, but he raised up many on his shoulders. A greater and truly grand man, Joseph Priestley, came also there a few years later, viz. in 1761, as teacher of languages and *belles lettres.* There he obtained a taste for science, and projected and began his scientific work with a history of Electricity. Priestley's life is too valuable for us to allow any of it to be neglected, and a short notice would be scarcely respectful ; it is not needful here to do more than to show its connection with the early struggles of this institution. He seems to have stimulated Dr. Percival to the study of chemistry, and induced him to encourage that interest in the science which he found beginning in Manchester, although we cannot suppose that Dr. Aikin was without a share in causing the stimulus, both with his example at Warrington and his influence carried on to the rest of Lancashire. We feel much pleasure in connecting ourselves with Priestley as an ancestor, and we certainly can do so to some extent, the Society having always felt his influence, both because of the exertions of his pupil and friend Dr. Percival, and its own attempt, however feeble, to assist him.[1] We might go farther, as he was an honorary member.

Still, evil-speaking came at last, not with prosperity, but, as often happens, with losses. We learn from Mr. Turner :—' The society at Warrington was at this period singularly agreeable. The tutors lived in perfect harmony with each other, and with Mr. Seddon, the minister of the place and the original projector of the academy ; who, therefore, considered the institution as his child, and, as

[1] In Priestley's difficulties the Society sent him fifty pounds. There was an ordinary member in Manchester of the name also of Joseph Priestley. At least we suppose that two individuals are indicated.

Rector Academiæ, kept up a constant intercourse with both the tutors and the students, with the elder of whom he was very familiar, and was greatly beloved by them. The trustees also were perfectly satisfied with the general conduct of the institution, and, in the year 1762, were encouraged to build in a more eligible situation a common hall and library, on a very handsome scale, together with two good houses for Dr. Priestley and Mr. Holt, Dr. Aikin being accommodated with a third house in the neighbourhood.' Alluding to Priestley it is said : ' But notwithstanding these promising appearances, the prospects of the tutors were in several respects by no means promising. The subscriptions of distant contributors gradually fell off, and threatened a defalcation of the annual salaries ; and, the terms which had been fixed for the board of students being unreasonably low (fifteen pounds a year), there was little room for a young tutor, with a lately married delicate wife and growing family, to flatter himself that he should be able to make provision for them. Perhaps his apprehensions of a failure of the academy were more readily indulged than they otherwise would have been, on account of Mrs. Priestley's ill health, and the wish to make trial of a change of air ; but it is certain that it was, in other respects, with great regret that he determined to separate from colleagues with whom he had lived so cordially and to quit a situation which was in every respect agreeable to him, and which had now in a manner ceased to be laborious. To the great disappointment, however, and mortification of the trustees, he accepted an invitation to become the minister of the congregation at Mill-Hill Chapel, in Leeds, whither he removed in 1767.' The rest of his active and eventful life forms no part of the history of our society or ancestry.

'During the interval between 1761 and 1767, the subscriptions originally promised being found to drop off gradually, partly, as Dr. Priestley states,[1] in consequence of the unhappy differences between Dr. Taylor and the trustees, partly through the natural apathy of a great majority of the subscribers, who, having never had a regular account-current of the annual expenditure presented to them (such as is every year furnished to each subscriber by the accurate and indefatigable treasurer for the York Institution), had no distinct idea of the object for which they were subscribing, and therefore, becoming weary of their subscription, were willing to lay hold of any pretence for dropping it. Various expedients were resorted to by the trustees. In 1762 Mr. Seddon was commissioned to visit London, Bristol, Birmingham, and other places, in order to ascertain by a personal application how far the annual subscriptions were to be depended upon, and to endeavour to obtain new ones. This produced a temporary revival; but the regular annual mode of distinct information of particulars continuing to be still neglected, the revival was only temporary. Another expedient was, to devise a means of increasing the number of students, particularly of lay-students, by accommodating those parents who injudiciously wished their children to resort to a place of education extremely unfit for them at so very early an age. For this purpose, they tried the experiment for a few years of taking boys under the age of fourteen, to be placed under the care of Mr. Benjamin Stapp, a divinity student of extraordinary promise, who, under the title of sub-tutor, was to train them in the Latin and Greek languages, and prepare them for the higher classes.'

[1] Life, p. 50.

After all they found at last something to quarrel about; but it appears that one great reason was their miserable pay: they might have been expected to be attached to each other as men are when all are sinking in the same boat. It does, however, appear that want of attention to the formal and, as we may say, external business of the establishment was one main reason of the decay of the school, although the want of success which followed its successors in York and Manchester must prevent us from looking too much to unbusiness-like habits for an explanation of that occurrence.

In after times Dr. Priestley remembered the happy days at Warrington, and wrote, 'In the whole time of my being at Warrington I was singularly happy in the society of my fellow tutors and of Mr. Seddon and the minister of the place. We drank tea together every Saturday, and our conversation was equally instructive and pleasing. I often thought it not a little extraordinary that four persons, that had no previous knowledge of each other, should have been brought to unite in conducting such a scheme as this, and be all zealous necessarians, as we were. We were likewise all Arians, and the only subject of much consequence on which we differed was respecting the doctrine of the Atonement, concerning which Dr. Aikin held some obscure notions.' [1]

Still the result was that in 1783 the academy was dissolved. It is often said that it went to Manchester; and this is not far wrong, as a certain remnant of its organisation still exists there. Much of its spirit went decidedly, and some

[1] From a paper by Mr. H. A. Bright of Liverpool, on the *Life and Letters of the Rev. John Seddon*, minister and tutor at Warrington.—*Christian Reformer*, 1854, p. 224.

persons connected with its first location ; and by degrees a new academy arose, not in its external matters much more prosperous than the first, although always having connected with it men of the highest intellectual rank: the Rev. John Kenrick and the Rev. James Martineau being enough to give it fame, and the Rev. J. J. Tayler to give it a place in the hearts of those who knew him ; these men being too great and good not to be admired even by those who have no sympathy with the same religious community.

When people laugh at Chowbent as a rough place, it is not unpleasant to note that one of the earliest promoters of the Warrington Academy was from that town, as seen by a letter from Mr. John Mort, minister there, a friend of Priestley's, a man to whom Mrs. Barbauld addressed the following lines :—

> Happy old man ! who, stretched beneath the shade
> Of large-grown trees, or in the rustic porch
> With woodbine canopied, where linger yet
> The hospitable virtues, calm enjoy'st
> Nature's best blessings all : a healthy age
> Ruddy and vigorous, native cheerfulness,
> Plain-hearted friendship, simple piety,
> The rural manners, and the rural joys
> Friendly to life. Oh, rude of speech, yet rich
> In genuine worth, not unobserved shall pass
> Thy bashful virtues ! for the muse shall mark,
> Detect thy charities, and call to light
> Thy secret deeds of Mercy ;

The 'rude speech' may be considered as more permanent than the 'large-grown' trees.

CHAPTER III.

DR. PERCIVAL.

WHEN Warrington was making this bold attempt to rise, Manchester was really beginning to be important. Active minds grew in it, and far-sighted men flocked there, attracted by its decided advance just before the seventh decade of last century. Lookers on previously did not see which Lancashire city was destined to the most rapid increase; some had believed the most promising to be Liverpool, others Ormskirk, but an influential class evidently supposed it to be Warrington; and there the notable but short-lived academy was established. The men who taught and those who learned were scattered, but not before some of the spirit had passed on to Manchester, and especially in the person of Dr. Percival, who had decided, after a very full medical education in Edinburgh, London, Leyden, and Paris, to begin practice in this town.

He seems to have been a singularly pleasant man, and one wonders what sort of people his ancestors were at Thelwall near Warrington, when his grandfather left the old family house and chose no longer to help the inmates to farm their own ground. We have few dates, but this must have been about 1670 or sooner. He (the grandfather) studied medicine, and returned to practise at Warrington; his name was Peter Percival, and he died in 1701. Martha

Worsley, his wife, was said to have been a woman of great talent ; her sister, Mrs. Mather, is better known on account of her theological correspondence with Bishop Burnet. There was talent therefore on both sides. The eldest of four sons became also a physician, and studied in Leyden, and we feel interested in thinking of him studying under Boerhaave, and learning from the lectures that animal heat was produced by the friction of the blood moving in the veins. This is a link of our society with an age which to chemists is as the history of Romulus to historians.

Peter had a thirst for wide knowledge, and read much rather than worked at his practice, so that he was not so much known out of Warrington as it is said he ought to have been. The third son, Joseph, became a merchant in the same town, and had leisure enough, as it appears, to give himself only occasionally to commerce : a hard thing this management by fits and starts in these present days when it is a struggle difficult to begin and often as much so to end. However, he lived quietly in Warrington, where his son Thomas Percival of our society was born September 29, 1740. Margaret Orred, the maiden name of the boy's mother, died early, and Joseph's elder sister. Elizabeth Percival, devoted herself to his training. To her he is said to have owed much. She was one of those women who cannot be too much admired, entirely unselfish, rejoicing in the happiness and fame of her brother. She lived till within a short time of his death, as full of goodness, intelligence, and truth as she ever was when she taught him his prayers and formed his gentle manners.

When Warrington schools and home teaching had prepared Thomas Percival, he went to Edinburgh to study medicine, and there obtained the acquaintance and friendship of Hume and of Robertson. This seems to have originated in a very simple way; he was boarded in the family of Mrs. Symes, the sister of Dr. Robertson the historian; much of his future success was probably owing to this accident. His manners and habits gave him a facility of taking advantage of the opportunity thus offered, and he was frequently a guest in Dr. Robertson's house. When subsequently he went to Paris he did not forget to call on Hume, who was then secretary to the English Embassy, and by this means he saw a good deal of French society. Not much of his French correspondence is preserved, but there are a few admiring letters from Madame Neckar. There also it may be supposed, as it is not stated, that he met with Benjamin Franklin, with whom he afterwards corresponded.

Lord Willoughby de Parham lived near Warrington, and thus Percival had an opportunity of cultivating an acquaintance, begun in London, and continued both there and in the country, when he became a decided favourite. It was by this influence that at the age of twenty-five he was made a Fellow of the Royal Society, Lord Willoughby being a vice-president. This was owing of course to the personality of the young man, not to his scientific labours. It would not be considered fair in these days; still personality has too much influence even now where that society has an imperfect mode of election, difficult however to change; it gives a *congé d'élire* for certain persons, whilst money for investigation is given where we might fancy zeal would find enough; but who can judge? No one is elected a Fellow who cannot pay. Science is not enough even there where it is supposed to rule. If this latter be the fault of the constitution, it is a fault that could be altered. In the same year, 1765, Mr. Percival went to Leyden to take his degree. It was the habit of Scotland to connect itself with Leyden, and especially at that time when some dispute had occurred in Edinburgh with the professors. Percival does not seem to have attended a course of lectures in Holland, because he received his diploma of M.D. on July 6, 1765, the year of entering Leyden. This was not got, however, without a fair struggle, as he defended his dissertation 'On Cold' in the public manner usual in that and other continental universities. At these discussions Latin only was spoken (we believe it is still so in Leyden): this shows that at Edinburgh or at Warrington young Percival had been well grounded. His thesis 'De frigore' is pointed to prove that cold has not a special existence, but is simply the absence of heat. If it does not show genius it displays at least the wholesome condition of mind of a well taught gentleman. When he returned home he married, and after staying two years in Warrington decided to live in Manchester rather than in London, as he at first intended. He seems to have come with a fame already made, a young man actually Fellow of such a society as the Royal—was ever anyone so young known to be elected! One also who had written essays, medical and experimental, published during this year!

He came into a fine practice rapidly in Manchester, and began at once an active and successful public life. For a long time he had a summer house at Harthill on the old Eccles Road, three miles from the town, where he had a house in King Street. He moved about all day in his carriage, one of the only three in the town, and read until he injured his eyes too early in life. Perhaps the motion of the carriage was great and irregular on account of the roads being far from excellent in those days, as well as on account of the mode of swinging the vehicles. He soon began to think in a manner different from his fellows, and to attempt to clear up to his own mind the duties of all members of Society, towards themselves and especially the poor. His experimental essays on scientific subjects cannot be considered important. Most of them were useful only as being suggestive for the time, and the results have much of that indefiniteness that is found in the transition age of chemistry and medicine, with both of which studies he was industriously engaged. This indefiniteness is more provoking than even alchemy itself, in which one is scarcely disappointed when the process spoken of is beyond comprehension. It arises from imperfect experiments—the key to explanation had not come. But Priestley was working at the same time and in a very different way, showing that the mastery was not gained by opportunity in which Percival had the advantage.

The earlier essays were published by different societies and in various ways, although afterwards collected. A second series of essays was published in 1773, entitled 'Essays Medical, Philosophical, and Experimental,' which made his reputation wide.

It is not intended to claim for him that all the ideas found in these essays were new, and it may be that none of them had the highest order of originality; but it is clear that he came to Manchester with remarkably wide thoughts on medicine and on science generally, and on the state of the country and of humanity. It is true that Dr. White was earlier in Manchester than Dr. Percival, and his son, Mr. Charles White, the surgeon, a contemporary; but Mr. White's mind was original in a different direction, and

Dr. Percival had a wider sympathy and a greater command of the field of action.

In the essay on 'The State of the Population in Manchester and other Adjacent Places,'[1] we see our supposed modern sanitary laws announced clearly to the people of Manchester by Dr. Percival. Let us look at some points.

He tells of the rapid increase of Manchester since 1765, that the births were more numerous than deaths, the first being as 1 to 25, the second as 1 to 28·4, and Liverpool increasing more rapidly, being multiplied by six since the beginning of the eighteenth century. He is astonished at 'the progress of trade and opulence,' and the expression 'so populous are the environs' sounds strange now.

Let us show some important conclusions.

Half the children born in Manchester die under five years of age.

Diseases are most frequent in January, February, and March. The difference between a small town, Bolton, and a county manor contiguous to it is held worthy of observation.

The quantity of rain at Manchester at some distance from the mountains is stated at thirty-three inches per annum (we make it a little more now).

It has been observed (in Rutley's 'Chronological History of Weather') that moist seasons in Great Britain and Ireland are more remarkably free from epidemic diseases than the dry ones; and that storms are attended with more health than calm weather. Elsewhere he mentions exceptions, when wet and heat come together; advises an enumeration of the people in England similar to that lately undertaken in Manchester.

[1] Vol. iv. of Dr. Percival's Works.

Males die earlier than females.

Great towns are in a peculiar degree fatal to children. The confinement of children in impure air, 'debarred from the free use of their limbs, cuts them off early in life.'

The love of money stifles the feelings.

On education, he says, 'Almost as soon as a boy has acquired the powers of speech, he is shut up many hours a day in a noisome school, secluded from the benefits of exercise and the refreshment of the open air, and tied down to the severe drudgery of learning, what serves only, at such a period of life, to overcharge his memory, and to destroy his native cheerfulness of disposition.' This will please Mr. Edwin Chadwick, whose labours in favour of the half-time system have been so long and valuable—a small portion only, however, of the sanitary work of which he is the great hero.

Dr. Percival speaks of the havoc produced in every large town by luxury, irregularity, and intemperance, and the pernicious influence of confinement, uncleanliness, and foul air.

A note in the collected works adds, whether alluding to the time of republication or not, does not appear; but probably it is so, namely 1807: 'There are at this time in Manchester no less than 193 houses for retailing spirituous and other liquors; and sixty-four in the other townships of the parish. At Birmingham the number of public-houses is still greater than at Manchester.' 'A very ingenious friend of mine (probably Dr. Percival's son is speaking) in that place has computed, that the quantity of malt consumed there in the public-houses requires for its growth a compass of land which would be sufficient for the support of 20,000 men.'

So many of the evils that every newspaper almost daily speaks of are thus shown to be old diseases of poor mankind.

To call attention to such conditions was fine work for a young man to do. The immediate effects we cannot fully enter on, or rather we must pass over them, and we must neglect to allude to numerous influential essays which he wrote on various subjects, making only occasional allusions to some as occasion may serve.

CHAPTER IV.

THE BEGINNING OF THE SOCIETY.

THE step of importance which interests us now more directly is the formation of this Society. It clearly arose from the high social position which Dr. Percival took. As he attracted to himself all the talent of the town, and was sufficiently easy in circumstances to entertain its representatives at his house, these meetings became so pleasant, and the conversations so important, that many persons sought to attend, so that the resources of a private house were strained. Then the proposal was to unite in a formal manner so as to advance the ends which all had in view, the promotion of Literature and Science.

Dr. Percival being thus able to collect around him men of influence, there came not merely such as were near him, and to whom his house became an intellectual camp, but men also from distant places, whilst others sent their opinions as to one who knew how to use them.

A lady now living remembers Dr. Percival, and having seen the portrait of him when young lately presented to the Society by Mr. F. Nicholson, our Honorary Librarian and one of his relatives, considers that much as he had changed when she saw him, there was still on the canvas a trace of his appearance. We can imagine him still young, charming all these men, many of them older, by his conversation, and the mysterious power in one who had studied in so many universities, and corresponded with politicians in both worlds; we must not forget too that other mysterious power which is supposed to exist in those who are in intimate connection with men of administrative influence of the time. Of all these external influences, unquestionably the greatest was his acquaintance with both men and women of literary and scientific fame, combined with his own charms of conversation, in which there must have been a confidence of force, and a feeling of superiority, not necessarily connected with actual mental superiority, but capable of putting into the hands of men of little more than average talent a power that quells for a time genius itself. Although Dr. Percival had shown more than ordinary talent, he could scarcely be said to rise to the heights of genius, unless it be in this very direction of knowing how to command the position or to attract to such an extent that men willingly left him to rule in his sphere.

The formation of the Literary and Philosophical Society of Manchester was an act of slow evolution. We may attempt now to bring it before our eyes more clearly, not merely as a meeting now and for a long time in George Street, but as a power active and beneficent, led for the most part by men who seldom interfered actively in public matters, but nevertheless guided when they were supposed to be idle, and who taught when they were supposed to be ignorant. It is certainly marvellous how much the usual authorities of the city have been influenced in early times by the Society; we cannot say the same now; if it be so it is certainly very indirectly, whilst many persons look on the members as a number of people amusing themselves with harmless speculations. One account of them is curious enough ; it is thus : 'We went into the Society and saw a number of old men sitting about a table talking about the moon.' We suppose they were looked upon by the very superior mind which gave expression to that sentence as a set of harmless lunatics. The weather (and with it in part the sun and moon) has received so much attention from Manchester, that it seldom failed even in late years to be the first object of conversation in every meeting, and there was at least room for a joke. But this city can bear such a joke when it remembers Dalton's meteorology. Dalton, no doubt, began the habit of talking about the weather.

It was then in this house of Dr. Percival's that our Society virtually began, although it was not there formally constituted ; we shall give a copy of the 'laws and regulations,' with a list of the first members. But before doing this it is well to give the preface to the first volume, as it tells more distinctly the views of the founders, although written some time after the volume itself.

PREFACE TO VOL. I.

'The numerous Societies for the promotion of Literature and Philosophy which have been formed in different parts of Europe, in the course of the last and present centuries, have been not only the means of diffusing knowledge more extensively, but have contributed to produce a greater number of important discoveries than have been effected in any other equal space of time.

'The progress that has been made in Physics and the Belles Lettres owes its rapidity, if not its origin, to the encouragement which these Societies have given to such pursuits, and to the emulation which has been excited between different academical bodies, as well as among the individual members of each institution. The collecting and publishing the more important communications which have been delivered to them, have saved from oblivion many very valuable discoveries, or improvements in arts, and much useful information in the various branches of science. These their modest authors might have been tempted to suppress, but for the respectable sanction of societies of men of the first eminence and learning in their respective countries, and the easy mode of publishing which their volumes of Transactions afford.

'Though, in France, societies for these purposes have been instituted in several of the provinces, in England they have almost been confined to the Capital ; and however great have been the advantages resulting from the researches of the learned bodies who are incorporated in London, it seems probable that the great end of their institutions, the promotion of arts and sciences, may be more widely extended by the forming of societies, with similar views, in the principal towns in this kingdom.

'Men, however great their learning, often become indolent, and unambitious to improve in knowledge, for want of associating with others of similar talents and acquirements. Having few opportunities of communicating their ideas, they are not very solicitous to collect or arrange those they have acquired, and are still less anxious about the further cultivation of their minds. But science, like fire, is put in motion by collision. Where a number of such men have frequent opportunities of meeting and conversing together, thought begets thought, and every hint is turned to advantage. A spirit of inquiry glows in every breast. Every new discovery relative to the natural, intellectual, or moral world, leads to a farther investigation; and each man is zealous to distinguish himself in the interesting pursuit.

'Such have been the considerations that have led to the institution of the Literary and Philosophical Society of Manchester. Many years since, a few gentlemen, inhabitants of the town, who were inspired with a taste for literature and philosophy, formed themselves into a kind of weekly club, for the purpose of conversing on subjects of that nature. These meetings were continued, with some interruption, for several years; and many respectable persons being desirous of becoming members, the numbers were increased so far as to induce the founders of the Society to think of extending their original design. Presidents, and other officers were elected, a code of laws formed, and a regular Society constituted, and denominated the Literary and Philosophical Society of Manchester.

'This Society now presents the first fruits of its institution to the public; and from the assiduity of the members, and the correspondence of others, there is reason to presume that a volume may be regularly sent to the press every second or third year. The selection of the papers has been made with as much impartiality, and as strict attention to their comparative merits, as could be expected in decisions of so delicate a nature. Yet the committee are sensible that a majority of votes, delivered by ballot, is not an infallible test of excellence in literary or philosophical productions. This consideration, they trust, will give them a reasonable claim to the candour of the reader, if there should be found occasion for its exercise. And they hope that gentlemen who have favoured the Society with valuable communications, will deem it no injustice or disparagement that their essays have not been inserted, through the imperfection of necessary forms and regulations. They are preserved in the archives of the Society, and may again come under review, when subjects of a similar nature to those on which they treat are offered for discussion.[1]

'No systematic order has been observed in the disposition of the miscellaneous materials which compose these volumes; because such an arrangement would have required the completion of the work, before any part of it could have been committed to the press.

'The sanction which the Society gives to the work now published under its auspices extends only to the novelty, ingenuity, or importance of the several memoirs which it contains. Responsibility concerning the truth of facts, the soundness of reasoning, or the accuracy of calculation, is wholly disclaimed; and must rest alone on the knowledge, judgment, or ability of the authors who have respectively furnished such communications.'

Laws and Regulations for the Government of the Literary and Philosophical Society of Manchester, together with a list of the Members.

LAWS.

I. That the number of the members of this Society, invested with the privilege of voting, electing members, &c., be limited to fifty.

II. That Honorary members, residing at a distance from Manchester, be eligible into this Society, provided no

[1] 'Several dissertations, by Dr. Percival, Mr. Henry, and others, enumerated in the printed report of the Society, were published by their respective authors, long before these *Memoirs* were committed to the press.'

gentleman be recommended who has not distinguished himself by his literary or philosophical publications, or favoured the Society with some paper, which shall have received the approbation of the Committee of papers.

III. That every candidate for admission into the Society, whether as an Ordinary or Honorary member, shall be proposed by at least three Ordinary members, who shall sign a Certificate of his being, from their knowledge of him, or of his writings, a fit person to be admitted into it; which certificate shall be read at four successive meetings of the Society, previously to the election. Such election, with respect to an Ordinary member, to be void, if he do not attend within four meetings afterwards, unless he can plead some reasonable apology.

IV. That every election shall be conducted by ballot; that the majority of votes shall decide; thirteen members at least being present; and that the president shall have a casting voice, if the number of votes be equal.

V. That two presidents, four vice-presidents, two secretaries, a treasurer, and a librarian, be elected annually, by the majority of members present, on the last Wednesday in the month of April: the election to be determined by ballot.

VI. That a Committee of papers shall be appointed, by ballot, at the same time, which shall consist of the presidents, vice-presidents, secretaries, treasurer and librarian, together with six other members of the Society: and that this Committee shall decide, by ballot, concerning the insertion in the register, or the publication, of any paper which shall have been read before the Society: and shall be authorised to select, with the consent of the author, detached parts of any paper, the whole of which may not be deemed proper either for insertion or publication : but that the presence of seven members of the Committee shall be necessary for such discussion, or decision.

VII. That visitors may be introduced by any member to the meetings of the Society, with the permission of the chairman.

VIII. That the subjects of conversation comprehend natural philosophy, theoretical and experimental chemistry, polite literature, civil law, general politics, commerce and the arts. But that religion, the practical branches of physic, and British politics, be deemed prohibited ; and that the chairman shall deliver his veto whenever they are introduced.

IX. That each member, who shall favour the Society with any interesting facts and observations, respecting philosophy, polite literature, &c., which may occur to him either from reflection, experiment, reading, or correspondence shall send his paper to one of the secretaries, the Monday before the meeting of the Society.

X. That the secretary, to whom the paper shall be delivered, shall, with the approbation of one president or two vice-presidents, have the power of suspending the recital of it, if deemed improper to be read, until the pleasure of the Committee of papers be known, a meeting of which shall be called by the secretary to inspect it : and if the Committee disapprove of its being introduced to the Society, they shall be empowered to reject it.

XI. That all papers which shall be delivered to the secretary, and not prohibited as above, shall be read by him, or the author, according to the order of succession in which they were presented.

XII. That each paper shall be read to the Society without interruption ; and that more than thirty minutes shall not be allowed to the reading of any single paper : if more time be required in the delivery of it, the remainder shall, except the Society determine otherwise, be deferred to the succeeding evening. No paper, however, shall engage more than two evenings, without the consent of the Society expressed by a ballot.

XIII. That a second paper shall not be read before the subject of the former one has been discussed.

XIV. That the Society shall meet every Wednesday evening, except during the months of June, July, August, and September : and that each meeting shall commence at half-past six, and be concluded at half-past eight o'clock.

XV. That each member shall pay one guinea annually, at half-yearly payments, into the hands of the treasurer, to defray the rent of the room, and other incidental expenses ; and also to establish a fund for the benefit of the Society. And if any member shall refuse or neglect to pay his subscription, he shall be excluded the Society. Each member on his election to pay his subscription for the current half-year, together with one guinea admission fee.

XVI. That it be recommended to each member to enter the Society's room with silence, and without ceremony.

XVII. That no laws shall be enacted, rescinded, or altered, but at the quarterly meetings, on the last Wednesdays in the months of January, April, and October : and that notice shall be given, at least fourteen days, previous to those meetings.

REGULATIONS.

I. That the Society shall publish a volume of miscellaneous papers every two years: and that, at stated times, the Committee shall select from the papers, which shall have been read to the Society, such as shall appear to be most worthy of publication: but that no papers shall be published against the consent of the authors.

II. That a library be formed for the use of the members of this Society; and that the librarian be authorised to purchase such books as shall be ordered at the quarterly meetings of the Society: but that no books shall be taken out of the library, without a written order from one of the secretaries, limiting the time of keeping it to seven days.

III. That the resolution to establish a library be announced to the Honorary members of the Society; and that it be intimated to them by the secretaries that donations of their past and future publications will be highly acceptable.

IV. That a gold medal, of the value of seven guineas, be given to the author of the best experimental paper on any subject relative to arts and manufactures, which shall have been delivered to the secretaries, and read at the ordinary meetings of the Society before the last Wednesday in March 1786.

V. That the adjudication of this premium be referred to the Committee of papers; that their decision shall be made by ballot; and that the medal shall be delivered by the president to the person to whom it shall have been adjudged, or to his representative, at the first meeting of the Society in October 1786.

VI. That if the person to whom the medal shall have been adjudged, be not one of the Society, his name shall be enrolled in the list of Honorary members.

VII. The regular attendance of members being essential to the prosperity and usefulness of the Institution, that if any member shall absent himself during the space of three months from the meetings of the Society, notice shall be sent to him, at a quarterly meeting, that the Society considers his absence as a mark of disrespect, and that a more punctual observance of the laws is expected from him.

VIII. To encourage the exertions of young men who attend the meetings of the Society as visitors, that a silver medal, not exceeding the value of two guineas, be annually given to any one of them, under the age of twenty-one years, who shall, within the year, have furnished the Society with the best paper on any subject of literature or philosophy; and that such adjudication shall be made by the Committee of papers.

A LIST OF THE MEMBERS.[1]

* James Massey, Esq. * Thomas Percival, M.D., F.R.S., &c.; S.A., and Reg. Soc. Med. Par. Soc.	*Presidents.*
* The Rev. Samuel Hall, A.M. * Charles White, Esq., F.R.S., Honorary Mem. R.M.S., and Cor. Mem. R.S.A. in Scotland, &c. * George Lloyd, Esq. * Mr. George Bew.	*Vice-presidents.*
* The Rev. Thomas Barnes, D.D. * Mr. Thomas Henry, F.R.S.	*Secretaries.*

[1] Those marked * are of the Committee of Papers.

Mr. Isaac Mosse. . . . . *Treasurer.*
Mr. Thomas Robinson. . . . . . *Librarian.*

Mr. Joseph Atkinson.
Mr. John Barrow.
Thomas Butterworth Bayley, Esq., F.R.S.
*Mr. John Bill.
Mr. John Birch.
Mr. Charles Frederick Brandt.
Mr. Ashworth Clegg.
Mr. Robert Darbey.
Mr. James Dinwiddie.
Mr. John Drinkwater.
*Mr. George Duckworth.
Alexander Eason, M.D.
Mr. Edward Hall.
Mr. Richard Hall.
*The Rev. Ralph Harrison.
Mr. Samuel Hibbert.
*Mr. Thomas Kershaw.
Mr. John Lawrence.
Mr. James Macaulay.
Peter Mainwaring, M.D.
John Mitchell, M.D.
Mr. John Orme.
Mr. George Philips.
Mr. John Philips.
Mr. Robert Philips.
*Mr. John Leigh Philips.
Mr. Thomas Philips.
*Mr. James Potter.
Mr. John Powel.
The Rev. Frederick Robert Slater.
Mr. George Wakefield.
Mr. George Walker.
Mr. John Wilson.

Those marked * are of the Committee of Papers.

HONORARY MEMBERS.

John Aikin, M.D.
Felix Vicq d'Azyr, R.S. Med. Par. Sec., and R.A.Sc.
Sir George Baker, Bart., F.R.S. Medic. Regin.
James Beattie, LL.D.
Patrick Brydone, Esq., F.R.S.
Mr. John Buchanan.
The Right Rev. Beilby, Lord Bishop of Chester.
Edwood Chorley, M.D.
Mr. Thomas Cooper.
James Currie, M.D.
Erasmus Darwin, M.D., F.R.S.
Edward Hussey Delaval, Esq., F.R.S. Reg. S.C. Götting., & Upsal. & Instit. Bologn. Soc.
The Hon. Sir John Talbot Dillon, Knight and Baron of the Holy Roman Empire.
Rev. William Enfield, LL.D.
William Falconer, M.D., F.R.S.
Anthony Fothergill, M.D., F.R.S.
Benjamin Franklin, LL.D., R.S. L. & R. Acad. Scient. Par. Soc., &c.
The Rev. — Frossard, D.D., of Lyons, in France.
William Hawes, M.D.
John Haygarth, M.B., F.R.S.
Mr. George Hibbert.
Thomas Houlston, M.D.
Alexander Hunter, M.D., F.R.S.
James Johnstone, M.D.
Monsieur Lavoisier, Reg. Ac. Scient. P. Soc.
The Right Rev. Richard, Lord Bishop of Llandaff, F.R.S.
John Coakley Lettsom, M.D., F.R.S., & S.A.
Mr. J. Hyacinth Magellan, F.R.S. & R. Acad. Petrop. and Paris. Corresp.
Mr. Patrick MacMorland.
Henry Moyes, M.D.
The Rev. John Pope.

The Rev. Joseph Priestley, LL.D., F.R.S., Acad. Imp. Petrop., R. Holm. & Med. & Reg. Acad. Scient. P. Sc.

Mr. William Rathbone.

Mr. William Roscoe, Liverpool.

Benjamin Rush, M.D., Professor of Chemistry at Philadelphia.

Dorning Ramsbotham, Esq.

Samuel Foart Simmons, M.D., F.R.S., & R.S.M.P. Soc., & R.S. Monspel. Corresp.

The Rev. William Turner.

The Rev. George Travis, A.M.

Mr. Alexander Volta, Professor of Experimental Philosophy at Como, &c.

Martin Wall, M.D., Clinical Professor in the University of Oxford

Mr. John Warltire.

The Rev. Gilbert Wakefield, B.D.

Josiah Wedgwood, Esq., F.R.S.

The Rev. John Whittaker, B.D., F.S.A.

CHAPTER V.

DR. PERCIVAL'S WRITINGS AND EARLY SANITARY WORK IN MANCHESTER.

HAVING given these necessary details it is now intended to say a little of some of the prominent members, and give an account of some of the papers which may seem most interesting; and, however contradictory to this conclusion it may appear, it is intended to leave the society for a little so as to view Dr. Percival's work here more clearly, and to do this it is quite necessary to allude to his sanitary work, and to show that Manchester was then the great centre of sanitary knowledge and Percival the true apostle. A few remarks may come in here regarding his general literary work. For a man like Dr. Percival, gentle and benevolent, with wide extent of reading, but with time chiefly occupied with his profession, it is not to be expected that, unless in cases where physical strength is great, any long-continued scientific investigation should be possible. And so we find in Dr. Percival's works much good sense, good language, and excellent arrangement, but a want of that power which sends words or works to a very attentive posterity.

'A Father's Instructions, adapted to Different Periods of Life from Youth to Maturity,' consists of short tales, fables, and essays, separate or mixed, sounding much like the style of the 'Spectator' at times without its exquisite polish, and of 'Æsop's Fables' at other times without their telling terseness. A style admirable in idea because it mixes the useful and the pleasant, but in this case carried out with too much formality of language to suit children, and too much youth of knowledge to suit those who are grown older. The essays cannot be called highly successful, but indicate a refined soul.

An exception may be made of the 'Medical Ethics' of Dr. Percival, which can be treated of only by those who have read similar previous works, and this has not been done by the present writer, unless we consider the 'Religio Medici' of Sir Thomas Brown to belong to them. There is no attempt in Dr. Percival's book to prove himself the wisest man under the sun and possessed of every virtue, but he shows himself a wise and a practical man, as his position in Manchester might be expected to prove him ; and he gives rules for the behaviour of medical men towards their patients and each other which are dictated by the highest feelings and the most refined perception and taste. So far as these are concerned, it seems scarcely possible to go beyond Dr. Percival, and we could imagine this treatise to be a code of morals and manners to all succeeding generations. If there be a fault, it is one which naturally arises out of the difficulty of keeping out all feelings of envy and jealousy from the minds of professional men. There is thus produced a code of etiquette towards each, which does not always sufficiently take into consideration the necessities of the patient.[1] In this way

[1] Since this was written a remarkable instance arose in the case of Lord Beaconsfield, where one man would rather keep some formal habit than do his

delicate questions are often introduced, and these are treated in a beautiful spirit; but there are always cases arising which are beyond advice, and such as must be left to the wisdom of the agent nearest to act, whilst blame will sometimes arise whatever he may do or leave undone. Late editions show that this work of Dr. Percival's is still valued.

The beginning of Dr. Percival's sanitary work dates as far back as 1773, and must be described, adding also a communication by the Rev. Mr. Dade, of York, which was appended to his own. It takes us back to a time before the formation of the Society, but it is necessary to go so far, as the connection must be made with work earlier as well as much later than our first meeting.

Proposals for establishing more accurate and comprehensive Bills of Mortality in Manchester[1] (*before* 1773).

'The establishment of a judicious and accurate register of the births and burials in every town and parish would be attended with the most important advantages, medical, political, and moral. By such an institution, the increase or decrease of certain diseases, the comparative healthiness of different situations, climates, and seasons; the influence of particular trades and manufactures on longevity; with many other curious circumstances, not more interesting to physicians than beneficial to mankind, would be ascertained with tolerable precision. In a political view, exact registers of human mortality are of still greater consequence, as the number of people and the progress of population in the kingdom, may in the most easy and

utmost to preserve a life. In such things the profession frequently offends, as it finds a life, however important, difficult to separate from a mere *case*.

[1] Dr. Percival's Works, vol. iii. pp. 428–435.

unexceptional manner be deduced from them. They are the foundation likewise of all calculations concerning the values of assurances on lives, reversionary payments, and of every scheme for providing annuities for widows, and persons in old age. In a moral light, also, such tables are of evident utility, as the increase of vice or virtue may be determined by observing the proportion which the diseases, arising from luxury, intemperance, and other similar causes, bear to the rest, and in what particular places distempers of this class are found to be most fatal.

'A few examples may perhaps confirm and illustrate these observations. In the Pais de Vaud, a district of Bern in Switzerland, and in a country parish in Brandenburgh, 1 in 45 of the inhabitants dies annually; and at Stoke Damerel in Devonshire, 1 in 54; whereas in Vienna and Edinburgh the yearly mortality appears to be 1 in 20; in London, 1 in 21; in Amsterdam and Rome, 1 in 22; in Northampton, 1 in 26; and in the parish of Holy Cross, near Shrewsbury, 1 in 33. In the Pais de Vaud, the proportion of inhabitants who attain the age of eighty is 1 in 21½; in Brandenburgh, 1 in 22½; in Norwich, 1 in 27; in Manchester, 1 in 30; in London, 1 in 40; and in Edinburgh, 1 in 42. These facts afford a striking but melancholy proof of the unfavourable influence of large towns on the duration of life. From the most accurate computation, London is found to contain 601,750 inhabitants; and from 1759 to 1768 the burials have exceeded the christenings every year upwards of 7,000, which is the recruit the metropolis requires annually from the country to support the present number of its people. In 1757 a survey was made of Manchester and Salford. The number of inhabitants then amounted to 19,839; and the burials, exclusive of those amongst Dissenters, were 778. But since that time the populousness of Manchester has considerably increased. Half of all that are born in this town die under five years old. The island of Madeira is so remarkably healthy, that two-thirds of all who are born in it live to be married. Autumn is the most healthy, and summer the most sickly season there. The mortality of spring and summer is to that of autumn and winter as 115 to 100. In Manchester diseases are most frequent and fatal in the months of January, February, and March; and least so in July, August, and September. The mortality of these two seasons is as 11 to 8; and of the first six months of the year compared with the last six months as 7 to 6. M. Muret, Secretary to the Economical Society at Bern, informs us that he had the curiosity to examine the register of mortality in one town, and to mark those whose deaths might be imputed to intemperance. And he found the number so great, as to incline him to believe that drunkenness is more destructive to mankind than pleurisies, fevers, or the most malignant distempers.[1] Such are the important uses to which Tables of Human Mortality have been applied.

'The following plan of a more exact and comprehensive register than has hitherto been kept, is submitted to the consideration and correction of those who undertake the charge of the Bills of Mortality in Manchester.

'I. Let a table of christenings, marriages, and burials be kept in every church, chapel, and place of religious worship in the town, and delivered at certain stated times to the clerk of the parish church, to be formed into one

[1] See a very valuable treatise on *Reversionary Payments*, by the Rev. Dr. Price; the *Bern Observations* for the year 1766; *Philosophical Transactions*, vol. lvii. and lix.; and Dr. Short's *New Observations*.

general bill, and quarterly or annually published. It is of importance that the still-born children, and those who die before baptism, should also be registered; and the midwives should be desired to deliver an account of them. Perhaps the sextons may assist in ascertaining their number, as they are usually interred in churchyards, or other public burial grounds.

'II. Let the table of christenings specify the males and females who are baptised; and the table of deaths express the males who die, under the several denominations of children, bachelors, married men, and widowers; the females who die, under the corresponding denominations of children, maidens, married women, and widows.

'III. An observance of these distinctions will determine the comparative number of males and females who are born; the difference between the sexes in the expectation of life; and the proportion which the annual births, deaths, and marriages bear to each other. Thus by the Bills of Mortality which have been kept at Vienna, Breslau, Dresden, Leipsic, Ratisbon, and other towns in Germany, it appears that the proportion of males to the females who are born is as 19 to 18. But the proportion of boys to girls who die under ten years of age is as 7 to 6; and of married men to married women in Breslau as 5 to 3, in Dresden as 4 to 1. At Vevey, in Switzerland, for twenty years, ending in 1764, there died in the first month 135 males to 89 females; and in the first year 225 to 162. The same accounts show likewise that, both at Vevey and Berlin, the still-born males are to the still-born females as 30 to 21. In the parish of Holy Cross, Salop, an account was taken by the vicar, A.D. 1760, of the number of males and females of the age of seventy and upwards.

The latter amounted to 35, the former only to 8. At Paris and in Sweden it has been observed, that women not only live longer than men, but that married women live longer than single women. And in Switzerland it appears particularly, from the calculations of M. Muret, that of equal numbers of single and married women between the age of 15 and 25, more of the former died than of the latter, in the proportion of 2 to 1.[1]

'Let the ages under 5 be specified by single years; and afterwards by periods of five or ten years.

'IV. Let the Bills of Mortality contain not only a list of the diseases of which all die, but also express particularly the number dying of each disease, in the several divisions of life, and different seasons of the year. To accomplish this, it will be necessary for the physicians of the town to consider the present list of distempers; to reject all synonymous and obsolete terms; and to give a short and easy explanation of those which are retained. And whenever a person dies who has been attended by any of the faculty, the physician, surgeon, or apothecary should be desired to certify, in writing, the age and distemper of the deceased.

. . . .

'The additional trouble which this more comprehensive and accurate register will occasion to the clerks of the several churches, etc., may be compensated by distributing amongst them, at the discretion of any judicious clergyman, the money which arises from the sale of the quarterly bills. If a hundred of these be subscribed for, or sold at the price of one shilling each, the sum of twenty pounds per annum will thus be raised, without imposing any new

[1] *Vide* Dr. Price's *Observations on Reversionary Payments.*

burdens on the town. Every second, third, fourth, or fifth year the bills may be collected into a volume and published, under the direction of two or more physicians, with observations on the state of the weather, the prevalence of epidemic diseases, their symptoms and method of cure, and the increase or decrease of population during that period. Such a work will afford the most important instruction to the public; and from the profits of it, a fund may be established for the benefit of the clerks, and the support of the institution.

'N.B.—It is obvious that the plan here proposed is not local, and that it may be executed with equal facility and advantage in every town and parish in the kingdom. Bills of Mortality might be rendered more useful in a political view, by taking sometimes the number of houses and inhabitants, under and above particular ages, wherever such registers are established.'

In connection with this paper there is printed in Dr. Percival's Collected Works, vol. iii. p. 438, a communication by the Rev. Mr. Dade of York, which gives something of the history of ideas on the subject and the condition of the question when Dr. Percival took it up; but people must search elsewhere for the full details of its growth, which would lead us almost into a history of civilisation. However, Mr. Dade's paper may follow Dr. Percival's here, as in the original.

'*Proposals for Establishing more comprehensive and accurate Parish Registers; communicated by the Rev. Mr. Dade, of York.*[1]

'Ralph Bigland, Esq., Norroy King at Arms, observes, in his pamphlet published a few years ago, that "the necessity of proper records for ascertaining the marriages, births, baptisms, deaths, and burials of persons within their respective parishes, is abundantly evident from a transient view of our ancient history, which for want of proper names, and real dates, and family connections occasionally to be referred to, is oftentimes rendered perplexed and unintelligible, and sometimes altogether inconsistent even with its own chronology."

'To remove this defect, Thomas Cromwell, afterwards Earl of Essex, being the King's Vicar-General, in the year 1538 issued out an order to the clergy throughout England that in their respective parishes a public register should be kept for the above purposes.[2] How far the intentions of that Minister of State are really answered is evident from the incorrect manner in which entries are too generally made. It has been long wished that the utility of parish registers was thoroughly investigated, that the defects in making the entries were pointed out, and such a plan laid down as might not only be useful, but easily applied to practice.

'Whether the present form, with the observations upon it, contribute to elucidate any of these points the public will easily determine.

'Each page is divided into six columns; the first, in the register for baptisms, contains in large characters the

[1] Dr. Percival's Works, vol. iii. p. 438.

[2] Perhaps a year or two earlier.

christian name: in the second column is the surname and seniority of the infant, also in large characters. The utility of this disposition will appear to any person who has examined parish registers with a degree of accuracy.

'Lest the object of our inquiry should escape us, how frequently are we obliged to undergo the toil of traversing every line in each page, written perhaps in small characters improperly spelt, and in a hand sometimes scarcely legible; whereas according to the present form, the reader will be able, with one glance of the eye, to run over the several names in each page; and will examine, in a few minutes, what otherwise would take several hours to accomplish.

'In the present form it is hoped that care has been taken to identify the persons; for when we are told that Robert Lutton, James Creyke, and Elizabeth Dealtrey were baptised; or that William Strickland, Mary Strangways and Richard Heblethwayte were buried on such a day, in a succession of years how shall we inform ourselves whether the parties were infants, adult or aged, married or single, of what profession, or how they stood related; circumstances we are too apt, at the time of recording those particulars, to think of no moment, because their consequences are so remote. Nor are our inquiries more gratifying in finding John son of William Fairfax, Mary daughter of Thomas Beckwith, and James son of Robert Anderson, baptised; or Mr. John Grimston, Mrs. Jane Turner, and James son of William Fountaine were buried on such a day. Was there no necessity for carrying our researches further than twenty or thirty years, the defect might be supplied by the testimony of living witnesses, though perhaps, even then, not without much trouble and inconvenience; but where it happens that the occurrences are not recent, and there are no collateral circumstances to assist us in identifying the parties, we must naturally be left in the dark. A gentleman in the West Riding of Yorkshire, some years ago, felt the full weight of this defect. Being desirous of forming a genealogical account of his family, he applied to the register of the parish; and though he collected nearly 100 baptisms and as many burials in the last century, there was not one circumstance that would enable him to digest them into any form, and to ascertain the respective branch to which each party belonged. Where families of the same name reside within the same parish, there will arise difficulties in proportion; and after the expiration of half a century, it will be impossible to distinguish the descendants of one house from those of another. There lived some years ago, in the neighbourhood of Thirsk, three respectable families, nearly allied, of the name of Kitchingman; and on examining the parish register, I find it verifies my assertion.

'Mr. Bigland had his eye upon these defects, when he observes, "It is of importance to every family, not excepting the least considerable, to pay some regard to their pedigrees, and consequently that every circumstance, whether of a public or private nature, that tends to illustrate genealogical intelligence, should be attended to with the most religious exactness."

'Let us then view the last mentioned names, registered according to the form, at the end of these remarks. With the addition of collateral circumstances, we shall easily distinguish the object of pursuit, whether it may regard the title of our property, or only the gratification of an inquiry natural to those who are desirous of knowing whence they are descended. We have therefore allotted the third column to the name, profession, and descent of the father, and the fourth to the name and descent of the mother, the particulars of which may easily be collected when the infant is baptised. Thus shall we hope, on trials of titles to estates, and genealogical inquiries, to raise a fund of intelligence to the industrious antiquary, as well as the gentlemen of the law; and perhaps they may allow this scheme to bid the fairest for supplying the place of visitations or inquisitions *post mortem*.

'The fifth column shows the birth, and the sixth the baptism of the infant; the entry of each being essentially necessary. When the age bears date from the baptism only, the child may become subject to great inconvenience. I have only to add, that the uniformity of the page has been consulted, and that the two last columns, in the register of burials, are intended to distinguish places remarkable for longevity, or the reverse, and to acquaint us what disorders mankind is subject to under particular seasons and climates; the use of which information is sufficiently evinced by Dr. Percival, of Manchester.

'Should this form meet with the approbation of the public, I can claim no other merit than having improved upon a hint, given to the community in the year 1715 by Mr. Thoresby, the ingenious author of "Ducatus Leodiensis," or the topography of Leeds, as proposed to him by an eminent antiquary, Thomas Kirk, Esq., of Cookbridge, near to that town.'

THE BOARD OF HEALTH.

We come to an important step taken by Dr. Percival and his friends, viz., the establishment of a committee for superintending the health of the poor of Manchester and Salford. Dr. Percival was evidently the leading spirit, as may be seen from the earliest document describing the objects to be sought. It is interesting to see how much his exertions excited the activity of medical men in other places, and as usual the opposition of the short-sighted at home, the bigoted men, the intellectual descendants of the witch-burners, who were losing their influence.

The account of this early sanitary movement in the history of this city is in an interesting little volume called 'Proceedings of the Board of Health of Manchester.' It contains a number of the original documents, and was published in 1805, to clear up the controversy which rose between the persecutors or opponents and the Board, nine years after the work was begun which was continued with success.

The public were very much alarmed at the proposal to establish a house of recovery for fever patients, fearing it might become a centre of infection, and proofs of the contrary required to be given. These were partly found in letters from Dr. Haygarth of Chester, giving the experience of that place, Dr. Bardsley, Dr. Currie of Liverpool, and a student who gave Edinburgh experience.

Although the first meeting was in January, the report of The Strangers' Friends Society, was able to say on November 12 of the same year 1796, 'In our last report it was stated that the fever was raging with great violence in many parts of the town. Happily that scourge of heaven is now comparatively almost withdrawn. This important change we ascribe, under God, principally to the House of Recovery, to the salutary effects of which we wish in this manner to bear our public and grateful testimony.'

The discussion reminds one of that regarding a small-pox hospital in Hampstead lately, and leads to quote, from the same small volume spoken of, Dr. Currie's remark in his letter from Liverpool, 'If a building is to be erected for the express purpose, every one will agree that it is better it should be wholly detached from every other.'

The struggle ended, but not until it brought out opinions also from Mr. David Dale of the Lanark Mills, Dr. Ferriar, Dr. Carmichael Smyth, Mr. Thomas Henry, and Dr. Garnett, giving the essence of what was known on the air, disinfection and contagion.

Copy of Dr. Percival's remarks, January 7, 1796.

'The objects of the Board of Health are threefold :—

'1. To obviate the generation of diseases.

'2. To prevent the spreading of them by contagion.

'3. To shorten the duration of existing diseases, and to mitigate their evils, by affording the necessary aids and comforts to those who labour under them.

'Under the first head are comprehended : the inspection and improvement of the general accommodations of the poor ; the prohibition of such habitations as are so close, noisome, or damp, as to be incapable of being rendered tolerably salubrious ; the removal of privies placed in improper situations ; provision for white-washing and cleansing the houses of the poor twice every year ; attention to their ventilation, by windows with open casements, &c. ; the inspection of cotton mills or other factories at stated seasons, with regular returns of the condition, as to health, clothing, appearance, and behaviour of the persons employed in them ; of the time allowed for their refreshment at breakfast and dinner; of the number of hours assigned for labour; and of the accommodations of those who are parochial apprentices, or who are not under the immediate direction of their parents or friends; the limitation and regulation of lodging-houses, or the establishment of caravanseras for passengers, or those who come to seek employment unrecommended or unknown; the establishment of public warm and cold baths; provision for particular attention to the cleaning the streets which are inhabited by the poor, and for the speedy removal of dunghills, and every species of filth; the diminution, as far as is practicable, of other noxious effluvia, such as those which arise from the workhouses of the fellmonger, the yards of the tanner, and the slaughter-houses of the butcher; the superintendence of the several markets, with a view to the prevention of the sale of putrid flesh or fish, and of unsound flour, or other vegetable productions.

'Under the second general head are included: The speedy removal of those who are attacked with symptoms of fever from the cotton-mills or factories to the habitations of their parents or friends, or to commodious houses which should be set apart for the reception of the sick in the different districts of Manchester; the requisite attention to preclude unnecessary communications with the sick in the houses wherein they are confined, and to the subsequent cleansing and ventilation of their chambers, bedding, and apparel; and the allowance of a sufficient time for perfect recovery, and complete purification of their clothes, before they return to their work, or mix with their companions in labour.

'Under the third head are comprehended: medical attendance; the care of nurses; and supplies of medicine, wine, approprite diet, fuel, and clothing.

'1. Inquire into the powers of the committee of police, and whether they be not competent both to originate and effectuate the proposed reforms.

'2. Or whether a board of health might not with more propriety, because with more legal authority, be appointed by the committee of police, to act under their auspices, and to hold from time to time a communication with them?

'3. Or might not a board of health be nominated by the magistrates of the quarter sessions, and act under their auspices in connection with the committee of police?'

Dr. Percival had written elsewhere, 'It has been found, by experiment, that the fumes emitted by almost every species of burning fuel are fatal to animals, when applied in a sufficiently concentrated state. I have computed that three hundred tons of coal are every day consumed in the winter season at Manchester. The factitious gas generated by its combustion must amount at least to one-third of this quantity; it is probable that the smoke proceeding from it constitutes another third part, and both together are capable of occupying a space of very wide extent. Now if it were not for the dispersion of these vapours by wind, the precipitation of them by rain, and the influence of other causes, which restore salubrity to the air, respiration could not be carried on under such circumstances. And we may observe that frosty weather, which is generally serene and without wind, always proves extremely oppressive, and sometimes even fatal to asthmatic patients in great cities. Indeed the rate of human mortality bears a pretty near proportion to their magnitude and population; and I have shown in another work,[1] that there is an astonishing difference between the expectation of life in Manchester and the country immediately surrounding it, although the inhabitants of both are subject to the same vicissitudes of weather, carry on the same manufactures, are supplied with provisions from the same market, and by their free intercourse are almost equally liable to attacks of small-pox, fevers, and other epidemics.'

We must also give extracts from Dr. Ferriar's remarks: —

'At the request of some of your number, who originally proposed this meeting, I submit to your consideration a few remarks towards the formation of a board, or committee, for superintending the health of the manufacturing poor in Manchester and Salford. . . .

'Having already published my sentiments pretty fully on this subject, I shall remark, without entering into any previous reasoning, that the principal sources of fever among our poor are lodging-houses, cellars, cotton mills, and the incautious intercourse of the poor with each other in places infected.

'1. Respecting lodging-houses, I have observed elsewhere, that the most desirable means of prevention would be to subject them to licences, which would bring them under the control of the magistrate. At present, as the town is much less crowded than it was in 1792, the mischief arising from these houses is less; and until the committee can acquire the proper powers, it would perhaps be sufficient to be at the expense of whitewashing such places as shall be reported to be over-crowded, to prevail on some of the lodgers to remove, which may be readily done.

[1] 'Essays, Philosophical, Medical and Experimental.'

'2. The number of damp and very ill-ventilated cellars inhabited in many parts of the town is a most extensive and permanent evil. . . .

'This deplorable state of misery becomes frequently the origin, and certainly supports in a great degree the progress, of infectious fevers. I have been able in many instances to trace the infection from cellar to cellar, and to say where it might have been stopped by prudent management on the part of the infected family. . . .

'In like manner, I conceive that by building a fever ward in each of the infirmary districts, and removing into them the worst cases from the worst houses, the progress of infection would be materially checked, and a great quantity of disease and mortality would annually be prevented. . . .

'More frequent changes of apparel, which conduce to health as well as to luxury, might perhaps be procured to the poor, by encouraging the establishment of clothes-clubs, which some of them have begun to form among themselves. . . .

'What I now propose to the committee can be regarded but as a measure palliative of the most urgent evils, for the only method of furnishing the poor with healthy habitations, which should effectually stifle the germs of infection, would be that of erecting small houses, at the public expense, on the plan of barracks, or caserns, to be let at small rents or gratuitously, according to the circumstances of the persons applying. . . .

'The want of proper sewers in several of the streets and the offal of slaughter-houses left to putrefy before the doors in several places, are nuisances which deserve the serious attention of the committee.

'On the subject of the propagation of infection in cotton-mills, it may be necessary to observe, that although it has been supposed that fever may be imported in the cotton, and though this opinion does not seem improbable in itself, yet no direct proof of fevers originating from this source has ever been obtained. . . .

'The great difference in the healthiness of different cotton-mills, which it would be invidious to point out here, but which may be easily learnt from the lists of fever patients kept at the infirmary for the last five years, sufficiently proves the benefits of care respecting the circumstances I have mentioned, and the danger of inattention. . . .

'The practice of smoking tobacco has been sometimes recommended as a preventive of infection ; whatever may be the effect of the herb properly prepared, I am confident that the acrid, irritating composition used by working people is more likely to excite than to prevent disease ; and I am persuaded that I have seen complaints in the stomach and bowels repeatedly occasioned by its use. . . .

'The obvious extension of the cares of the committee to a superintendence of the morals of the poor, as intimately connected with the preservation of the health, comprehends a variety of most important objects which cannot be obtained without application to the Legislature of the country.'

Dr. Haygarth, of Chester, communicated his opinions to Dr. Percival. They were as follows :—

January 6, 1796.

'My dear Friend,—You desire me to communicate some observations on the best means of stopping the progress of the low fever at present very prevalent in Manchester and its neighbourhood.

'You may remember that in the Chester Infirmary we have, for the last twelve years, received all infectious fever patients that require our assistance into the fever wards, one for each sex, appropriated to this purpose.

'This institution arose from the speculations, which you know had engaged my attention, on the nature of contagion. Numerous facts having proved that a person liable to receive the small-pox was not infected by a patient in the distemper when placed at a very little distance, I next considered the nature of the contagion which produces putrid fevers; I soon discovered that their infectious atmosphere was limited to much narrower extent than even the small-pox. So manifestly I observed this to be the case, that in a clean, well-aired room of a moderate size, the contagious poison is so much diluted with fresh air, that it very rarely produces the distemper even in nurses exposed to all the putrid miasms of the breath, perspiration, fæces, &c. Whereas, in the close, dirty, and small rooms of the poor, the whole family generally catch the fever. Hence we may conclude, that in a well aired and clean apartment, the air is seldom so fully impregnated with the poison as to acquire an infectious quality.

'By taking out of a house the first person who sickens of a fever, we preserve the rest of the family from infection, together with an indefinite number of their neighbours, who would otherwise catch the infection. At this very time, when the inhabitants of Manchester, and many other places, are afflicted with a fatal contagious epidemic, only two patients are now in our fever wards, and both convalescent: and the apothecary to the infirmary, who attends the out poor of the whole city, informs me that he has now not a single fever patient under his care.'

'On these considerations, I ventured to propose the admission of typhus fevers into the attic storey on one side of our Infirmary, to be separated into two wards. From the experience of a dozen years I am warranted to maintain the safety of this measure, if conducted under very easy practicable regulations. During this period it never was suspected that infection has been communicated to a single patient in other parts of the house.

'Farther, I maintain that an establishment of this kind is indispensably necessary in all infirmaries, to preserve them from what is called the hospital fever. You may remember that I have collected a considerable number of cases to prove that typhous contagion, in some instances, remains in the body many days and even weeks, in a latent state, before the symptoms of fever commence. Patients, ill of other disorders, are admitted into the Infirmary from infectious houses, where they have caught the poison. The fever begins after their admission, and frequently infects others in the same ward;—when there is not a due attention to fresh air and cleanliness, or when several patients, thus previously infected, are admitted into the same ward. But in the Chester Infirmary every fever patient, as soon as observed, is immediately removed into the fever wards, so as to preserve all the rest of the house perfectly free from contagion.

'During this war, Chester has been unusually exposed to the danger of putrid infectious fevers. Many new raised regiments coming from Ireland, with numerous recruits, taken out of jails, remained in Chester for a few weeks, after their voyage. Great numbers of these soldiers, and their women, were ill of putrid fevers, and were immediately received into the fever wards of our infirmary. If such contagious patients had been distributed in the public-houses and poor lodging-houses through this city, the consequences to many of our inhabitants must have been dreadful.'

An *extract from a letter written by a Medical Student* in *Edinburgh*, whose name is not given, will also show the kind of advice given and the state of opinion in a prominent place.

'The establishment of fever wards has been opposed as if it were to give birth to a new evil, whilst it is obvious that we have only to inquire whether the baneful effects of a contagion that already exists will be augmented or lessened by the measures of the Board of Health, and our conclusion must be founded on a fair comparison of the present state of the diseased poor, as favourable or otherwise to the diffusion of febrile infection, with that which will be produced by their collection into a hospital.

'Contagious disorders, we all know, may be communicated either immediately by the effluvia surrounding the sick, or by fomites.[1] Now will either of these sources of disease be rendered more destructive than at present by the establishment of fever-wards ?

'To the active virulence of the first, circumstances could scarcely be more favourable than before the institution of the House of Recovery. Confinement of the exhalations from the sick, the great origin of all contagion, was an evil which in many of their dwellings that I have seen could not be remedied; and the foulness of the surrounding atmosphere gave additional malignity to their diseases, and strongly promoted the copious generation of this subtle poison.

[1] 'Fomites consist of the contagious matter from the bodies of the sick, accumulated and combined with the foul apparel, furniture, walls, &c.'

'It may be apprehended, however, that the collection of a number of fever patients within the narrow limits of a hospital will give rise to an accumulation of contagious matter, and form a centre from which it will be diffused amongst all who live in the immediate vicinity. But bad management alone can render your establishment such a nuisance; for, by proper ventilation, the effluvia from the sick may be removed before, by confinement, they augment so much in quantity or acquire such virulence, as to endanger the safety of the neighbourhood. That the sick do not suffer an aggravation of their maladies from being gathered together into a public receptacle, we have the testimony of Dr. Fordyce, who says expressly, that "in general more patients recover of fevers in the London hospitals than in private families, with similar practice."

'And the experience of the past winter in the clinical ward here clearly shows, that the wards of a hospital may be rendered harmless to all who enter them: for I am unable to recollect half a dozen who have caught the fever during their six months atttendance on the infirmary; and Dr. Duncan's memory does not furnish him with so large a number, notwithstanding his extensive and almost universal knowledge of the students. He assures me, also, that more pupils receive infection by acting as nurses to their sick friends, than directly from the patients in the hospital. Of those infected in the latter way, many are known to have suffered by imprudently hanging over the diseased, rather than from any necessary exposure.

'A better instance could hardly be adduced of the limited influence of contagion, than is presented by the Royal Infirmary of this place. Most of your medical men must remember that it stands in a fully inhabited part of the city, and that it is an asylum for those labouring under fever as well as under other diseases. Between the windows of the clinical ward, appropriated to the women, as well as a fever ward, and those of a neighbouring house, I am sure that thirty feet do not intervene, and a current of air must frequently be carried, when the wind is west, immediately through these wards, which have windows almost constantly open on each side, to this and other houses: yet no example, Dr. Duncan informs me, has been known, within his recollection, which extends many years back, of infection being conveyed to these houses; and he is certain, that in the family of Mr. Alexander Wood, who inhabits one of them, there has not been a fever of many years. He is equally ignorant of any harm having befallen passengers in the street, or the chairmen who convey patients labouring under all the stages of fever, in sedans belonging to the hospital, and lined in the usual manner, though the men employed are not confined to this business, but are called, as for other purposes, off the common stands. It would, doubtless, be prudent, however, to avoid in the construction of your chairs all such materials as are known longest to retain the matter of contagion.'

The quotations show how remarkably similar to the thoughts given to and extended by Manchester during the generation spoken of are the thoughts of the present, whilst misery is still unremoved. It is time that we learnt that it cannot be removed by the plans already tried; it seems to be our system or want of system, as well as the innate helplessness of men, which deposits dregs of humanity in our cities and unfortunately carries some good men among them. It requires to be proved that the system is inseparable from our nature.

The long struggle for a house of recovery resulted in success it is true, but the question in some new or wider form has risen again and again as population has increased, and we have not yet arrived visibly nearer to satisfaction, although we are probably much nearer. As it is curious to find that the old discussion last century in Manchester, 'Is the House of Recovery a nuisance?' rose but lately in London, so it is strange to find Lord Mansfield's opinion of a nuisance quoted in these Manchester reports, although still older, scarcely yet recognised. Speaking of an offensive smell, he is quoted as saying, 'It is not necessary that the smell should be unwholesome; it is enough if it renders the enjoyment of life and property uncomfortable,' and this meaning we are only arriving at, having it perverted by our determination to follow reasoning only which goes in narrow lines instead of the broad common sense which guides even animals very inferior to ourselves. Our subtle reasoning certainly drives us far wrong, when it neglects our instincts.

The mode in which sanitary ideas were recommended to be carried out is seen in the second volume of the Society's Memoirs, p. 501, and if we can greatly improve on it now I fear we have not done so. Yet there are some curious points, and especially the fumigation with tobacco, admired then by some of the medical men, which we can scarcely agree to.

The Medical Board advises nervous persons to be careful in entering cotton works or mills, or in visiting mines, caverns, stoves, hospitals, or prisons. Houses and works were smaller and more confined in those days, but there is at present far too much fear of the presence of close air for limited periods. People forget the meaning of its occasional use and its constant use. They will starve themselves in a railway carriage in order to avoid what they suppose to be analogous to fever, but they forget that close air may take years to injure whilst cold air draughts kill with a blow. We can all give illustrations of this in every family, but we are nevertheless driven on by wild enthusiasts that break our windows in cold nights and send us supperless to bed in the wind.

It is a little amusing to listen to Dr. Percival's complaint of 300 tons of coal being burnt every day in Manchester, or about 90,000 tons in a year. Now, surely we must burn 3,000,000 per annum, but what a result : still not in proportion to the amount, as we do burn with a little, not much less smoke. However, the fogs at certain seasons are now so frightful, that we may use words stronger than Percival's oreven John Evelyn's. There have been many plans formed of burning the carbon so as to prevent fogs in London and elsewhere. It is easy to prevent black smoke when machinery can be used ; the evil of fogs lies more in the sulphur than the smoke ; but again we may say that the black part of the smoke is not carbon merely, although there is carbon in it. We require to remove the sulphur before we obtain pure air or wholesome fogs, but the removal of the carbon is of course a great improvement. In the fifteenth and sixteenth reports of proceedings under the Alkali Act, mention was made of the enormous value of the ammonia alone obtainable from the 15,000,000 tons of coal made now into coke ; if the process said to be so successful at Bessèges should be found successful here, it would save ammonia enough to increase our crops by eight million pounds sterling in value. If we were to treat all the coal used in the country in the same way, we should have above six times as much ammonia, which would be capable of increasing our crops by fifty millions sterling of value. The proposal to burn gas and coke instead of coal has been a frequent subject of discussion; it may be difficult to treat all the coal so, but if coke can be manufactured as well by the Bessèges plan of distilling as by our non-distilling process, then the application to the fifteen million tons is certain, and it is well that some are trying it. But if we are amused at the anxieties of Dr. Percival, we may be more amused at some of our own cures and innumerable proposals. One is to buy land for parks to which the people may go and recreate themselves. A few people go into our parks, and it is well, but of the six hundred thousand in Manchester is there ever one per cent. in all the parks put together in the best weather and in the brightest season? The parks we want are such as allow the wind to blow around us during the day, and to supply us also during the night; for although we may not allow as much air to enter at night as during the day when we have fires, we want it to be good. We want the children to play before the doors in good air, and not to be taken once a month for an hour or two, or once a year at Whit-week, to see grass and to feel the pleasure of breathing the winds of heaven, instead of that which has swept the streets. Parks are good, but they must not be merely outside but inside a town. This, it is said, we cannot afford. You will afford it some day. *Delenda est Carthago.* An enormous part of Manchester and of all our great towns must come down before we have comfort. This cannot be done at once on account of the expense; we need not attempt to prophesy the method, but one way may occur, the people may go and leave the present crowded land in such numbers as to render it cheap enough to be made into parks, playgrounds, gardens, or still better into deserts. When Ancoats and Hulme are made into parks, some fresh air may pass through the town. This may happen from decay, since the sheds in which the people live do not stand long. Sanitary literature has been fashionable for a full generation, and the writer of this has read much of it, and finds that the amount of rubbish he has been obliged to pass through his mind is appalling. He has long sought to avoid the bewildering babble. Yet two or three of the million haystacks have a needle in them.

It was certainly interesting to the writer to inquire how far the members of the Society were acquainted with the laws of health, and it is hoped that it will be interesting to the Society, because this is the strongest point with which the intellectual and scientific life of Manchester began; but in the lifetime of a man it was all forgotten, and we soon forgot that we in Manchester had once been great 'sanitary' teachers. In 1843 a Royal Commission inquiring into the health of towns visited Manchester, and reported on its condition. The condition in which the town was found is one of the most melancholy proofs of that which many wise men have imagined—that the human race is really incurable. Within a moderate lifetime the voluntary commission spoken of had sat in Manchester, and the preface to the volume from which we have already quoted contains the following, which it is also of use to remember:—

'Painful to their feelings as were many of the productions in the controversy respecting the establishment of a

House of Recovery, they have now the satisfaction to reflect, that in discussing the theory of contagious diseases the minds of their fellow-townsmen were relieved from many fanciful and absurd prepossessions ; that the propriety and urgency of the measures proposed became more generally understood ; and that a more powerful interest was exerted for carrying them into effect than could have been expected, had their merit been, in the first instance, allowed to pass unquestioned. The success which attended the execution of this scheme, and the important benefits which have resulted from it, having excited in the metropolis, and several of the principal towns throughout Great Britain and Ireland, a very general desire to promote similar establishments, an unexpected demand was made for the papers contained in the present volume, copies of which in a detached state have been long unattainable.' (1805)

The following will also illustrate the state of knowledge in Lancashire, and opinions on the Manchester School of Medicine and Sanitary Knowledge. Dr. Campbell was one of those whose letters to Dr. Percival are preserved ; the following reminiscence of him by a townsman may take the place of his letter.

Remarks on an Epidemic of Typhus, which prevailed in the cotton districts of Lancashire, and was described by Dr. Campbell, of Lancaster, in the year 1785. *Read by Christopher Johnson, of Lancaster, at the meeting of certifying surgeons, Manchester, July* 14, 1869.

'Dr. Campbell, of Lancaster, published, in the year 1785, "Observations on the Typhus or Low Contagious Fever," in which he gave a description of an epidemic which prevailed during the two preceding years among the cotton-mills in various parts of Lancashire, and more especially at Lancaster and at Backbarrow near Ulverston.

'This fever seems to have been so malignant as to have given rise to a panic among the operatives and the people among whom they dwelt.

'It was believed that the cotton was poisonous. Dr. Campbell succeeded not only in proving to the public the groundlessness of this opinion, and that the business might be safely carried on by attention to certain sanitary regulations, but by his very judicious management he saved what would be even now considered a large proportion of lives.

'Of the treatment adopted, time will only allow me to say little. Believing the disease one of debility, he avoided the bleeding and lowering practice of the day, and employed a supporting method. He refrained from purgatives, and checked the least tendency to diarrhœa ; he gave wine liberally, and bark and opium. In fact his treatment was similar to that of Dr. Graves, thirty years ago, and of many good practitioners of the present day.

'Like Graves, he fed fevers, and he anticipated that distinguished physician in the use of musk and other antispasmodics, and in the administration of tartar emetic and opium.

'He made a close examination of the mills and of the habitations of the workpeople, and paid great attention to ventilation, fumigation, disinfection, and cleanliness.

'He found at Backbarrow privies contiguous to the workrooms emitting a very offensive odour. This he remedied by a very ingenious contrivance ; having wide pipes made, so that the excrementitious matter fell direct to the bottom, he turned through them a stream of water, which washed all away as it came.

'The following are the results of his treatment at Lancaster and Backbarrow:—Lancaster, 500 cases, 34 deaths; Backbarrow, 180 cases, 7 deaths. Taking the cases at both places, there were—

Men, 206,	of whom 25	died,	rather less than	1 in 8
Women, 235,	„ 13	„	„ „	1 in 19
Children, 225,	„ 3	„	„ „	1 in 80

Of these three cases of children two were doubtful.

'You will find on reference to an article by Dr. Gairdner, in the present number of "Braithwaite's Retrospect," that 9 per cent. deaths is much better than the average rate in London hospitals.

'About the same time he says—"A contagious fever prevailed in so great a degree at Radcliffe, in this county, and in the cotton-mills there, as to become the object of the attention of some very respectable gentlemen in their capacity as magistrates. As these mills or factories are now becoming numerous in the county, and individually employ great numbers of persons, any circumstances which may materially affect the health of those who are concerned in them are certainly matters of public concern."

'Every praise therefore is due to the magistrates, who, in consequence of the representations that were made to them, have taken such rational and effectual methods to prevent the production and propagation of these diseases, by procuring several gentlemen of eminence of the faculty from Manchester (Drs. Percival, Cowling, Eason, and Chorley) to inspect the places where the sickness was most frequent, and who have, at their request, arranged such directions as, if duly observed, cannot but be productive of the best effects, not only in the particular place for which they were originally drawn up, and in similar manufactories, but in every other situation where many persons are employed in common workrooms.'

The following is the report alluded to :—

'I. All the casements of the windows and the three large western doors of the cotton-mills should be left open every night ; the same regulations should take place during the recess from work at noon ; and as many casements should be kept open in the hours of labour as may be compatible with carrying on the operations of the machinery.

'II. The casements are too small, being in dimension only one-sixth part of the window. They are likewise placed high, and parallel to each other, a position obviously unfavourable to complete ventilation, for the inlet of the air ought to be lower than the outlet.

'III. Several fireplaces with open chimneys should be erected at proper distances in each workroom. The stoves now employed afford no sufficient passage for the offensive vapours generated in the rooms, and increase the contamination of the air by the effluvia which they emit. Turf would be the cheapest, and also a very salutary fuel, for it consists chiefly of the roots of vegetables, and yields in burning a strong, penetrating, and pungent smoke, which is likely to prove as good an antidote to contagion as that of wood is found to be by long experience.

'IV. The rooms should be daily swept, and the floors washed at least once every week with strong lime water, or with water strongly impregnated with the spirit of vitriol, or the acid of tar. The walls and ceilings may be scraped and whitewashed at first every month, and afterwards twice yearly. Lime fresh burnt and as soon as it is slaked must be used for this purpose, and the wash laid on whilst it is hot.

'V. During the prevalence of the present fever, the apartments should be fumigated with tobacco. Brimstone might, perhaps, be more powerful, but in burning it yields an acid which would be injurious to the cotton.

'VI. Great attention ought to be paid to the privies. They should be washed daily, and ventilated in such a manner that the smell arising from them shall not be perceptible in the workrooms.

'VII. The rancid oil which is employed in the machinery is a copious source of putrid effluvia. We apprehend that a purer oil would be much less unwholesome, and that the additional expense of it would be fully compensated by its superior power in diminishing friction.

'VIII. A strict observance of cleanliness should be enjoined on all who work in mills, as an efficacious means of preventing contagion, and of preserving health. It may also be advisable to bathe the children occasionally. The apparel of those that are infected with the present fever should be well fumigated before it is worn again, and the linen, &c., of the sick should first be washed in cold water, lest the steam arising from the heat communicate the distemper to the person engaged in that operation. Croster's lye, when it can be procured, is preferable to water. The bodies of those who die of the fever should be closely wrapped in pitched cloth, and interred as soon as propriety or decency will permit. Smoking tobacco will be a useful preservative to superintendents of the works, and to others exposed to infection who can practise it with convenience.

'IX. We earnestly recommend a longer recess from labour at noon, and a more early dismission from it in the evening to all who work in the cotton-mills. But we deem this indulgence essential to the present health and future capacity for labour of those who are under the age of fourteen. For the active recreations of childhood and youth are necessary to the growth, the vigour, and the right conformation of the human body. And we cannot excuse ourselves on the present occasion from suggesting to you, who are the guardians of the public weal, this very important consideration: that the rising generation shall not be debarred from all opportunities of instruction at the only season of life in which they can be properly improved.'

The remark as to bathing the children occasionally sounds as if it had been entirely neglected; and even the Doctor was not fully alive to its importance.

Mr. Johnson here remarks:—

'Had these men omitted the concluding paragraph from their report, we should even then have considered they had done the State good service, and conferred a benefit on the cotton trade at a critical period of its existence. Its insertion gives no ordinary value to their work; the document assumes a prophetic character, its authors seem to gaze into the far future, and to realise the times in which we now live.

'Here we have the bold outline of a complete Factory Act, the necessity for legislation demonstrated, the direction and the extent clearly defined.

'"Brave men lived before Agamemnon," and brave and true men laboured in our profession for the best interests both of rich and poor, long before the names of Oastler or Ashley were heard amongst us.'

Thus we see that in 1796 Manchester claimed to be, and was acknowledged to be, a teacher of the nation on sanitary subjects, whilst at least one of the medical men whose treatises or remarks are contained in the volume of Transactions and proposals was active in mind when the Commission came in 1843 with Mr. Edwin Chadwick and Dr. Lyon Playfair, although he had retired from practice. We find a short paper by him on the employment of children especially during the night, and the want of attention in cotton-mills to ventilation and cleanliness. This was Dr. Bardsley, a very prominent figure in Manchester as he had been in 1796, a man with manners refined and elegant, having a memory of the earlier times, and reflecting favourably but without vigour its principles, habits and speech.

At both these periods Dr. Samuel Argent Bardsley was put on committees of inquiry. He must be remembered by not a few persons besides those who knew him in private, as a frequenter of very agreeable meetings, lectures, and discussions which used to take place in the Royal Institution. In 1843 science had begun to be more widely spread than it had been, and the men interested in it could meet more easily than now, partly because there were not so many living out of reach, and chiefly because dinners of an expensive kind did not attract so many. These latter amusements have done much harm in destroying the calm reading evenings of scientific men in England and elsewhere, since people frequently feel obliged or inclined to give up or hurry their work for their pleasure, and sometimes, like the famous broomseller, incline to steal it ready made. Dr. Bardsley showed his connection with the past in his appearance ; he was, so far as the writer knows, the last of those here who powdered their hair. He had but little to powder, and the white dust flowed over his shoulders and his dress, but it improved the appearance of a man of his years, as it gave a completeness to the whiteness and covered what imperfections might exist in the complexion of the head. His manners were exceedingly pleasing, easy, but formal; recalling the past and contrasting with the present hurry of business. He took us to the time of Percival, who again took us to the times of the old régime of France, a time when appearances were beautiful, however deceitful. Dr. Bardsley lived in later life in a house on Ardwick Green, at the north corner of Brunswick Street. He liked to recall old days, and to look also at new science, but especially to speak of all he remembered. Sir James Lomax Bardsley, M.D., was his nephew, and till lately active among us.

The sanitary episode, a very important one in Manchester, has come in as a part of the life of Dr. Percival who began it. It is not our intention to give minute details of any life. We wish only to touch upon them lightly, and to show their connection with the Society. We shall meet the founder again when giving a short account of his paper on the perceptive power of vegetables, but we cannot leave this more formal attention to him without a renewed expression of a full belief, that Manchester had in him a wise and good man, who had a broad view of his duties and a true love of his fellow-creatures.

And whilst he saw the greatness and oneness of Creation in the present he was not narrowed even to that, but hid in his heart a large sympathy with the past and hope for the future. He was not a man who need be asked if he believed in God, because he lived so much and closely with Him that belief was not the term that could express the intimate faith and love.

Mr. Grindon informs us that:—

'Dr. Percival's town house was in King Street. His country seat was Hart Hill, in the Eccles Old Road, nearly opposite Claremont. It was then an old-fashioned white stuccoed house. The existing pseudo-classical mansion is comparatively new. Dr. Percival was one of the only three gentlemen in the community at the period in question who kept a private carriage.'—*From 'Manchester Banks and Bankers,' by Leo H. Grindon.*

The family name Percival has left, but as a Christian name it is found in Sir Percival Heywood, whose grandfather married a daughter of Dr. Percival. In our Society we have kept it in our memory by a marble tablet behind the President's chair. Lately this has been covered by a portrait in oil taken from a miniature, and presented as said by Mr. F. Nicholson.

NOTE.—As it is not intended to return to the sanitary epoch if we can avoid it, we may say here that another movement is not well known to have begun in Manchester, namely, the use of carbolic acid in curing wounds. Mr. Alex. McDougall, when beginning the manufacture of disinfecting powder, used to have many people coming to him with wounds, and reported to the writer numerous cases of marvellously quick healing. We do not think that he ever published an account of the circumstances.

Mr. McDougall was once desirous of forming a sanitary society. Every man was to have his house examined at suitable times. He wished the writer of this to put it in motion; but it first required a man to rouse the public and make a commotion, and the invitation was declined. The public mind, too, was not then prepared as it is now; but it is well to remember that these ideas existed in 1852. The general introduction of carbolic acid and carbolates, in which the writer moved, is not included here.

The value of a smelling gas being driven into sewers as a test, was also found by Mr. McDougall in his valuable but little noticed experiment of disinfecting the sewage in Tottenham Court Road, when the smell of the carbolic acid was perceived in most of the houses, if not all, down to the Thames. Prof. Allen Miller then said, 'What a startling thing this is ; people complain of breathing poison, and murmur against the antidote.' This was in 1859 and 1860. Like many other things, it required to be redis covered. The whole experience with carbolic acid was wider than it is now, that is, it had more applications in the minds or imaginations of Mr. McDougall and his colleagues.

CHAPTER VI.

MEMOIRS OF THE SOCIETY.

THE first volume of the Society's memoirs was published in 1785, and was dedicated by permission 'To the King,' 'with peculiar gratitude for his gracious patronage of the first fruits of their Institution;' no other mention is made of royal acknowledgments of the Society.

This permission was obtained through the good offices of Mr. Pitt, to whom the Society sent appropriate thanks, as the minutes show. The volumes of the Society have not contained an account of the proceedings until of later years. This portion of the work of a society is often of great interest, and ought not to be neglected.

It is proposed to look over the volumes, especially the earlier ones, and to extract whatever may seem characteristic of the men and the time—partly showing the best or most interesting papers. This may be mixed up with some biographical details; an exact separation of these departments is not essential, or rather is to be avoided.

The early papers were copied by the secretary into volumes, and these are not all printed. The council, which was then called the 'committee of papers,' made its choice.

Not much has yet been found concerning Mr. James

Massey, who was the first President of the Society, and stood alone according to the MS. books of the Society, although in the first list printed by the Society he is put along with Dr. Percival. In the MS. journal the first presidents are Dr. Mainwaring, and James Massey, Esq.

In the 'Memorials of St. Ann's Church, by the Rev. Charles Wareing Bardsley, M.A.,' it is said, p. 93, that the Manchester Literary and Philosophical was founded chiefly through the exertions of the Rev. Samuel Hall, a very popular minister, and curate of St. Ann's, and afterwards first rector of St. Peter's, for whom especially we may say that church was built. This clergyman was an active man, and may have helped to bring the founders of the Society to a decision, but it has not appeared that there is anything to cause a change in the account of the source of the spirit which ruled in the Society, and Mr. Hall himself was not one of the original members, but was elected on April 11.

First and Second Meetings of the Society, from the 'Journal.'

Officers, February 28, 1781.

Peter Mainwaring, M.D. James Massey, Esq.	*Presidents.*
Mr. Thomas Henry, F.R.S. Mr. George Bew	*Secretaries.*

First Meeting, March 14, 1781.

Present—Dr. Mainwaring, James Massey, Esq., Dr. Wright, Dr. Eason, Dr. Bell, Mr. Charles Wright, Mr. William White, Mr. Richard Hall, Mr. Uniach, Dr. Drinkwater, Mr. Polier, Mr. Henry.

Read an account of the Harmattan, by Dr. Dobson.

The second meeting was on March 21, 1781.

Present—James Massey, Esq., Dr. Percival, Dr. Eason, Dr. Bell, Mr. Edmund Hall, Mr. Richard Hall, Mr. Foxley, Mr. Reid, Mr. Oldham, Mr. Thomas, Mr. William White, Capt Robertson, Mr. John Massey, Mr. Uniach, Mr. Henry.

This list is given in order to show those who took the first active interest. Mr. James and Mr. John Massey are both here; they were among the most public-spirited of the population, as is shown by their benevolence and their munificence.

The two meetings mentioned were attended by men who were not afterwards proposed as candidates, and must be considered originators, although not attending the first meeting; also by Mr. Uniach, who does not seem to have become a member. They belong however to the originators, and he who brought them together it is believed was Dr. Percival, although he was not in an active condition at the time, and did not attend the first seven meetings, and was not first President.

On May 2, 1781, Dr. Percival and the Rev. Thomas Barnes, Thomas Butterworth Bayley, Esq., and Dr. Eason were elected Vice-Presidents.

DR. BELL ON ANIMAL HEAT.

The first paper published by the Society was read on May 16, 1781, by George Bell, M.D., and was simply called 'Some Remarks on the Opinion that the Animal Body possesses the Power of Generating Cold.' We are informed in the 65th vol. of the 'Philosophical Transactions, Royal Society,' that Dr. Fordyce and other gentlemen went into a room the air of which was heated to a degree far above that of the human blood; although they remained there sometimes for the space of half an hour, yet the heat of their bodies was not increased by more than three or four degrees.

It is interesting to find that Dr. Bell, in criticising this paper, struck a right key, and gave a good tone to the young society. He says, 'We are compelled to refuse credit to the assertion even of Dr. Fordyce, that there was no evaporation. The evaporation must have been great, and would diminish the effect of the external heat by surrounding the surface with a cool atmosphere.' It is true that Dr. Bell says that 'the cause of animal heat remains unknown,' and he is not fully aware of the great amount of heat carried off by the evaporating water, still his mode of reasoning is sound.

We see that, unable as he confesses himself to solve the whole problem, he succeeds in guiding out of the way of error, and as we may say, criticising with some vigour a publication sanctioned by the Royal Society.

The action of oxygen was only beginning to be understood, and its name was not familiar to chemists; heat was still a substance however subtle and strange, and phlogiston was a component part of metals, for some years after this, even to the mind of Cavendish. Notwithstanding this belief Priestley and Lavoisier were Honorary Members of the Society, and the former had in 1775 discovered oxygen, calling it pure or dephlogisticated air.

Such a subject as heat was a fine key-note for the Society. The tune that followed has been played well, and the mechanical theory of heat has been developed by one of our still living members, and begun to change the face of the world by penetrating into most of its science and into all of its mechanics. Enough for a Society if it had done nothing else.

'The child is father of the man,' a familiar quotation illustrated by knowing that the first paper is connected with the honours which have been brought to our Society in its later years ; and as Dalton made the first remarkable discoveries capable of making chemistry a science, so we find his great theories connected in an unforeseen manner by Joule, giving us the mechanical and chemical equivalent of heat, as a circle of completeness to the chief work of this our first century of existence.

ADDRESS TO THE SOCIETY BY THOMAS HENRY, F.R.S.[1]

Among the first members of the Society was Thomas Henry, one of the Secretaries, already made a Fellow of the Royal Society ; he shows to our mind the firmest hand in guiding the Institution, after it was begun, and the clearest view of the methods of research. He begins with an essay which one would think to be scarcely needed among such men as constituted the meetings, although it was of a kind not uncommon in these early days ; it is 'On the Advantages of Literature and Philosophy in general,' but it is a fitting address to a new society from one of its principal officers. Such essays were interesting to the Society, even when they only fluttered around truth without seeing much of it. But in him we have no merely sentimental love of science, literature, or philosophy, although such a love we by no means object to. The essay was written with a clear desire to draw the minds of the commercial class to the consideration of studies which might at first appear

[1] *Science and Taste*, vol. i. p. 7.

foreign to their interests, but were in reality closely related. And how long it was before a School of Art was erected in Manchester, and this ultimately by pressure from outside! Only in this year 1881 has Manchester been able to obtain a separate building for it.

Mr. Henry admires science, history, and the useful arts, and he admires the 'polite arts' because it is supereminent taste that has distinguished the productions of a Wedgwood and a Bentley above all their competitors in the same line of business. Such a taste would doubtless be equally beneficial to the manufacturer of the fine cotton and silk goods of Manchester, &c. (Vol. i. p. 28.)

On the advantages of Literature and Philosophy in general, and especially on the consistency of Literary and Philosophical with Commercial Pursuits. By Thomas Henry, F.R.S. Read October 3, 1781.

We quote only from the latter portion :—

. . . .

'The sciences of Natural History and Botany require so much time to be devoted to the study of them, and such minute investigation, that, however pleasing, they may be justly considered as improper objects for the man of business to pursue scientifically, so as to enter into the exact arrangement and classification of the different bodies of the animal, vegetable, and mineral kingdoms. But reading and personal observation will supply him with ample matter for reflection and admiration.

'But several branches of Natural Philosophy seem peculiarly adapted to fill up the vacant hours in which the tradesman can withdraw from his employments. A general knowledge of all will tend to open and enlarge his understanding, at the same time that it affords him the most rational amusement; whilst the study of some, in particular, may not only tend to effect these desirable purposes, but supply him with a kind of information which may turn to good account, by furnishing him with the means of extending his commercial concerns, and conducting them to greater advantage; of improving those manufactures in which he is already engaged, or inventing new fabrics, which may give additional life and spirit to trade.

'As Pneumatics, or the doctrine of the nature and properties of air, display an ample field of investigation to the philosopher, so will they also supply to the more superficial inquirer much instruction and entertainment. Every man is interested in the properties of a fluid to which he is so intimately related, and without which he cannot subsist a moment. Its various degrees of gravity, elasticity, heat, moisture, and purity, all affect the human race. Many of the most dire diseases which affect mankind are occasioned by noxious impregnations of the atmosphere, or cured by more favourable states of it. And many of the operations of nature and art are essentially influenced by the changes which are continually occurring in it.

'Philosophy has lately made most rapid advances in discovering the constitution of common air. The ingenious Dr. Priestley has even taught us the art of fabricating it artificially, of producing it in a degree of purity far exceeding that of the most salubrious climate, and of reducing it to the state in which we commonly breathe it when debased by exhalations from the various bodies which it surrounds. From him we have also learned a mode of judging of the different degrees of purity in air, by means of the eudiometer, as of its gravity and heat by the barometer and thermometer. This excellent philosopher, to whom, as a learned foreigner has observed, "Nature takes delight in revealing her secrets," has also first discovered, and Dr. Ingenhouse, treading in his paths, has more completely demonstrated the method by which Nature makes use of the leaves of vegetables to purify the atmosphere, when contaminated with putrid or phlogistic vapours. When in this state, every leaf acts as a strainer to the air, imbibing and applying to the nurture of the plant such parts as are unfit for animal respiration, and throwing it out again, thus filtered and suited to act again as a menstruum for the phlogiston, which is continually evolving by the breathing of animals, the corruption of vegetables, and by the many various processes which are by nature and by art continually carrying on.

'Electricity is another branch of science which has afforded great light to the operations of nature. A knowledge of its leading principles, and a dexterity in making a number of entertaining experiments, may be attained by moderate application, and thereby a field of amusement opened to the mind, at an easy expense of time and money.

'To obtain a perfect acquaintance with the science of optics, much attention and close application would be requisite. Such a knowledge of it, however, as is sufficient for general purposes, is easily arrived at. The nature of the reflection and refraction of the rays of light, of vision, and of colours, the properties of lenses, are useful and entertaining objects of inquiry. But the very minute divisibility of the rays of light fills the mind with astonishment. When we are informed that there proceeds more than 6,000,000,000,000 times as many particles of light from a candle, in a second of time, as the whole earth contains grains of sand, supposing each cubic inch of it to contain 1,000,000; when we are told that light, in its passage from the sun to the earth, moves with the immense velocity of 95,173,000 miles in seven minutes and a half, we are impressed with the most profound veneration for that Almighty Being, who has so wisely adjusted the proportions between the bulk and velocity of these rays as to make them answer all His benevolent intentions to mankind; whereas, an increase or decrease in the one or the other might have been fatal to the animal and vegetable world.

'By the telescope and microscope our eye is enabled to reach far beyond the limits of our natural vision. By the former, objects at considerable distances are brought, as it were, within our grasp, and we can soar upwards into other worlds. By the latter, we are empowered to search into the minutiæ of nature, to admire the delicacy of her operations, and the wonders of creation, exhibited in the perfect fabrics of the smallest animals and plants.

. . . .

'Nor is the utility of chemistry more confined, or less connected with manufactures than mechanics. Indeed chemistry may be, not improperly, called the corner-stone of the arts. They not only are supported by her, but many of them derive their very existence from this source. She even furnishes instruments to every one of the branches of natural philosophy we have enumerated. The truth of this proposition will be evinced, when it is considered that metals cannot be separated from their ores, nor glass produced without her aid. She supplies the astronomer with his lenses, and the mathematician with his instruments. The air-pump, electrical, hydrostatical and hydraulic machines cannot be constructed without her intervention ; and scarcely a piece of mechanism is formed to which she does not contribute something.

'In the finer arts the influence of chemistry is very conspicuous. To her the painter owes most of those colours by which he is enabled to give the resemblances of distinguished personages to the inquiring eye of a grateful posterity ; to place before their view more clearly than words can express the martial deeds of the hero, and the firm virtue of the patriot ; and to represent those beauteous scenes of nature, to the description of which language is inadequate. Without chemistry, the fine colouring of a Titian could never have delighted the enraptured beholder. Nay, even the works of the philosopher, the historian, and the poet, are indebted to her for their diffusion and permanency.

'To show the advantages arising from this science in all the arts through which they might be traced, would carry me far beyond the limits of my present design. It may be sufficient to point out the connection which subsists between chemistry and those manufactures which are the pride and glory of this respectable commercial town.

'Bleaching is a chemical operation. The end of it is to abstract the oily and phlogistic parts from the yarn or cloth, whereby it is rendered more fit for acquiring a greater degree of whiteness, and absorbing the particles of any colouring materials to which it may be exposed.

'The materials for this process are also the creatures of chemistry, and some degree of chemical knowledge is requisite to enable the operator to judge of their goodness

Quick-lime is prepared by a chemical process. Potash is a product of the same art, to which also vitriolic and all the acids owe their existence. The manufacture of soap is also a branch of this science. All the operations of the whitster, the steeping, washing, and boiling in alkaline lixiviums, exposing to the sun's light, scouring, rubbing, and blueing, are chemical operations, or founded on chemical principles. The same may be said of the arts of dyeing and printing, by which those beautiful colours are impressed on cloths, which have contributed so largely to the extension of the manufactures of this place. How few of the workmen employed in them possess the least knowledge of the science to which their profession owes its origin and support? If random chance has stumbled on so many improvements, what might industry and experience have effected, when guided by elementary knowledge? The misfortune is that few dyers are chemists, and few chemists dyers. Practical knowledge should be united to theory, in order to produce the most beneficial discoveries. The chemist is often prevented from availing himself of the result of his experiments by the want of opportunities of repeating them at large; and the workman generally looks down with contempt on any proposals the subject of which is new to him. Yet under all these disadvantages, I believe it will be confessed, that the arts of dyeing and printing owe much of their recent progress to the improvements of men who have made chemistry their study. Much, however, remains to be done; and, perhaps, in no respect are the manufactures of this country more defective than in the permanency of their colours. Sensible as our manufacturers are of this defect, is it not strange that so few of them should attempt to acquire a knowledge of those principles which would most probably supply them with the means of improving and fixing their dyes?

'A taste for the Polite Arts, especially those of drawing and design, should appear a desirable acquisition to the manufacturer of the finer and more elegant wares. If not possessed of this, he is always dependent on others for the patterns of his fabrics. Whereas, were he capable of inventing them himself, he would possess considerable advantages over his less accomplished neighbours. His imagination would continually supply him with something new; and of what importance novelty is, in these times of fashion and fancy, every day's experience furnishes convincing proofs. It is this supereminent taste that has distinguished the productions of a Wedgwood and a Bentley above all their competitors in the same line of business. Such a taste would doubtless be equally beneficial to the manufacturer of the fine cotton and silk goods of Manchester, and he would be enabled to equal in elegance of pattern, as he excels in strength of fabric, the manufactures of our neighbouring and inimical rivals.'

Dr. Barnes on the Affinity subsisting between the Arts.[1]

'So great is the analogy between the several arts, that no man knows to what extent the improvement of any single art may affect others, even where the relation, at first sight, appears most distant. Who would have imagined that the discovery of the properties of the magnetic needle would have had such amazing, and almost infinite effects? That by this property alone navigation should become so astonishingly extended, new

[1] Vol. i. p. 72.

continents be discovered, and a new era opened, in the history of the globe! I was, a few days ago, greatly pleased with tracing the progress of an invention into several branches of art, with which, at first, it appeared not to have the remotest affinity. I refer to the cylinder, covered with wire-cloth of different fineness, originally intended only for sifting flour, meal, and bran, immediately as they come from the millstone. For this ingenious invention, Mr. Mills got a patent, the term of which is now, probably, expired; for the person who showed it me, informed me, that he had himself applied the cylinder, with little variation, in sifting gunpowder, snuff, tanner's bark, and sand.'

The Rev. Samuel Hall, M.A., writes of 'An Attempt to show that a Taste for the Beauties of Nature and the Fine Arts has no Influence favourable to Morals.' This is in reply to a paper read by Dr. Percival to the Society, and published among his works. *See* p. 94.

LIFE IN NORTHERN LATITUDES.

The paper by Dr. Aikin on this subject might have been written for the present time. The advantage of fresh meat has been appreciated, but it has also been neglected without any good reason. Whether alcohol assists in developing scurvy has not been brought out fully so far as the writer knows. The mode of obtaining a steady temperature and even comparative warmth by burrowing underground is a good if not always a practicable plan.

Remarks on the different success, with respect to Health, of some Attempts to Pass the Winter in high Northern Latitudes. By John Aikin, M.D. Read January 16, 1782.[1]

We extract the following (p. 90) :—

'Towards the beginning of the last century, several voyages of discovery were made in the Northern Seas ; and the Greenland whale fishery began to be pursued with ardour by various European nations. These two circumstances have given rise to various instances of wintering in the dreary and desolate lands of high Northern latitudes ; and the surprising difference of success attending these attempts must strike every reader.

'The first remarkable relation of this kind that I have found, is that of the wintering of Captain Monck, a Dane, in Hudson's Bay, latitude 63° 20′. He had been sent on a voyage of discovery with two ships, well provided with necessaries, the crews of which amounted to sixty-four persons. The ships being locked up in the ice, they landed, and erected huts for passing the winter, which they occupied in September, 1619. At the beginning of their abode here, they got abundance of wild-fowl, and some other fresh provision ; but the cold soon became so intense that nothing further was to be procured abroad, and they were obliged to take to their ship-stores. The severity of the cold may be conceived from their seeing ice three hundred and sixty feet thick, and from their beer, wine, and brandy being all frozen to the very centre. The people soon began to be sickly, and their sickness increased with the cold. Some were affected by gripes and looseness, which

[1] Vol. i. p. 89.

continued till they died. At the approach of spring, they were all highly scorbutic, and their mouths were so extremely sore, that they were unable to eat anything but bread soaked in water. At last, their bread was exhausted, and the few survivors chiefly subsisted on a kind of berry dug out from beneath the snow. When the spring was far advanced, no fresh vegetables could yet be found. In June, the captain crawled out of his hut, and found the whole company reduced to two men besides himself. These melancholy relics supported themselves in the best manner they were able, and recovered their strength by feeding on a certain root they discovered, and some game caught in hunting. At length they embarked in the smaller ship, and after undergoing numberless dangers and hardships, returned home in safety.

'In the year 1633 two trials were made by the Dutch of establishing wintering-places at their northern fisheries; the one at Spitzbergen, the other on the coast of Greenland, in latitudes about 77° or 78°. Seven sailors were left at each, amply furnished with every article of clothing, provision, and utensils thought necessary or useful in such a situation. The journals of both companies are preserved.

'That of the men in Greenland takes notice, that on September 18th the allowance of brandy began to be served out to each person. On October 9th they began to make a constant fire to sit by. About this time, it is remarked that they experienced a considerable change in their bodies, with giddiness in their heads. They now and then killed a bear; but their common diet was salt meat. In March they were all very ill of the scurvy; and on April 16th the first man died, and all the rest were entirely disabled, but one person. This poor wretch continued the journal to the last day of April, when they were praying for a speedy release from their miseries. They were all found dead.

'The journal of those who were left at Spitzbergen recites, that they sought in vain for green herbs, bears and foxes in that desolate region, and killed no other game than one fox the whole time. The scurvy appeared among them as early as November 24, and the first man died January 14th. The journal ends February 26th; and these too were all found dead. . . .

'On the same side of Spitzbergen, between latitude 77° and 78°, a boat's crew, belonging to a Greenland ship, consisting of eight Englishmen, who had been sent ashore to kill deer, were left behind, in consequence of some mistake, and reduced to the deplorable necessity of wintering in that dreadful country, totally unprovided with every necessary. . . .

'The melancholy of their situation was aggravated by the absence of the sun from the horizon from October 14 to February 3, of which period twenty days were passed in total darkness, except the light of lamps, which they contrived to keep continually burning. With all this, it does not appear that any of them were affected with the scurvy, or any other disorder; and the degree of weakness, which seems implied by the mention of their recovering strength in the spring, may be sufficiently accounted for merely from their short allowance of nutritious food. At the return of the ship on May 25 they all appear to have been in health; and all of them returned in safety to their native country. . . .

'In the year 1743, a Russian ship of East Spitzbergen, in latitude between 77° and 78°, was so enclosed with ice, that the crew, apprehensive of being obliged to winter there, sent four of their men in a boat to seek for a hut, which they knew to have been erected near that coast. The hut was discovered; but the men, on returning to the shore, found all the ice cleared away, and the ship no longer to be seen; and indeed it was never more heard of (p. 97).

'The flesh they eat almost raw, and without salt; using by way of bread to it, other flesh dried hard in the smoke. Their drink was running water in the summer, and melted ice and snow in the winter. Their preservatives against the scurvy were, swallowing raw frozen meat broken into bits, drinking the warm blood of reindeer just killed, eating scurvy-grass, when they could meet with it, and using much exercise. By these means three of them remained entirely free from this disease during the whole of their abode. The fourth died of it after lingering on to the sixth year.

'In a note to the account of the four Russians, it is said, "Counsellor Müller says, the Russians about Archangel should be imitated; some of whom every year winter in Nova Zembla without ever contracting the scurvy. They follow the example of the Samoides, by frequently drinking the warm blood of reindeer just killed. The hunting of these animals requires continual exercise. None ever keep their huts during the day, unless the stormy weather, or too great quantity of snow, hinders them from taking their usual exercise."

'In a manuscript French account of the islands lying between Kamtschatka and America, drawn up by that eminent naturalist and geographer, Mr. Pallas, I find it mentioned that 'the Russians in their hunting voyages to these islands (an expedition generally lasting three years), in order to save expense and room in purchasing and stowing vegetable provision, compose half their crews of natives of Kamtschatka, because these people are able to preserve themselves from the scurvy with animal food only, by abstaining from the use of salt.'

'Lastly, in the excellent oration of Linnæus, on the advantages of travelling in one's own country, printed in the third volume of the Amænitates Academicæ, it is asserted "that the Laplanders live without corn and wine, without salt and every kind of artificial liquor, on water and flesh alone, and food prepared from them; and yet are entirely free from the scurvy."[1]

'When we compare the histories above recited, it is impossible not to be immediately struck with these leading circumstances, that those in whom the scurvy raged fed upon salt provisions, and drank spirituous liquors; whereas those who escaped it, fed upon fresh animal food, or at least preserved without salt, and drank water. . . .

'On the other hand it seems to be a fact, that several of the Northern nations, whose diet is extremely putrid (as before hinted with respect to the people of Kamtschatka), are able to preserve themselves from the scurvy; therefore, putrid aliments alone will not necessarily induce it. On the whole, on an attentive consideration of the facts which have been recited, some of which are upon a pretty extensive scale, I cannot but adopt the opinion that the use of sea-salt is a very principal cause of the scurvy, and that a

[1] 'In Lapplandiâ observabit homines absque Cerere et Baccho, absque sale et potu omni artificiali, aquâ tantum et carne, et quæ ab his præparantur, contentos vivere.

'Quare Norlandi, ut plurimum, scorbuto sint infecti; et cur Lappones, contra, hujus morbi prorsus expertes?'

total abstinence from it is one of the most important means for preventing this disease. . . .

'In what precise manner these substances (viz., the fat and oil of fish and marine animals) act, is not perhaps easily explained ; but as the use of them would, doubtless, cause an accumulation of similar parts in the body, and as we find all animals destined to endure the severe cold of the arctic climates are copiously furnished with fat, we may conclude that it possesses some peculiar efficacy in defending from the impressions of cold. . . .

'Writers on the scurvy seem almost unanimously to consider a portion of these liquors as a useful addition to the diet of persons exposed to the causes of this disease ; and due deference ought certainly to be paid to their knowledge and experience : but, convinced as I am that art never made so fatal a present to mankind as the invention of distilling spirituous liquors, and that they are seldom or never a necessary, but almost always a pernicious article in the diet of men in health, I cannot but look with peculiar satisfaction on the confirmation this opinion receives by the events in these narratives. . . .

'We have acquired, by association, the idea of opposing actual cold by matters potentially or metaphorically hot ; but this in great measure is a fallacious notion. On the contrary, it is found that the effects of excessive heat are best resisted by warm and acrid substances, such as the spicy and aromatic vegetables which the hot climates most abundantly produce, and which are so much used in the diet of the inhabitants. And if it be admitted as a general law of nature, that every country yields the products best adapted to the health and sustenance of its inhabitants, we should conclude that aromatic vegetables and fermented liquors are peculiarly appropriate to the warmer climates; while bland, oily animal matters are rather designed for the use of the frigid regions. . . .

'Another extremely pernicious effect of these liquors, is the indolence and stupidity they occasion, rendering men inattentive to their own preservation, and unwilling to use those exertions, which are so peculiarly necessary in situations like those described in the foregoing narratives. And this leads me to the consideration of a third important head, that of exercise. . . .

'The two companies of Dutchmen seem to have done little during their melancholy abode but drink brandy and smoke tobacco over their fires. On the other hand, Captain James' men were very sufficiently employed in the laborious task of building their pinnace, which, notwithstanding their weak and sickly state, they had nearly completed before they found the work unnecessary. . . .

'But it is to be remarked, that in these instances, what I consider as the most powerful cause of the scurvy, the use of salted provisions, did not exist; and therefore less powerful preservatives would be necessary. . . .

'And the advantage of subterraneous lodgings is proved by the well-known fact of the unchanging temperature of the air at certain depths beneath the surface.

We turn now to a very different subject.

An attempt to show that a Taste for the Beauties of Nature and the Fine Arts has no influence favourable to Morals. By the Rev. Samuel Hall, A.M. Read May 15, 1782,[1]

and extract the following :—

. . . .

'The very ingenious author of the "Elements of Criticism" tells us, that there is a strong and close affinity between taste and the moral sense. "Taste," says he, "in the fine arts goes hand in hand with the moral sense, to which indeed it is nearly allied."[2] . . .

'"It is a remarkable circumstance," says Brown in his "Essay on the Characteristics," that, "in the decline of both the Greek and Roman States, when religion had lost its credit and efficacy, this very taste, this species of philosophy, usurped its place, and became the common study and amusement both of the vile and vulgar" (p. 230). . . .

'But we are further told, "that a taste for the beautiful scenes of nature, not only composes and harmonises the temper, but disposes the mind to acts of piety and devotion, by raising our ideas from nature to nature's God."[3] The thought is pleasing and ingenious, but must not be admitted without many exceptions (p. 233). . . .

'A taste for elegance was so universally diffused among all ranks of people (in Athens) that even a herb-woman, we are told, could detect a very small deviation from propriety of speech.[4] Taste could not possibly have a fairer field wherein to display its natural effects. But the history[5] of these times and the moral lectures of Socrates sufficiently evince, that the Athenians were a people

[1] Vol. i. p. 226. [2] *Elem. Crit.* Introduc., p. 7.
[3] Percival on a *Taste for the Beauties of Nature.*
[4] *Xenoph. Memorab., passim.* [5] Rollin's *Ancient History*, vol. iv.

addicted to every kind of sensual pleasure, at once refined and voluptuous, licentious and effeminate (p. 236). . . .

'"If," says Lord Orrery, in his letters from Italy, "you take a view of the princes of the Medici in a group, you will feel reverence and respect at one part of the picture, and be struck with horror and amazement at the remainder. To revere and honour them you must consider their generosity, their benefactions to men of learning, their policy, and scientific institutions. To view them with horror and amazement, you need only listen to the undoubted outrages of their private lives; by which you will be convinced, that few or none of the whole race were endued with the softer passions of the human soul. I wish that in many of their group their love was not lust; their good nature, ostentation; their dignity, pride; and their sense, cunning." . . .

'I wish only to disprove the affirmative of the proposition, and show that taste cannot reasonably be considered as a moral principle of action: that, unassisted by reason and good sense, it becomes subservient to the purposes of folly and extravagance; and that, connected with a base and sensual heart, it unhappily serves to embellish guilt and gloss over the deformity of vice (p. 238). . . .'

Many people have reasoned on this subject, but history has never been brought to corroborate the idea that taste in the fine arts promotes virtue; the finest taste seems to have come to a nation when the vigour of the nerve was gone, and refinement took its place along with weakness. It is to be hoped that we may find refinement and strength in combination—and such does exist in individuals, showing its possibility.

But to teach virtue by taste in the fine arts is a desire never yet satisfied, so far as we can find, although the opposite result has often been attained, viz. the destruction of the character by a weakening refinement and a love of that which is merely beautiful externally, agreeable, and within reach. The reason is probably not far to seek; we do not know what intellectual action is, and we can only guess at some vague idea regarding some of its laws. It may be that they are geometrical to a great extent, a strange mystic geometry played out by the mysterious atoms which constitute those organs that produce consciousness, a chemistry of the brain. The emotions of the higher kind, however, are far more obscure, and come from a more mysterious region of the soul, but the perception of beauty in music and in painting is more allied to mere external movement; the musical instrument sounds the chords of the brain—we may refer to Helmholtz's 'Tonempfindungen' for this—and a pleasure is felt which may be entirely unconnected with intellectual life, and enjoyed by persons whose characters have only this one touch of elevation, if it is elevation, in them. Indeed, we know that music is enjoyed by many of the lower animals, and paintings by many of the lowest men.

Still there is a taste for the fine arts which refines some of the lower habits, but the beauty cannot be observed by all men; whilst a taste which refines the higher does exist, that is, when it comes in connection with the higher gifts of the mind. This does not come either from the painter or the sculptor. We do not find their arts well fitted to develop minds. This explains why no amount of opportunity of seeing beautiful pictures and statues raised the population of Italy, or made it less of a land of robbery and murder. The improvement is coming when the taste for the fine arts has left. The time will come when the two will unite, as in the case of the religious painters.

Abstractly we think that good dramas must improve men, but the historic effect there also has been small, whilst the degradation attendant on, we do not say caused by, dramatic effects has been obvious enough. Æschylus alone might make a man think how lofty the drama might be. It was then above the age and taught; now its advocates tell us it is a reflex of the age, yielding the point. Reflecting is not teaching.

We may be excused for giving our own opinions here in corroboration of the views advocated by the Rev. Samuel Hall and Dr. Falconer; it is a subject on which we have thought, seeking in history for a sure guide. Yet how frightfully men deceive themselves. They might read of the Greek character sinking when their best statues were made; the same process had taken place in Egypt, the same took place in Italy. We might follow the same effect everywhere. We are not afraid to go to the frequenters of operas and of our best music cathedrals, to find a similar proof of deterioration in more cases than can give us elevation. Refined music of a class requiring great study as well as talent, seems to be enjoyed by persons of a character most intimately selfish and utterly devoid of the love of man or the fear of God. It may drive even intellect out of the man and make him a machine for the sensual enjoyment of musical vibrations, which, moreover, he cannot understand, because, although they are connected with intellect and character, they cannot take the place of either, and their language is in want of a definite grammar. This does not prevent us from allowing it to be possible that music may take the place of language some day, to guide man far beyond his present power of speech. There are even some souls who have this happiness in incipient revelation ; but to most men the indication is at most a very distant one, absolutely unheeded.

So in painting : imagine men softened by attempts at faces, none of them ever so sweet as their own mothers have shown, although in form more beautiful ; how woefully behind are the best in feeling compared with the living face ; or imagine them made devoted by the faces of saints for whom, although the living human face was used as a model, the very best of painters have failed to portray well that piety which is supposed to be represented. We say this after some care. Imagine men civilised by pictures in galleries which try to imitate nature in landscape, when the inexpressible beauty of nature is unheeded before them. Still, we yield here also something. The study of the works of men striving after the highest model is a great advantage to any one in a similar track ; he is shown the way by easier steps ; there is, therefore, a stage at which even the inferior works of artists, as much as the greatest of them, may turn out to be of advantage to thinking men. But strangely they seem never to begin civilisation, or to improve men who have not made some marked advance, whilst the subjects often produce degradation by increasing the love of the external and unspiritual. The finest civilisations have begun in earnestness and force mainly, even if joined to violence, injustice, and cruelty ; not in anything refined. That is not the first stage.

Bleaching.[1]

A curious view of the simplicity of the times with

[1] Vol. i. p. 240.

regard to the treatment of cloth, the most truly Manchester subject in the volume, is given by Dr. Eason on p. 240, vol. i. (Aug. 7, 1782). The author wishes to recommend the use of muriatic acid instead of sulphuric acid in the bleaching of cloth, after the alkaline treatment ; because not only is it cheaper, but when sulphuric acid is used 'the selenitic matter adhering to the threads of the cloth will injure it and make it feel hard to the touch, and probably is the reason why some linens wear so badly!'

The present aim is to load the cloth to the utmost with extraneous matter, and if selenite is not used much at present, it is because another sulphate comes in more conveniently. An exporter of sulphate of magnesia in Stassfurt was asked rather in fun, if he did not think it a dishonest thing to sell that material to the Manchester people in order to enable them to adulterate their goods? 'That I never do,' he said ; 'I sell this and know nothing of it after it leaves me. I would not sell it for such a purpose as you mention.' Men defend the custom by speeches and letters in newspapers, and defend their bad cloth by lawsuits, and put on an appearance of ill-usage when they lose the case.

> Wonders in nature we see and scan,
> But the chief of them all is man.

Dr. Martin Wall.

Dr. Martin Wall was Prælector of Chemistry in the University of Cambridge in 1782 ; we find him paying the greatest respect to the rising scientific authorities in Manchester, and writing with great deference. A gentle essay 'On the Use of Symbols' (chemical) shows his classical knowledge and tastes ; but we do not find in him either depth of insight or deep classical knowledge; and we are led to wonder much why such a university, with centuries of life and superabundant wealth, should have cared so little for the advance of knowledge in directions so distinctly pointed out by Nature as leading to the greatest regions; and how different is Dr. Wall's knowledge of all that is done in chemistry from that of his contemporary, John Friedrich Gmelin, the author of 'Geschichte der Chemie.'

Classical knowledge comes more suitably from Dr. Falconer when he speaks of the 'influence of the scenery of a country on its inhabitants,' or on the 'style and taste of gardening among the ancients,' and in vol. ii. 'On the knowledge of the ancients respecting glass,' but on these matters later inquiries have attained what could not have been anticipated even by genius.

Mr. Bew on Blindness.

The discovery of colour blindness has hitherto been given to Dalton, and unquestionably he first raised it into the region of science; but it has not been observed, so far as the writer knows, that Mr. Bew or anyone else had observed the peculiarity. Here we seem to have the true beginning, on p. 182.

An essay by Mr. Bew, read April 17, 1782, is entitled 'Observations on blindness, and on the employment of the other Senses to supply the Loss of Sight.' The Society unfortunately employs the term Mr. without the Christian name so frequently that it is not easy, even when possible, to identify the person alluded to. This essay has two remarkable descriptions in it, one is of Dr. Henry Moyes, who is worthy of being remembered, as he lectured on chemistry in Manchester before Dalton came; the other is of John Metcalf, a man connected with the neighbourhood, and certainly wonderful as being a surveyor of hill roads, a blind man dealing with distances and precipices.

The following is from Mr. Bew's paper, vol. i. p. 168, of the 'Memoirs of the Society.'

'I pass over a number of instances that might be offered to your notice, and proceed to give some account of Dr. Henry Moyes, the elegant reader on philosophical chemistry, whose lectures the greatest part of this Society had the satisfaction of attending, and whose personal acquaintance several of us have enjoyed.

'Possessed of native genius, and ardent in his application, he made rapid advances in various departments of erudition, and not only acquired the fundamental principles of mechanics, music, and the languages, but likewise entered deeply into the investigation of the profounder sciences; and displayed an acute and general knowledge of geometry, optics, algebra, of astronomy, chemistry, and, in short, of most of the branches of the Newtonian philosophy.

'Mechanical exercises were the favourite employments of his infant years. At a very early age he made himself acquainted with the use of edged tools so perfectly, that notwithstanding his entire blindness, he was able to make little windmills; and he even constructed a loom with his own hands, which still show the cicatrices of wounds he received in the execution of these juvenile exploits.

'By a most agreeable intimacy and frequent intercourse which I enjoyed with this accomplished blind gentleman whilst he resided in Manchester, I had an opportunity of repeatedly observing the peculiar manner in which he arranged his ideas and acquired his information. Whenever he was introduced into company, I remarked that he continued some time silent. The sound directed him to judge of the dimensions of the room, and the different voices, of the number of persons that were present. His distinction, in these respects, was very accurate, and his memory so retentive that he seldom was mistaken. I have known him instantly recognise a person, on first hearing him speak, though more than two years had elapsed since the time of their last meeting. He determined, pretty nearly, the stature of those he was speaking with, by the direction of their voices; and he made tolerable conjectures, respecting their tempers and dispositions, by the manner in which they conducted their conversation.'

In the same paper we are told of another blind man.

'This is one John Metcalf, who, like the gentleman already mentioned, became blind at a very early age, so as to be entirely unconscious of light and its various effects. This man passed the younger part of his life as a waggoner, and, occasionally, as a guide in intricate roads during the night, or when the tracks were covered with snow. Strange as this may appear to those who can see, the employment he has since undertaken is still more extraordinary; it is one of the last to which we could suppose a blind man would ever turn his attention. His present occupation is that of a projector and surveyor of highways in difficult and mountainous parts. With the assistance only of a long staff, I have several times met this man traversing the roads, ascending precipices, exploring valleys, and investigating their several extents, forms, and situations, so as to answer his designs in the best manner. The plans which he designs, and the estimates he makes, are done in a method peculiar to himself, and which he cannot well convey the meaning of to others. His abilities, in this respect, are nevertheless, so great, that he finds constant employment. Most of the roads over the Peak in Derbyshire have been altered by his directions, particularly those in the vicinity of Buxton; and he is, at this time, constructing a new one, betwixt Wilmslow and Congleton, with a view to open a communication to the great London road, without being obliged to pass over the mountains.'

Longevity.

Dr. Fothergill gives us a treatise on Longevity, vol. i. p. 355, which would not satisfy Mr. Thoms, but one which is inclined to view with a somewhat broader mind the tales concerning age. He is a bold man who puts limits to life, and who asserts that he knows the causes either of life or of decay. It is in the nature of things that there should be exceptions and extremes, and it would be wonderful if when the natural life of a dog is ten, but of an unusual dog thirty, that man also should be found never exceeding in any case much more than his usual limit. Nay more, is it not natural to suppose that he too has specimens which double or triple the usual term of human life? It is better to learn how wide nature is than to try to prove favourite points. It is remarkable how consistent with each other the conditions are of men who have lived above 100. Of those occurring several times annually in our own islands, all are poor—the poorest are in Ireland among a race remarkably tenacious of life, men among whom usually lives are long, and where centenarians might be expected according to reason without even a grain of sentiment;

such classes are more likely to have exceptions of corresponding increase of tenacity, because of a fundamental characteristic being tenacity. It is true that Mr. Thoms does not deny the possibility, but limits himself to want of evidence; but after all his exertions he can only show that men sometimes exaggerate, and this is true in all history. We must remember that Nature in her own way exaggerates a great deal more, and laughs at the feebleness and littleness of our incredulity.

Our age is incredulous in some things, but frightfully credulous in others, superstitious to an extent previously unsurpassed regarding the power of nature, exactly showing the character of the men from whom it has sprung. The Saxon boor will believe nothing out of his sphere; he will not believe till he sees it, that steam can drive a coach, but he knows that a bogle lives in the wood. We are not inclined to the bogle because we have not seen it, but we are inclined to think that men die about seventy, although perhaps we never in our lives saw one die whose age we knew exactly; and if it be difficult to prove that any man is a hundred years old, we must remember that it is also difficult to prove any man to be sixty years old, when he is not a public character, or a man who has lived long with his early companions.

Some people think that scepticism is a grand thing; they boast of a want of belief in anything wonderful. How facts put down these men, accumulating wonder upon wonder, with exceptions, anomalies, and eccentricities! There are unknown laws enough to account for all wonders.

Registers of the Population, and its Work.

Mr. Wimpey writes 'On Economical Registers,' and advocates a general directory of all the people in Great Britain, and that all people should have a medal about their person when twelve miles from home as a guarantee of their individuality. We should be as unhappy as a German who carries or must show when required, a Geburtschein, an Impfschein, a Taufschein, and how many more, to show his birth, baptism, confirmation, and all his petty history to a government which delights in small facts. We should like to tell Mr. Wimpey that we can run off a couple of hundred miles and still sleep at home at night.

The article is curious in another respect because of a sentence on p. 14, vol. i. 'In a fertile country like England, which grows more corn than its inhabitants can consume and of course renders it a commercial article, it is of great importance to ascertain the following facts for the regulation of the exportation of that article.

'I. What is the annual average yield of corn in England for a series of years?

'II. What is the average annual consumption in the same time?'

And Mr. Wimpey has been found right in great part; we make now a decennial census, and we seek to learn the amount of corn grown in England, although we have not yet arrived at the exactness he desired.

On Diversions.

One almost thinks on reading this first volume of memoirs, that the early man of Manchester had burst into the world from some previous cave-dwelling and then revelled in the scenes put before him by the glamour of science. We find him inquiring if he does well to hunt and fish, or if he ought to live on pulse only, afraid to kill animals, and if there is reason to be afraid to kill even plants lest they should suffer in their sensitiveness? We remember these fancies in our childhood. The unnamed writer 'On the Diversions of Hunting, Shooting, Fishing, &c.,' considered as compatible with humanity, p. 341, has leapt bravely through the weaknesses of sentiment that keep us from the use of our nature in the direction of those healthy sports. He says, 'It might then perhaps appear that amidst all the variety and eccentricity which the contemplation of a given character presents, the primary disposition, the original nature, and springs of action are extremely few. If this were proved, the seeming inconsistency between many of the actions of an individual must disappear, as it would be unfair to reason from any partial view of his character.'

This seems true, even when character rises high the foundations are left: we stand upon the earth. This by no means shortens the height to which we may see, or diminishes the world in which the mind lives. We must not forget that the universe of matter has an extension beyond all our conceptions, although we must equally remember that the space between the moving spheres contains power if not matter also, and is inconceivably greater than any space occupied by visible or known material. The materialist has been obliged so to extend his ideas of matter that it has grown into mind; the visible universe with all its greatness has become too small for those who have learnt to look on the magnitude of that which is active but invisible.

It will be seen that in the first volume we have certainly some very varied information mixed with essays on subjects that in our time would seem better suited to a school for the young; but society was consolidating itself. Education was in an earlier stage, and the demands were simpler than now; old ideas had in many cases been forgotten for want of institutions in which to embody them: they lay entombed in books for want of a new body in which to rise; whilst new ones came fresh into the world and began to receive that encouragement for which wise men and philanthropists had waited in vain in former times. On careful consideration it will appear that such essays were required at the time, and their translation into continental languages with their general reception is a guarantee that they showed an advance on the age, notwithstanding what may have previously existed in more recondite volumes.

Dr. Mainwaring.

Dr. Peter Mainwaring is mentioned as one of the first presidents of the Society. He is also called an eminent physician and a magistrate of the town. He presented to the Royal Infirmary a small collection of books and a bookcase, forming the nucleus of the present library (*Manchester Historical Recorder*). He lived in King Street. He died in the ninety-first year of his age in 1785. (*Harrop's Manchester Mercury.*)

Dr. George Bell.

When Dr. Charles Bell, a nephew of the famous Sir Charles Bell, M.D. Edin., came in 1847 to reside in Manchester, he supposed Dr. Geo. Bell to be one of the family; but Dr. Geo. came from Dumfriesshire. (See Currie's account in Mem., vol. ii., p. 382.) He died young. He deserves a longer notice.

CHAPTER VII.

THE THREE HENRYS—DR. EASON—THE MASSEYS, ETC.

WE do not know the ethnology of the Henrys, but from the name we may suppose them to be English, and probably Norman English. However, the family is said to have been in Antrim for several generations. The grandfather of our first Manchester Henry, namely Thomas, commanded a company of foot in the time of James II.; and during the disturbed times which in Ireland succeeded the Revolution was shot by an assassin in his own garden. The son, Thomas Henry's father, was an infant, and was taken care of by a neighbouring nobleman and educated in Dublin; afterwards he was brought to Wales. He married the daughter of a clergyman and began a ladies' school at Wrexham, where Thomas was born. The school was subsequently transferred to Manchester. Thomas Henry, who was born on October 26, (Old Style) 1734, was educated at the grammar school of Wrexham after careful instruction from his mother. He was intended for the Church, but the expense was held to be too great considering the number of the family, and he was apprenticed to an apothecary, Mr. Jones, who soon died, and Henry went to another of the same profession at Knutsford. He studied 'Boerhaave's Chemistry,' and after his apprenticeship went to assist an apothecary at Oxford by name Malbon. He attended anatomical lectures, refused a partnership which would have demanded seven years of study for full medical practice, and returned to Manchester as an apothecary, practising in the manner usual at the time. This was a little before Dr. Percival's arrival.

The paper read to the Royal College of Physicians on 'An Improved Method of preparing Magnesia Alba' is the first mentioned in the life by his son. It was written purely with scientific interest, and the magnesia as medicine was not prepared for sale until Mr. Henry had been strongly advised, and had received the opinions of Sir John Pringle, Sir Clifton Wintringham, Dr. Warren, and others. This and some other essays were published in a separate volume. Mr. Henry was elected a Fellow of the Royal Society, by the interest of Sir John Pringle, Priestley, and Dr. Franklin, and gradually rose into fame, whilst the family wealth was solidly founded. Mr. Henry introduced to the English chemists the works of Lavoisier up to the year 1776, and illustrated them with notes.

He also first observed that a certain amount of carbonic acid in the air is favourable to the growth of plants, and these experiments were received by Priestley with great interest.

His mode of keeping water pure at sea was an improvement on that of Dr. Alston, of Edinburgh. Dr. Alston had proposed the use of lime to prevent putrefaction, and when the water was required he proposed to precipitate the lime with carbonate of magnesia. This certainly unpractical proposal was changed by Henry into passing carbonic acid though the lime-water and precipitating carbonate of lime. This is the origin probably of Clark's process of purifying water, and it is remarkable that such a simple thing should have gone through so many stages. Clark added lime to water already containing carbonic acid, and this made a precipitate which not only consisted of the lime added but also of the carbonate which was previously in solution, added to a good deal of organic matter on certain occasions. The 'putrefaction of water' at sea was at one time an alarming evil. People did not consider that pure water could not putrefy, they did not separate the idea of water from that of its contents. Henry's plan may still be used with advantage in many places where the wells require attention, although it is always better to seek a fresh supply purified by nature.

Mr. Henry and Dr. Barnes were the first Secretaries of the Society, and in 1807 the former became President, retaining this position during life, or to the year 1816.

He was a man of clear mind, as his papers testify, ready and practical. He read much, had a good knowledge of all the science known at the time, and gave much attention to history. His sympathies were active with his friends and with the struggling public, and he was one of the early members of a society for the abolition of the African slave trade, showing himself a true man and enlightened thinker in his own house and active laboratory, as well as in the public work of the increasing town, and in his aspirations avoiding the narrowness of self by seeking liberty both in this and in other countries.

On June 27, 1781, a letter was read from James Massey, Esq., to Mr. Bew, containing a new and simple method of impregnating water with fixed air, with a drawing of the apparatus, as well as for decomposing lime-water and rendering putrid water sweet.

Probably the non-publication of the paper is to be accounted for by the previous publication of Henry's volume.

An admirable portrait of Henry, painted by Allen, hangs on the walls of the Society's rooms. It was painted when he was advanced in years, but still shows that calm power and activity of mind which Henry's life and writings evince. Clearly he was not a great philosopher, his education was imperfect and his disposition was more that of a worker than an abstract thinker ; but he was a good type of the practical race of Englishmen, or of people of north-west Ireland.

Before leaving Thomas Henry we may bring together some further account of his more important work.

We see the clearness of the man's mind in some very simple expressions; he quotes 'Baumé' (vol. i. p. 449) as supposing 'that when calcareous earth is deprived of air and water it will return to its primitive state, viz. that of silicious earth.' Mr. Henry says, 'This theory is rather fanciful than just. The operations of nature, it must be allowed, are generally simple, but we may simplify too far ; and in forming systems we should not suffer our imaginations to carry us beyond those bounds which our senses and experiment warrant.

'Calcareous earth indeed, in the form in which we commonly find it, is a compound consisting of earth, air, and water, and is not considered as pure till it be deprived by fire of the two last elements. It is then properly pure calcareous earth ; but it does not appear that longer calcination, though it may divest it of some of the properties of calcareous, will ever reduce it to the nature of silicious earth.

'Every earth with which we meet and which when separated from those acids or other accidental substances that are combined with it resists every power we possess to produce any further decomposition, and yet differs in all or any of its properties from the other known earths, may be admitted to form a new genus.' But even he fails soon in his reasoning, and when discussing the production of sea salt and nitre forgets the strong individuality he has already given to the elements, and makes them grow; at least, it is so of nitric acid and potash. 'But it may be said that, in the one both the alkaline and acid parts of the salt are formed; whereas in the other the acid only is produced on the beds, and it is necessary to add an alkaline salt to constitute the basis of the nitre. I cannot, however, allow of the force of this objection. Though the addition of the alkali be necessary in these northern latitudes, yet in warmer climates, where nature is more vigorous and active, there is no doubt but the former one develops both the acid and alkali of nitre at the same time.' Dr. Wall, in vol. ii. p. 77, says 'that the vegetable alkali (potash) is produced by the operation of nature only in the putrefaction of vegetables.'

It is interesting to view this mode of reasoning. There is a clear idea of development in this case, or rather the passage of one element so-called into another, a thoroughly alchemistic idea, if not an idea common to Druidism, or of witchcraft, and the earliest magic, when the change of one thing into another showed that no exact idea existed as to the quality of matter or of any permanent nature of things. If, as in an Egyptian or an Irish tale, a human being can turn into a cow, a tree, or a splinter of wood, the essence of things is not in the matter but in the spiritual character. Things are viewed as we view the character of a man who may be good and powerful whether he weigh nine stone or twenty.

On the other hand, the idea of development of the world does not come into Mr. Henry's mind, but he agrees with the Bishop of Llandaff (see 'Watson's Chemical Essays,' vol. ii.) that the seas originally created salt. It was not customary at that time to view the universe as a whole, or to watch it gradually developing itself as we now watch young plants. Now it is common for man to view the growth of worlds, placing himself out of measurable time and sitting in fancy beyond measurable space, whilst the whirlpools of atoms waste their fury, coming from their impenetrable caverns still farther away than our imagination can travel, and swinging into existence with an irregular force that gradually seems to learn its duty, and concentrates itself in a well behaved and regular sun or planet; he watches over some stray piece which it may keep near itself as satellite, spending the fury of its youth, and learning to move with a regularity that makes it fit to be a time-piece for creation.

Mr. Thomas Henry's clearness grows more observable as he goes on, and in vol. iii. p. 363, on 'Different Materials as Objects of the Art of Dyeing,' we find him coming to sound views as to the action of alum as a mordant. It is not always easy to obtain the meaning even of writers so late as Dr. Henry on this subject; their ideas were loosely held, and their language was suitable, so that it is capable of different bends. Still one sentence by Mr. Henry may be considered sufficient evidence of originality and unusual distinctness: 'When cotton is to be dyed and some of these bases are requisite, not only the basis is to be precipitated by the astringent colouring principle, but the attraction of the material to the basis is to be increased by other intermedia. The permanency of the extractive dyes therefore depends on the previous treatment of the cotton, and, where alum is employed, of that salt, so as to procure a more copious precipitation of its earth and to unite it by means of other substances to the material.'

He observes, however, that Mr. Keir, the ingenious translator of Macquer's 'Dictionary of Chemistry,' appears to have been the first who suspected that the earth of alum was precipitated, and in this form attracted to the material. However, the full explanation seems to be Henry's ; and he also combats the ideas of Macquer on the subject, that chemist having looked to the influence of the alkali which is added, and supposed the alumina to be redissolved, and the alkaline salt with aluminous basis to be the real mordant. The idea of animalising cotton cloth to enable it to take up colouring matter without mordant as wool does, also occurred to Mr. Henry, but he acknowledges that Bergman had the same idea ; still it was only an idea, and even now but partially successful as a process of manufacture, although in use and growing.

Melting of Platinum.

At a meeting of the Society on Aug 13, 1789, a letter was read from a London chemist, Mr. Thomas Willis, giving an account of the melting of two ounces of platinum in a crucible 3 inches wide on a bed of powdered charcoal. Mr. Henry, junior, is mentioned as being present at some of the experiments mentioned. This must have been William Henry, who would then have been quite a boy, and is soon to be spoken of.

MORTALITY IN MANCHESTER.

About the middle of last century a desponding feeling rose in the minds of many persons, as it has often done, that all things were going to decay and the inhabitants themselves were decreasing. Evidently Manchester and Salford thought that they made a great community, and in 1773 a number of men who afterwards became members of this Society subscribed for the purpose of obtaining accurate statistics of the place. They found that it was actually increasing. In a paper 'On the Bills of Mortality for Manchester and Salford,' read by Mr. Thomas Henry in 1786 (see vol. iii. p. 159), we read, 'By casting our eyes on the bills of mortality for those years (intervening between 1773 and 1786) we find the population of the towns greatly advancing, and what is a pleasing circumstance, especially considering the number of men of which they were drained for the supply of his Majesty's fleets and armies, we see a striking superiority of the births over the burials.'

Observations on the Bills of Mortality for the towns of Manchester and Salford. By Thomas Henry, F.R.S., Acad. Philos. Amer., Philadel.; Med. Lond. and Physic. Edinb. Soc. Read Jan. 18, 1786.[1]

'In the year 1773 several persons, many of whom are now members of this society, subscribed for the purpose of obtaining an accurate account of the state of the population of the towns of Manchester and Salford,[2] which should

[1] Vol. iii., pp. 159-173.

[2] 'Manchester and Salford, though distinct townships, are only separated by the river Irwel, and communicate by means of several bridges. In the year 1757 the number of inhabitants was no more than 19,839'

contain the number of houses, families, males, females, &c. The result of this inquiry, which was instituted with a view to the opinion, at that time propagated, of the general decline of population in the kingdom, proved that instead of being diminished, as was supposed to be the case with the inhabitants of London, the number of persons residing in Manchester and Salford was greatly increased; that the number of tenanted houses was 4,268, of families 6,416, and of inhabitants 27,246, or $6\frac{1}{3}$ to a house. But in this account, the number of inhabitants residing in the townships, almost the whole of which were then nearly contiguous with the towns, and now form a part of them, was not included. These districts contained at that time 311 houses, 361 families, and 1,905 individuals. This number added to the former, makes that of the inhabitants amount to 29,151.[1]

'Soon after the period at which this survey was taken, a very considerable increase of inhabitants took place. The spirit and ingenuity of our manufacturers made extraordinary and rapid improvements in our fabrics; and the introduction of machinery, instead of lessening the number of hands, found employment for many additional people. The town extended on every side, and such was the influx of inhabitants, that though a great number of new houses were built, they were occupied even before they were finished.

'The progress of the trade and population, though certainly checked, was not wholly restrained by the unfortunate and ever to be lamented war which was waged, during a period of almost nine years, with our American colonies, supported by the immense and united forces of

[1] Dr. Percival's Essays, vol. iii.

France, Spain, and Holland. Contrary to every reasonable expectation, the manufactures of Manchester were not affected by the war to any great and alarming degree, and they still found their way by various channels to almost every market where they had been usually sold. By casting our eyes on the bills of mortality for those years, we find the population of the towns greatly advancing, and, what is a pleasing circumstance, especially considering the number of men of which they were drained for the supply of his Majesty's fleets and armies, we see a striking superiority of the births over the burials.

'On the happy event of the restoration of peace, the influx of inhabitants was surprisingly greater. Multitudes of men who had served abroad or in our provincial regiments at home, now returned into the country, and the success of the opposition which was made to the monopoly of the cotton machines, drew from various quarters large recruits of people. During the last three years the number of our christenings has been much augmented, but though they still maintain a majority, yet I am sorry to observe that the list of burials, when compared with those of the three preceding years, is more than proportionably enlarged. A contagious fever has proved very destructive, and its virulence has been probably increased by the crowded and uncleanly manner in which the poorer people have been lodged, owing to the want of houses to accommodate them; for though many have been erected, yet several causes have contributed to restrain the spirit of building. During the war, the high price of timber was a considerable obstacle, and since the peace, the frosts, which were for two years together very intense, and continued till the spring was far advanced, have prevented the making of bricks, and, together with the tax, greatly enhanced their price. From these causes, I believe, were an actual survey taken at present, the number of inhabitants to a house would far exceed the amount in the year 1773.[1] But it is proper to observe that the devastations of this disease have not been confined to this place. Dr. Fothergill, of Bath, informs me that all the manufacturing towns in the vicinity of that city have been afflicted by a fever of a similar kind. . . .

'In 1773 the total number of the inhabitants of Manchester and Salford, including the townships, was 29,151. . . .

'From all these different views we may, I think, be authorised to conclude that the number of inhabitants of the two towns cannot be much lower than 50,000, especially as from a circumstance of which I shall hereafter take notice, it is probable that the annual number of deaths is underrated. . . .

'Dr. Percival, whose attention was some years since particularly directed to the subject of this paper, pointed out a plan of keeping the parish register, which, if it had been pursued, would have been productive of great advantages; and he took pains to ascertain the proportion of deaths by the small-pox to those by all other diseases. In the course of this inquiry he found that in a space of six years, from 1769 to 1774 inclusive, the deaths by the small-pox were nearly one-sixth and a half of the whole.[2] I am happy to observe that in the last six years

[1] 'I have too frequently had opportunities of seeing a man with his wife and three or four children, all residing in one small room, in which they dress their victuals, eat, work, and sleep.'

[2] 'During the years 1772–3 and 4, the deaths by the small-pox in Liverpool amounted, according to an account communicated by the late Dr. Dobson to Dr. Haygarth, to one in $5\frac{1}{2}$ of the whole.'

the fatality of this terrible disease has abated, for the deaths by the small-pox from 1780 to 1785 inclusive only amount to one-seventh and a half of the whole number of burials registered at the collegiate church. . . .

'Accordingly we find that, as our town has increased, the proportion of deaths at ages above seventy has decreased. During two periods of five years each the number of deaths of persons above that age will appear from the following table.

Table containing the different number of deaths of persons above the age of seventy, in two periods of five years each.

From 1776 *to* 1780 *inclusive.*	
From 70 to 80	212
,, 80 ,, 90	101
,, 90 ,, 100	16
	329
From 1781 *to* 1785 *inclusive.*	
From 70 to 80	226
,, 80 ,, 90	114
,, 90 ,, 100	19
	359

'The number in the former period is as 1·7 to 9·3; whereas that in the latter is only as 1·5 to 11·5 of the whole of registered funerals. (This is not very clear, but the meaning is that the number 226 in the second era ought to have been 231. But observe the figure for 90–100; it is 19, whereas the number ought to have been 17·4 if the proportion had remained; there is here an increase.)

'But injurious as large towns may be to the duration of life, and though it must be granted that by annually draining the country of a number of inhabitants, they consume many lives, which, in their original situation, might have continued to exist for several years longer, but are cut off by diseases produced by vitiated air, by infection, or by a change in their modes of living, yet, on the whole, they are not, perhaps, so unfavourable to population as they may, at first sight, appear. For in large towns, at least in those where extensive manufactures are carried on, the encouragements to matrimony are considerable; and therefore, if life be more speedily wasted, it is, probably, produced in a far greater ratio.[1] A sensible, industrious manufacturer considers his children as his treasure, and boasts that his quiver is full of them; for where children can be employed at an early age, the fear of a large family is not only diminished, but every child that is born may be regarded as an addition of fortune.

'A large and populous town, also, is favourable to population, by extending its influence to a very considerable distance beyond its own districts. Manchester supplies employment to many thousand people resident within the country, to the extent of several miles, who gain a comfortable livelihood in different branches of the manufactory, without suffering the inconveniences which attend the town. The demand of this great body of people, who raise but a very small part of the provisions they consume, added to that of the town, has an effect upon a still larger tract of country, the inhabitants of which are occupied in agriculture; and, being sure of finding a ready and advantageous mart for their products, they are encouraged to a better tillage of their lands, already in cultivation, and to the improvement of waste

[1] 'That this is actually the case in Manchester and Salford appears from the registers: although during a period of twenty-one years the marriages and births have been more than doubled, yet the increase of burials is only as 29 to 16.'

lands; and that cultivation and competency will increase population by removing the obstacles to matrimony, is an axiom the truth of which cannot be disputed.'

To remove these evils we find that even then they were 'widening and providing for the ventilation of the streets, and that modern houses were made more commodious,' but notwithstanding this, as the town had increased, the proportion of deaths at ages above seventy had decreased.

Thus we see in Manchester the struggle against excessive disease and death by municipal changes is above a century old, and the battle is still against us.

The condition of England, as of Europe, was long disturbed, and it is clear from the descriptions we have by Dr. Percival, Dr. White, and their friends, that the activity of men's minds was stirred not merely by physical want or by the imitation of France. The increase of trade and manufactures had been improving the condition of the people, and Manchester specially had begun to advance rapidly, giving opportunity to men to think when they were willing. As their minds became clearer, interruptions to their prosperity were more impatiently borne, and so we find that the very increase of intelligence caused misfortune to produce the greater commotions, whenever these interruptions began. We find a time of trial bringing poverty and disease, so that the necessity for public action was clear.

The paper from which quotations have just been made was one of those which influenced strongly that movement which was the beginning of the Board of Health; and as usual there were opponents, and the men of sense and goodness had to make elaborate explanations like apologies for attempting to benefit the people: the usual course of things.

Similar causes stirred up the politicians, and thus we read of Thomas Walker, the Boroughreeve, chairman of a Constitutional Society which was raised up in opposition to the 'Church and King Club,' the true old Tories, the opponents of Jacobites. We have no very favourable picture of Manchester society at this time. There were no reading-rooms, libraries, or clubs for the evening, and few houses which could contain invited friends as one must suppose, since 186 public-houses made a political proclamation, showing how much they owed to the discussion of politics taking place there. This will tell no matter on what side the proclamation leaned, although it is remarkable that only one, John Shane's back parlour, was left for Jacobins and dissenters.

The great trial of Thomas Walker for sedition and the failure to convict was a remarkable triumph (see Prentice's 'Manchester') of freedom, and the numerous arrests, as is well known, ended in showing how little judges know or care for natural law, and how much clearer are the heads of men who have not been misled by the study of the artificial devices too frequently passed by Parliament and called laws, and which pervert the minds of lawyers.

Whilst we are told that some inhabitants went to Liverpool for peace, we learn that the opposition there stretched even to the Literary Society, and the author of the Italian histories, William Roscoe, and the writer of the 'Life of Burns,' Dr. Currie, were, with the Rev. William Shepherd and others, induced to give up their meetings. This political commotion can scarcely be said to have ended till the corn laws were abolished; it existed, bursting occasionally into considerable violence, even after war had ceased. All this time there were men sitting in this Society's rooms or at the Academy, and as occasion required at the Board of Health, thinking of matters interesting to the world, as well as to themselves. We shall not say which were the greater men ; those who fought for freedom had the most painful struggle and required most courage ; those who sought science required the most careful thought, and in a public struggle they would have lost their peculiar value. The scientific man finds truth for all time, and thus he is put perhaps unfairly on a higher station ; the political struggle must be repeated for every nation, and sometimes it must be carried on in every town or country, and the village Hampden is often the most unselfish whilst expending those qualities which might have governed a kingdom. He may be sufficiently appreciated to serve as an example to another ; but the work of the man of science is not merely an example, but a magic lamp that needs no fuel—that famous lamp which burns for ever if not broken by violence. Still it is true that the scientific man may gain, by much less labour, that prominence which belongs rather to the truth he finds than the eminence of the qualities which find it. (See further p. 171.)

Dr. William Henry, F.R.S.

Mr. Henry's son, Dr. William Henry, born 1774, is generally considered the most eminent of the family.[1] He had more opportunity of learning than his father, and we may say the best opportunity afforded by the district, as

[1] See vol. vi. Second series of *Memoirs of the Society* : Life, by Dr. William Charles Henry.

young men were sent to Manchester from a distance to learn at the Academy where the Rev. Ralph Harrison was classical teacher. Here again we find the influence of Dr. Percival, as we learn that soon after Mr. Henry left the Academy he became, as others also had done, a reader and assistant to Dr. Percival, whose weak eyesight prevented his activity. It was a great favour to be allowed to study with such a man ; Henry lived for five years in the house, having succeeded Dr. Holme who acted in the same capacity. We do not find that he went to any university until after being for some time practically engaged in the Infirmary, under Dr. Ferriar, another of those physicians who made Manchester famous. He went to Edinburgh in 1795, and a second time in 1805 ; to what place could a man go in England to study medicine and receive a university education at the same time ? In Edinburgh he studied chemistry under Dr. Black, a man whose style of thought and of work was well calculated to produce enthusiasm in a mind prepared by intimacy with Dr. Percival, a man of similar manners and elevation of character. Henry had the advantage when not too young, as many Scotch students are, of hearing other eminent men of that city. Playfair and Dugald Stewart took up much of his time ; whilst among the students he had such acquaintances as became well known to the world under the names of Marcet, Roget, De la Rue, Thomson, Allen, Scarlett, Jeffrey, and Lord Brougham. He was roused there to the highest enthusiasm, and quitted the place with regret, feeling long afterwards that all his time in Manchester was comparatively given to inglorious repose, active although most people considered him to be. He took his degree of M.D. in 1807, but ten years previously he had given to the Royal Society a proof of his activity, if not of accuracy, in his inquiry if carbon was an element, and in 1800 in his experiments on muriatic acid. He had obtained a facility of operating on gases, and by the electric spark decomposed that acid over mercury, obtaining calomel and hydrogen, or without the mercury, that which was in time called chlorine. It was, however, left to another to explain these results. In 1803, he showed the effect of pressure on the absorption of gas by water, supporting the theory of Dalton that it was due to mechanical agencies.

We may say that his care and his refinement contributed very much to the knowledge of the analysis of gaseous mixtures and compounds, and we especially owe to him the knowledge of the composition of coal gas and various methods of ascertaining it. His method of using chlorine was long employed, although bromine, &c., have now taken its place, and he applied also spongy platinum in a manner which for a while was considered the most convenient way of uniting oxygen with hydrogen and with carbonic oxide when at 340° Fahr.

Dr. Henry's large work, a system of chemistry, had passed through eleven editions in 1809, and may still be consulted with advantage by those who wish to learn the history of the best method of operating with eudiometers. Although not strong, he both studied the science to which his father had introduced him, and practised medicine, whilst his active mind could not refuse to write papers on that subject also, and his general love of knowledge compelled him to attend somewhat to the progress of every other department of scientific inquiry. We may consider him as taking the place of Dr. Percival on the demise of that gentleman; he had the same refinement of manner, the same eloquence of speech, but with more self-consciousness and assertion in society. An accident in boyhood, the fall of a beam against his right side, subjected him to great pain, and stopped his growth, while it was succeeded by attacks of neuralgia which occurred periodically during his whole life. He never yielded, nevertheless, to despair, and preserved at all times his love of superiority which distinguished him in conversation; although we cannot hear that it was ever observed to an extent unpleasant to his friends. On the contrary, his house was continually sought by scientific men, and also by other eminent persons visiting Manchester; and he so far outshone Dalton to all appearances that it was said by some, 'Your great man here is Henry, and you do not know it.' However, it was well known, as this expression shows, that Dalton was the true hero of the place, but the fame of the day and of the dinner-party belonged to Henry entirely, with a fair but comparatively simple share reserved for succeeding generations. Dalton was not visited much, because his house was incapable of hospitality, and he himself lived too much in himself to be capable of entertaining others. Probably some men of Manchester during the most of Henry's life held him as the greater of the two; but comparisons are not always pleasant, and we end by saying that Henry was an accomplished and original man, one who advanced science, and took a prominent place amongst the chemists of the age, and one whose name must stand in the history of chemistry as for a time in the front place in his own department.

We cannot take leave of these two men, the first and second Henrys of Manchester, without remembering how much they contributed to dignify the chemical arts by an assiduous attention to their own manufactures, in the first place by manufacturing magnesia in such a condition that after a century it still stands the test; whilst, without going deeply into the history of artificial mineral waters and aerated drinks, we are inclined to believe that the elder Henry was the true inventor, or evidently considered that he was first in the field. Dr. Henry separated from his partner Mr. Thompson, taking for himself the magnesia, and leaving the aerated waters to the latter.

Three Henrys were mentioned. The third, Dr. William Charles Henry, being still alive, we shall not attempt to describe him. The wisdom and care shown by his father and grandfather left him entirely independent of his profession, and allowed him to live in affluence; whilst the remarkable skill shown in dealing with the scientific life of Dalton has proved that the wealth which was given to him was loss to the scientific community, perhaps to himself also.

Dr. Eason.

Dr. Eason was an important member of the medical staff of Manchester at the time of the formation of the Society, and one of the proofs that medical and especially sanitary studies had made remarkable progress in Manchester. He was descended from a dignitary of Dysart in Fife, a baillie, and a member of Parliament in 1703. The member's duties were important, as in the previous year, Alexander Swinton, M.P., is instructed by the town council to assert the independence of the nation, 'and that he shall be against the alteration of the succession till the union of England be consented and agreed to.'[1] The

[1] From the *Fifeshire Advertiser*, 1864, Oct. 15. 'Extracts from Ancient Records, &c.' This begins with an old phrase as motto, 'Up wi' the carles o' Dysart.'

meaning may not be clear, but it shows the importance of the duties. This M.P. must have been the father of George Eason, or Easson, who married Barbara, daughter of Alexander Aytoun of Inchdairnie. Dr. Alexander Eason was born in 1735, and he also married an Aytoun from the same house Inchdairnie, a cousin once removed.

In Manchester Dr. Eason lived in Lever Street, Piccadilly, next what was once the White Bear Inn. He bought the house and plot of ground for 800*l.*, and at his death General Aytoun, brother to Mrs. Eason, sold it for 1,000*l.*, to invest the money for his sister and her only child Barbara Eason, afterwards wife of Thomas Wilkinson. A few years ago this property brought in 1,600*l.* annually to Dr. Ashton's father, the baker. In early life Dr. Eason travelled on the Continent with Lord Moira, and afterwards was in the Inniskilling Dragoons, or the Marquis of Drogheda's, as army surgeon.

He is especially said to have given his time to the poor in Manchester, and a tablet in the cathedral was put up by the people of Manchester; a penny subscription contributed to it, and is a striking proof of his popularity. He had, however, medical practice among all classes. His death was tragic; riding out to see a patient at 'Clugh,' Miss Yates, an aunt of Sir Robert Peel, the horse put its foot into a hole, causing a sudden effort on the part of the rider. The effort broke or dislocated the spine near the neck, and all below was paralysed. He knew at once 'that he was a done man,' but his brain remained clear till his death at Miss Yates' a fortnight afterwards, on May 27, 1796. He was 61 years old. He was buried from the house where he died; all the mills and shops on the way were closed.

If it is fair to get amusement from a tragic death, we shall give here a letter sent by Dr. Eason's wife to him while he was lying ill at Miss Yates' house. This specimen of writing by a Fife lady of good family has, in the postscript at least, a strange turn of thought, not intended to be comic we dare say.

Manchester, 17th (only date given).

'Oh my beloved Sandie, that I had wings like a dove that I could fly to Churchland to do my duty to you, as you have always done to me! But this is a subject far too soft for my pen at present; my tears would flow faster than my ink. A thousand thanks for your kind remembrance by Dick Hall, which I will take care of. It gave me the greatest pleasure to hear by the Reverend Mr. Hall that your mind was so composed, and my prayer has never been wanting on that subject, nor ever shall. But I certainly must be allowed to come and see you; and yet, I really think it would be too much for both. Reason says this, but not your affectionate

'JANE EASON.

'N.B. My kindest gratitude to Mr. and Mrs. Peel (other names not legible).

'I dare not trust my pen longer, notwithstanding I cannot help telling you in the midst of my affliction I feel a kind of pride, for the whole town, high and low, rich and poor, are your friends, and I do believe if you was to leave us in want we would be supported for *your sake*; in short, the whole town and county is in an uproar about you, and if it is the Almighty's will to *spare you*, you will be given again to the prayers of thousands. I even was in hopes to go first to *kingdom come*, and it will be no disappointment to me now to let me go and say you are coming. I'll keep a good place for you; let me tell you it is a good thing to have a friend at court, Sandie, but I hope you will have faith in that friend that sticketh faster than a brother, and whose blood cleanseth from all unrighteousness, and who has said there is more joy in one repenting sinner than ninety and nine just persons. A lady called this day who was at the chapel in Oldham St. Your name was put up in three different petitions; that you were sent of God—you did so much good to the poor, that if the Lord would but spare you this time, and they call *all out* three times Amen.'

The name Eason has been made familiar to the present generation in Manchester by being a Christian name of one of his descendants, Dr. Eason Wilkinson, who stood high among the medical men here, and whose house in Greenheys had often pleasant company. On his death his widow retired to Middlethorpe Hall, near York. From her the above particulars were obtained.

There are three papers by Dr. Eason in the first volume, a very thoughtful one on crystallisation, putting together various similar phenomena; one on bleaching, from which a quotation is made, and one on the ascent of vapour, in which he advocates the view that electricity is required to keep the vapour up, two clouds, similarly electrified, repelling each other, but when one is positive and the other negative, there is a discharge of electricity, the particles of water unite, and rain falls.

JAMES MASSEY.

The name Massey is found in the Directory of the time under Chapel Street, Salford. There were two brothers, James and Joseph. James is interesting to us, as along with Dr. Mainwaring president of the Society for the first year. A portrait of Mr. James Massey was presented to the Infirmary by Mr. Tate in 1793. This introduces an amount of confusion which I hope will be removed. Joseph became endeared to Manchester by paying all the expenses of the first year of the Infirmary, and being, as it is said, its first president (1752), when yet in Shudehill. (It is also said that Mr. Miles Bower was first president, but others must settle that point.)

These Masseys were evidently men of wealth and of weight, with intellectual and benevolent tendencies.

In the MSS. there is mentioned as present at the second meeting of the Society Mr. John Massey.

Mr. James, the president, had some knowledge of chemistry, and his paper seems to indicate having been abroad. It is a good specimen of the thinking of the time, and we shall give a pretty full extract.

A Treatise on Saltpetre, by James Massey, Esq.

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P. 188. 'Saltpetre, to give a just description of it, is a neutral saline concrete, evidently formed by a combination of a peculiar acid with a fixed vegetable alkaline salt. This acid is found in certain earths, from which it is extracted, by elixiviating them along with wood-ashes, the fixed salt of which, uniting with the acid, forms this neutral one, which crystallises in the ley when boiled down to a due consistence.

'From this plain account of the formation of saltpetre, it must be obvious that it can nowhere be found without the concurrence of these two principles; and, consequently, not in the air, or in vegetables or animals, because, though this peculiar acid may perhaps be found in these subjects, the fixed salt must needs be wanting.

'That it may be sometimes found in the earth we shall not deny, owing to the accidental introduction of wood-ashes to a soil impregnated with this acid. And that from hence it may pass into the stems and apices of some plants, with the moisture that enters their roots, is far from being improbable. But that whole provinces can even be covered over with it, or that it can be generated in these organised bodies, as Lemeri and some others have imagined, must exceed all belief.

'The accounts which travellers generally give us of this salt are, that it is extracted from the soil of the countries they have visited, by elixiviating it with water, and evaporating the fluid; which we believe may be consistent with truth; but here it should not be forgotten that a certain portion of wood-ashes is always added to this soil before it is elixiviated, a circumstance which, either through ignorance or inattention, they have too often omitted to mention.'

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P. 190. 'Of these earths the most distinguished are, the rubbish of old houses, the ruins of old vaults and cellars, &c., which rarely fail to yield us the crystals of this salt when elixiviated with wood-ashes. That these earths possess an acid quality is not to be disputed; seeing that upon reducing them to a coarse powder, and percolating a fixed alkaline solution through them, this solution will be neutralised, and no longer yield us an alkaline, but a neutral salt.'

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P. 191. 'From the well-known fact, that the rubbish of all such houses as have been occupied by the filthiest inhabitants, and of such clay walls as have stood in the neighbourhood of dunghills, or wherever putrid vapours more plentifully abound, is always most strongly impregnated with this acid, it is most natural to believe, that these vapours must confer it upon them, and consequently, that it must have its origin in putrid substances; but to this there are likewise many objections. In the first place, the recent juices of vegetables and animals, some few of the former excepted, if we are not mistaken, contain no kind of acid whatever, and in a putrid state everybody knows they are of a volatile alkaline nature, which being the most powerful objection, we shall here principally endeavour to remove, and upon the whole shall undertake to show that there is an original acid in all vegetables and animals, which being rendered volatile by putrefaction, assumes the specific character of the nitrous. And that, since this acid constantly arises in vapour from putrid substances, hence it is that the rubbish of old houses, and of old clay walls, become impregnated with it, as well as those earths that lie in conjunction with them.

'That the recent juices of vegetables and animals are in general perfectly neutral, we shall readily admit; but from hence we think it does not follow that they contain neither an acid nor alkali, as is commonly concluded; on the contrary, we apprehend a more just inference is that, being mixed, they must necessarily contain both. It is certain that if we throw a calcareous earth or fixed salt into any of these juices, the earth or salt will be neutralised by it; which we take to be a proof that it contains an acid, which quits the weaker to join with the stronger alkali, according to the law of affinities.

'And the case will be the same, if these juices are putrefied. If we throw a fixed salt into any putrid liquor it will be neutralised by it, and now, if we dip a piece of soft paper into this mixture and dry it, it will burn like a match, in the same manner as if dipped into a weak solution of saltpetre; which shows, that it not only contains an acid, but one of the nitrous sort; and provided this liquor were putrefied, and the marine salt, with which all nitrous leys greatly abound, carefully removed, we cannot help thinking that upon being boiled down to a due consistence it would yield the crystals of saltpetre. The author must acknowledge he has boiled down many of these mixtures without success: but it was at a time when he was ignorant of the necessity of attending to the above circumstances.

'That all putrid substances, and consequently their juices, are of a volatile alkaline nature, is not to be denied, owing to an union of their acid and oily parts with their earth, which is equally subtilised by the putrid process.'

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P. 193. 'But the strongest proof of the existence of an acid in putrid juices, if the earths of stables and cow-stalls do not afford an equal one, must be drawn from the soil at the bottoms of graves, which can certainly derive its nitrous acid quality from nothing but the corrupt bodies with which it lies in contact; and this may satisfy us in respect to the source from which other absorbent earths may derive it.

'Other earths, in common use among the saltpetre makers, are those of stables and cow-stalls, that have drunk up much animal urine; the bottoms of stinking pits and ditches and the like. These they take out and lay in heaps, till by repeated trials they find them fit for their purpose. It is commonly supposed that, during this period, they draw their nitrous quality from the air; but for this there is certainly no just foundation, seeing they are brought to maturity as soon in the closest vault or cellar as in the most open exposure. The truth is, that all putrid juices contain many oily and mucilaginous parts, which, till they are duly attenuated by putrefaction, will not suffer any crystals to form in the leys that are drawn from these earths; and they are laid in these heaps for this event to take place.

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'The ingenious author of the "Chemical Dictionary" has told us, that the nitrous acid is nowhere found but in such earths as are impregnated with the juices of vegetables and animals, and where these juices have sustained the whole putrefactive process. But having assigned no reason for it, he seems to have been little regarded.

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'The common soil in some parts of India is naturally nitrous, owing plainly to the fish and slime that is left upon it by the inundations of the river Ganges, which soon corrupt in that hot climate, and fill the earth with putrid juices; and here putrefaction, being carried on with the greatest rapidity, is, of course, soon completed, and the natives are, in a short time, furnished with a nitrous earth perfectly matured. But it must not be forgotten, that their strongest earths are found at the bottoms of their tanks or shallow ponds of water, which, in this country, are often of great extent, where, the water being evaporated by the heat of the sun, large quantities of fish are left to corrupt, which furnish a mud of the strongest nitrous quality.

'In this manner are nitrous earths naturally formed in these parts of the world, and might doubtless be formed in others, though not perhaps so expeditiously, by throwing into shallow ponds of water, natural or artificial, all sorts of dung and carrion, with other putrid and putrefiable matters; where the water, being evaporated by the heat of our summers, must certainly leave a mud of the same kind and quality.

'Putrid juices and putrid vapours are dispersed through the earth and air, so that there are few earths of an absorbent kind that are not, in some degree, nitrous.

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P. 197. 'Glauber, who, from the observations he had made upon the fruits and effects of the bottoms of stinking ditches, seems to be the first that attempted to form artificial nitre beds, threw into pits, covered from the rain and sun, but exposed as much as possible to the air, all sorts of dung, with the cuttings of trees, refuse of gardens, and other putrid and putrefiable matters, to which he added wood-ashes; and, by this means, in a course of time, obtained, not a mere nitrous, but a true saltpetre earth, that afforded him the crystals of this salt upon simple elixiviation and evaporation.

'It does not appear that this celebrated chemist had the least idea that these putrid matters were of any other use than to draw the nitre, as he called it, from the air, in which the fixed salt of the wood-ashes might possibly assist.'

. . . .

P. 201. 'About thirty years ago, an ingenious chemist of our own nation, having visited many of the great works abroad, and made the observation, that to form a nitrous earth nothing more appeared to be necessary than to mix up calcareous earths with any kind of dung, and expose these materials to the air, returned home, fully persuaded that he was master of the secret, and had interest enough to prevail upon many of his friends to join him in erecting a large saltpetre works, at Fulham, near London. Here many hundred loads of lime were got together, and laid, with strata of horse muck, in long high ridges, the more to be exposed to this element; the consequence of which was, that the rain running off, without penetrating the mass, no putrefaction ensued, and the lime, at the end of four or five years, was found to have received little or no impregnation; upon which the work was dropped, with great loss to the proprietors.'

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P. 211. 'Upon many accounts it has been before observed that Glauber sometimes threw all sorts of dung into a large wooden vessel, and, when they had completed their putrefaction, percolated a fixed alkaline solution through them; which furnished him with a ley of the same kind and nature with that drawn from nitrous earths and wood-ashes.'

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P. 220. 'All these things being considered, with the practice of the Swedes, and the success of our own experiments, we judge ourselves authorised to advise all those who are employed in making saltpetre, to place but a few wood-ashes at the bottom of their tubs, to serve by way of filter, and to supply their place with potash.

CHAPTER VIII.

ESSAYS AND LIVES, VOLS. I.–IV.

Sensation and Perception in Vegetables.

DR. PERCIVAL wrote a short essay on the perceptive powers of vegetables, called by himself, partly in excuse for thinking in such a manner, a *jeu d'esprit* ; he seems to have felt uncertain whether he would print it or not. Some parts of this paper raise the author high as a general thinker on nature, and show that he had talents for investigation, and certainly for an observer, although his gentle nature and want of bodily strength led him into calmness of thought, which frequently produces diffuseness of style. Still he who looks on nature with the eye of a poet and a moralist, with much knowledge of natural law, and much acquaintance with phenomena, is a man of a high class, and in some respects of a much higher class than the man of genius, who sees in one direction only, although he who sees far is the rare man, and one to whom humanity owes most and gives most honour, and to whom alone we are accustomed to apply the title of *Great.*

To the first class of men Dr. Percival certainly belonged, seeing nature in its great width and watching the existence of mind, descending even to the plants as life itself does.

Some may say that the fundamental idea in the paper shows a touch of genius, and to this we might have agreed had we not known that it has occurred to many young sympathetic minds. Several have tried to give it a place in scientific thought. We remember it as a natural outgrowth of our childhood, when untaught by any one we stopped the process of cutting a branch lest perhaps it felt pain, an idea nourished in us afterwards by Virgil, who learnt it from a long line of literary ancestors by fairy tales from various nations, including ancient Egypt; but many ideas require no ancestors except the germs existing not solely as bodies, but as the peculiar movements of bodies in human blood.

As we write this we think of sacred trees, and bleeding bushes, trees in which lived Hamadryads, or trees which live and die with chosen individuals. The whole world has been given a soul as early as Plato, and Pantheism puts this soul everywhere; but to approach it as a naturalist shows a change of aspect of the question and a certain amount of boldness if Dr. Percival really did approach it of his own impulse; had he read Adamson for example? It would appear as if he had not, and he seems not to have read Dr. George Bell's essay, which however was printed afterwards in the same volume. We shall bring an extract from it before Percival's paper.

Dr. Bell's article 'On the Physiology of Plants,' vol. ii. p. 394, was written previous to Percival's, and published in Edinburgh 1777, as a Latin thesis. It was translated by Dr. Currie and published in these Memoirs; he says—

'The analogy between vegetables and animals, which was formerly pointed out, gives a reasonable presumption that the fluids of both are moved by similar powers. In animals, the powers of circulation are respiration and muscular action; of those powers in plants we have already treated, and what has been said on the subject seems to show, that the motion of the juices in plants is rather to be ascribed to them than to capillary attraction.

'The analogy of animal nature appears to favour the opinion, that the juice rises through the wood only, and descends only through the bark; but this analogy is not complete throughout. The arteries are not placed in the internal parts alone, nor the veins in the external, but they accompany each other through every part of their distribution.

'On the whole we may conclude, that the formation and growth of the parts of plants depend chiefly on the vital energy, which is not however exerted except on the application of stimuli. We admire the marks of wisdom and design, which appear in the creation and preservation of vegetables, but we have no reason to believe that they are possessed of any intelligent power, which presides over and directs their peculiar functions.

'The principle of life seems universally diffused through nature, but bestowed on different beings in different degrees. To animals is given the largest share; but throughout the whole animal kingdom, one species descends below another in the perfection of its mental powers, as well as of its organic sensations. And this progression is so very gradual, that the most perfect of an inferior species approaches very near to the most imperfect of that which is above it. The chain is continued between vegetables and animals.

'And if we admit such motions, as criteria of a like power in other beings, to attribute them, in this instance, to mere mechanism, actuated solely by external impulse, is to deviate from the soundest rule of philosophising, which directs us not to multiply causes, when the effects appear to be the same. Neither will the laws of electricity better solve the phenomena of this animated vegetable: for its leaves are equally affected by the contact of electric and non-electric bodies; show no change in their sensibility, whether the atmosphere be dry or moist; and instantly close when the vapour of volatile alkali or the fumes of burning sulphur are applied to them. The powers of chemical stimuli to produce contractions in the fibres of this plant, may perhaps lead some philosophers to refer them to the vis insita, or irritability, which they assign to certain parts of organised matter, totally distinct from, and independent of, any sentient energy. But the hypothesis is evidently a solecism, and refutes itself. For the presence of irritability can only be proved by the experience of irritations, and the idea of irritation involves in it that of feeling.'

Speculations on the Perceptive Power of Vegetables. By Thomas Percival, M.D., F.R.S. Read February 18, 1784. Vol. ii. p. 114.

'Vegetables bear so near a similitude to animals in their structure, that botanists have derived from anatomy and physiology almost all the terms employed in the description of them.

'A tree or shrub, they inform us, consists of a cuticle, cutis, and cellular membrane, of vessels variously disposed, and adapted to the transmission of different fluids; and of a ligneous, or bony substance, covering and defending a pith or marrow. Such organisation evidently belongs not to inanimate matter; and when we observe in vegetables, that it is connected with, or instrumental to the powers of growth, of self-preservation, of motion, and of seminal increase, we cannot hesitate to ascribe to them a living principle. And by admitting this attribute, we advance a step higher in the analogy we are pursuing.

'For the idea of life naturally implies some degree of perceptivity; and wherever perception resides, a greater or less capacity for enjoyment seems to be its necessary adjunct. Indefinite and low, therefore, as this capacity may be, in each single herb or tree, yet, when we consider the amazing extent of the vegetable kingdom, "from the cedar of Lebanon to the hyssop upon the wall," the aggregate of happiness, produced by it, will be found to exceed our most enlarged conceptions. It is prejudice only which restrains or suppresses the delightful emotions resulting from the belief of such a diffusion of good. And, because the framers of systems have invented arrangements and divisions of the works of God, to aid the mind in the pursuits of science, we implicitly admit as reality what is merely artificial; and adopt distinctions, without proof of any essential difference.'

Let us compare the latest conclusions on this subject by the man who of all others seems fitted best to give an opinion. In his concluding remarks (see 'The Power of Movement in Plants,' by Charles Darwin, LL.D., F.R.S., assisted by Francis Darwin), pp. 571–573, he says:—

'Finally, it is impossible not to be struck with the resemblance between the foregoing movements of plants and many of the actions performed unconsciously by the lower animals. With plants an astonishingly small stimulus suffices; and even with allied plants one may be highly sensitive to the slightest continued pressure, and another highly sensitive to a slight momentary touch. The habit of moving at certain periods is inherited both by plants and animals; and several other points of similitude have been specified. But the most striking resemblance is the localisation of their sensitiveness, and the transmission of an influence from the excited part to another which consequently moves. Yet plants do not of course possess nerves or a central nervous system; and we may infer that with animals such structures serve only for the more perfect transmission of impressions, and for the more complete intercommunication of the several parts.'

But as if to approach more nearly the feelings of Dr. Percival, he says at the end: 'It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements.'

After all, and even after reading Darwin's book on the motion of plants, we cannot be held to be nearer than Wordsworth, who says in 'Lines written in Early Spring':

> Through primrose tufts in that sweet bower,
> The periwinkle trails its wreaths;
> And 'tis my faith that every flower
> Enjoys the air it breathes.
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> . . . .
>
> The budding twigs spread out their fan,
> To catch the breezy air;
> And I must think, do all I can,
> That there was pleasure there.

GRADATION IN MAN AND ANIMALS.

Few people would expect the doctrine of progress in creation to have any representatives in the early Manchester Society, but this is chiefly because it seems so little known how far the world had advanced in the idea, and how many persons allowed it to pass through their minds. Dr. Charles White (we call him Dr., although not M.D.) had carefully thought of the remarkable smallness of the steps by which nature advances from the lowest forms up to the highest, and also the similar character of the advances in man himself. His opinions are to be found in a broad but thin quarto volume published in London in 1799; they had been given previously in a series of papers to the Literary and Philosophical Society. Their publication was not refused by the society, but he himself seems to have thought that it would entail too great an expense on that young institution. The volume is entitled 'An Account of the regular Gradation in Man and in different Animals and Vegetables, &c., from the Former to the Latter.' A plate shows these gradations in man and animals from birds to the highest human type. Mr. White had studied 'Camper's Facial Angle Theory,' but had made great advances upon him. He had studied Bonnet, and has given the gradation of animals as shown by him from man to earth and to fire, and even 'a more subtile element,' and he had read Lord Monboddo's writings. He is not willing to go with that very clear-headed advocate of evolution, even to the limited extent attempted to be proved by him. Lord Monboddo does not demand belief in the evolution of man from an animal lower than the ourang-outang, and to make that more easily believed he had exalted that animal much more than modern inquiry justifies ; still he himself thinks that it may be necessary to go far back, and an evolutionist he is to an extent most decided. The mode in which language and thought are evolved is reasoned out in a manner which must surprise many who rush to show their ideas of development in various departments, calling it Darwinianism, and not distinguishing that from evolution ; Lord Monboddo does his part coolly, slowly, and deliberately, like a man who did not expect to be believed soon.

Gradation in animals Dr. White saw clearly, but he refused to believe in development from species to species, and distinctly stigmatised Lord Monboddo's ideas as out of the pale of reason, as so many have done after him. It could not be expected that reasoning such as Darwin's should be ripened last century when vegetable and animal anatomy were so little advanced ; but reasoning with the instruments at hand was clear in the mind of Monboddo ; it was no mere sentence or clause of a sentence that he gave to the public, but a full-grown system up to a certain point. He begins with development of thought, and proceeds to his main point, development of language. It is difficult to imagine that a similar series of thoughts should have grown in society without giving Lord Monboddo credit or discredit for his part.

Dr. White proceeded more on that method of reasoning which may be called scientific in opposition to philosophic so far as this, that he did not go beyond that which he saw before him. This by some men is held to be the true scientific method, and it is enough for a large class of such for example as have a short vision, a useful class of men, because with narrow views they often see their small points with great exactness. The man of genius goes further, but we must not blame the less lofty scientific men ; we cannot all be men of genius, seeing cosmos in the smallest acts of nature.

But taking the subject from another side, who cannot see its beauty and correctness! There are gradations of man, of all animals, and of all plants, and it is clear that if they did not arise as such in the mind of the Creator they exist in creation distinctly before us as such. Yes, there was evolution in the thoughts of God, because one fact clearly leads the mind on to another, and if the connection is intellectual and moral, what objection can we make to having it material also? Let no one suppose that by speaking thus we try to rob the Creator of foresight. Growth is quite compatible with a knowledge of results, and if we sow a seed with full knowledge what kind of tree it will turn up, we may readily suppose that worlds sown broadcast cannot have developed without abundant foresight as to results. The means are very sure for the end, and of creation in its largest works we may say as of the smallest plants : things grow.

Darwin has not brought us to this general law, but we have been glad to learn from him how things grew in certain departments of nature's activity.

There is a kind of insanity spreading among scientific specialists, strongly developed among Darwinians so-called, but the larger mind of Darwin has never sanctioned it. They speak of natural selection as a power when it is only a method by which a power operates. In the same way differentiation is treated as a power, and people actually think they explain when they tell us of this occurrence in nature. This, instead of strength, is the utmost of weakness. Darwin has not shown this, but the weaklings (and nearly all his followers have been slow to reason) will now probably think that geotropism and apogeotropism will take the place of nature's most occult laws and will fancy these words also to be explanations. We should not be surprised to hear some of those who imagine themselves to be followers, but really are laggers behind, giving circumnutation as an explanation of intellect, and making the nutation of the plant as similar in meaning to the nutus of power. Some people also think that the 'survival of the fittest' is a great discovery. What else could survive? Were there ever men who believed that the least fit to live could live longest? It is, however, a telling expression—a name for a fact.

It is only fair on the general question to quote Lord Monboddo's words; he neglected the best part of his ideas and wandered over all the world losing the path with which he began. We may see what a fine foundation he had to work on. The following is from his 'Origin and Progress of Language,' 2nd ed. vol. i. p. 175, 1774.

'For it seems to be a law of nature, that no species of thing is formed at once, but by steps and progression from one stage to another. Thus naturalists observe several different appearances betwixt the seed and the vegetable, the embryo and the animal. The principles of body in general are *points*, *lines*, and *surfaces*, which are not *body*; and of *number* the *monad* and *duad*, which are not numbers, and in general the elements of things are different from the things themselves.'

Here we have clearly enough expressed, notwithstanding some imperfection in utterance, the idea of the progressive growth of all things from the lowest point to the highest. He goes even farther than the lowest material and points, as he may be said to begin with mere ideas, for example: 'There is the same progress, according to my hypothesis, in the formation of man, and the same distinction between the elements of this species, and the species itself.' He leaves the body, as it is his intention to keep to the design and progress of language, but on p. 182 he says, 'This is the scale of being, rising by progressive gradations from mere matter and sense to intellect.'

His strong belief that the ourang-outang was a man has no influence on this theory, and the length of his dissertation, which went over nearly all history and all the usual reading of men of the time, served only to weaken his main argument, so that few read his six volumes and almost as few ever refer to the book. It is very important, if one does refer to it, to use the second edition. The general ideas are in the first volume, before the special discussion on language and its progress begins.

We may conclude that gradation exists in all creation, and the only difference of opinion exists as to the time of the rise of each step. Man is an animal with a skeleton and anatomy resembling other animals so closely that every lion, tiger, and gnat recognises it. We live on the earth and are built of it, and we may as readily believe that we have passed through the stages of the lower living animals as through the still lower stages of the vegetable and the dead animals out of which we have certainly and visibly been made.

Here we may have Mr. Charles White's views brought in.

'Every one who has made natural history an object of study, must have been led occasionally to contemplate the beautiful gradation that subsists amongst created beings, from the highest to the lowest. From man down to the smallest reptile, whose existence can be discovered only by the microscope, nature exhibits to our view an immense chain of beings, endued with various degrees of intelligence and active powers, suited to their stations in the general system.

'Enough, however, it is hoped, is ascertained to disprove the theories by which naturalists have attempted to account for what they denominate varieties of the human species; and to establish that of a gradation as well of the human race as of the animal and vegetable kingdoms in general.

'A gradation in the human race, supposing all to have descended from one pair, could only be the temporary result of accidental causes, and would scarcely merit a minute investigation. But as a contemplation of the facts produced leads to the conclusion that various species of men were originally created and separated by marks sufficiently discriminative, it becomes an important object in general physiology to trace the lines of distinction. Previously to discussing the question of species it seems necessary to consider the signification of the term as used by naturalists.

'This leaves us to infer, as most naturalists have done, that species were originally so created and constituted as to be kept apart from each other, with certain characteristic distinctions which form a proper subject for investigation.

'The opinion here maintained, so far from degrading, tends much more to dignify the human race than the opposite one. For if, according to the latter, we admit that such great varieties can be produced in the same species as we find to exist in man, it would be easy to maintain the probability that several species of simiæ are but varieties of the species man; since they differ as little in their organisation from some individuals of the species as these do from men in general. And if the argument be still further extended, almost all the animal kingdom might be deduced from one pair, and be considered as one family; than which a more degrading notion certainly cannot be entertained. But the opinion advanced above effectually precludes any such consequences, as it places each species upon its own proper basis, and debars them from intermixing with other species, unless nearly resembling themselves, and even that in a limited manner.'

Lyell, in his 'Principles of Geology' (edit. 1853), chapter xxxvi. p. 608, has some remarks on the theory of gradations in intellect as shown by the facial angle, in which Charles White's name is not treated with due respect. After mentioning that Camper first attempted to estimate the degrees of sagacity of different animals and of the races of men by the measurement of the facial angle, Lyell goes on to say, 'A great number of valuable facts and curious analogies in comparative anatomy were brought to light during the investigations which were made by Camper, John Hunter, and others to illustrate this scale of organisations; and their facts and generalisations must not be confounded with the fanciful systems which White and others deduced from them.'

Charles White, F.R.S.

Charles White, F.R.S., the author of 'Gradation in Man,' was one of the original four vice-presidents of the Society, and was one of the most eminent and valued surgeons of the time, famous in all the country and not merely in Lancashire for his skill in manipulation, his ready resource and the success of his innovations. Still he was a thorough Manchester man, his father, Dr. Thomas White, having practised in the same town. He was educated in London and Edinburgh, and was a fellow student and friend of John Hunter. He lived in King Street, in a large house, prominent in views of Manchester of the time, with an imposing flight of steps on the spot, where afterwards was built the Manchester Town Hall, now in 1881 the home of the Free Reference Library. Mr. White had a country house at Sale, which is above five miles distant. The Manchester Infirmary may be said partly to owe its position to him; the Lying-in Hospital was also raised by his influence. We are informed by Thomas Henry that out of London the only infirmaries before the Manchester one 'in this part of England' (the meaning is not quite clear) were those of Shrewsbury and Liverpool.

Mr. White was an enthusiast in surgery. His museum of anatomical preparations was presented to the Lying-in Hospital; he and his son took part in the institution, begun in 1783, for the delivery of lectures on Literature, on Science, and the Arts. They took the anatomical department. He was the author also of many papers besides the work here mentioned, and his fame rested on his public spirit and his science, as well as on his fine touch.

Studying Botany, beautifying his garden, collecting forest trees, attending to the wants of the public by raising medical charities, and to as many patients as his time would permit, we see him rise into practical scientific thought, and in the above-mentioned essay to the wider position of generalising, and hear of him being recognised by various societies, and honoured by the acquaintance of many who themselves have received honour. We have reason to be proud of this one of our most brilliant founders. He lived a valued life, dying in 1813, his 85th year.

The writer had a pleasant walk this April (1881) with Dr. Joule, who took such interest as only a warm-hearted man could in finding out the monument to Dr. Thomas White, which Charles White, the more eminent son, had put up, on the land which both in turn possessed, and near the house where they lived. It is called The Priory, and is at Sale, about a mile from Dr. Joule's own house. In the 'Directory' of 1800 it is said, 'Passing the Mersey a pretty hermitage belonging to Dr. White.' The house still bears that appearance, although in coming near, one finds that time has injured it. The trees have now passed beyond their prime, and many have died or been taken down ; some are now being removed by a new possessor, who is otherwise making improvements. When we reached the monument it was with surprise and pity, whilst even laughter struggled for a place. The pillar was outside of the grounds of The Priory, the limits having been shortened towards the north ; it could be seen from the railway, but no one seemed to know what it was. One man said it was a monument to a horse, although it has an inscription on it, readable with care. It is next to the premises once occupied as Murray's stables, where 'hunters' were taken care of, but although put out of its own grounds it is not included in Mr. Murray's, but stands close to the pigstyes. It is on the edge of a bank,[1] below which is a piece of low flat land often flooded by the Mersey, and looking towards Manchester. The foundation is of bad bricks, and they are giving way; the bank itself is wearing down. The pillar is built of red sandstone, each stone being bevelled, so that in many cases water lodging in the hollows has worn away the edges, and in at least one case the deep cavity made is stuffed up with bricks. It is almost fourteen feet high; a little ornament that was believed to be on the top is broken off, and the whole looks desolate, outcast, and forlorn, ragged and wretched. We have seen monuments two thousand years old in better condition. Probably some one will say that the monument is well known because carefully described in some books. We did not know it, and now record our pilgrimage of this year.

We add the inscription, carefully read and written out by Dr. Joule—

To the memory of Dr. Thomas White, who, after acquiring prominence in his profession, retired from its honors and emoluments to enjoy in rural tranquility the pursuits of knowledge. Serene and cheerful through the declining period of life he attained the 81*st year of his age with faculties unimpaired, and died July* 20, 1776. *The grove which he planted and reared is now in its maturity. Consecrated to his revered name by his only son, Charles White, who erected this monument* A.D. 1790.

[1] The bank is really the old river limit. The Mersey is now confined as a rule to a narrow channel, but sometimes it seeks its old haunts and forms a wide lake. The sides of this old limit are called the Ees. Is that the Celtic *Eas*, steep bank or water-fall, or is it not rather a name from the cutting which in floods *eases* the flow?

It is not easy to obtain near Manchester the sight of any house with its grounds nearly as they were a hundred years ago. Ruinous as these of the Priory have become, they are like bad sketches, where the outlines are not seen exactly, but are blurred by the artist to save trouble; such pictures as are generally of twilight in quiet distances, or of mist as if made to conceal instead of to reveal; when not intended to cover incapacity, ignorance, or idleness.

In Ashton Old Church there is an inscription on a marble tablet on the north wall—

Near this place lieth the body of
THOMAS WHITE, M.D.
Who died July 20, 1776, *aged* 80, *and*
ROSAMOND,
His wife, who died April 23, 1777, *aged* 80.
Beneath this marble lieth also the body of
CHARLES WHITE,
Member of the Corporation of Surgeons, and Fellow of the Royal Society,
Who, after rendering himself eminent in his profession
For the space of 60 *years,*
By a dexterity and extent of knowledge scarcely exceeded
By any of his contemporaries,
Retired to the enjoyment of rural and domestic felicity
In the society of his family and friends at
Sale,
Within this parish.
Died on the 28*th February*, 1813, *aged* 84.
Also the body of
JOHN BRADSHAW WHITE,
Who died April 27, 1797, *aged* 27.

We think this from Mr. White, the grandson of Dr. Thomas, may still be interesting.

A Short Account of an Excursion through the Subterraneous Cavern at Paris. By Mr. Thomas White, Member of the Royal Medical Society of Edinburgh, in a letter to his Father. Read February 9, 1785. Vol. ii. p. 361.

Paris : July 29, 1784.

'I yesterday visited a most extraordinary subterraneous cavern, commonly called the Quarries. But before I give you the history of my expedition it will perhaps be necessary to say a few words concerning the Observatoire Royale, the place of descent into this very remarkable cavern. This edifice is situated in the Faubourg St. Jacques, in the highest part of the city. It takes its name from its use, and was built by Louis XIV. in 1667, after the design of Claude Perrault, Member of the Academy of Sciences, and First Architect to his Majesty. It serves for the residence of mathematicians, appointed by the King to make observations, and improve astronomy. The mode of building it is ingenious, and admirably contrived, it being so well arched that neither wood nor iron are employed in its construction. All the stones have been well chosen, and placed with a uniformity and equality which contribute much to the beauty and solidity of the whole edifice. It is reckoned to be about eighty or ninety feet in height, and at the top there is a beautiful platform, paved with flint stones, which commands an excellent view of Paris, and its environs. In the different floors of this building there are a number of trapdoors, placed perpendicularly over each other, and when these are opened the stars may be very clearly distinguished, from the bottom of the cave, at noonday.

'At this place I was introduced to one of the inspectors (persons appointed by the King to superintend the workmen) by my friend Mr. Smeathman, who had used great application and interest for permission to inspect the quarry, and had been fortunate enough to obtain it. For as this cavern is extended under a part of the city of Paris, and leaves it in some places almost entirely without support, the inspectors are very particular as to showing it, and endeavour to keep it as secret as possible, lest, if it should be generally known, it might prove a source of uneasiness and alarm to the inhabitants above. For, what is very remarkable, notwithstanding the extent of this quarry, and the apparent danger many parts of the city are in from it, few, even of those who have constantly resided in Paris, are at all acquainted with it, and on my mentioning the expedition I was going to undertake to several of my Parisian friends, they ridiculed me upon it, and told me it was impossible there could be any such place.

'About nine o'clock in the morning we assembled to the number of forty, and, with each a wax candle in his hand, precisely at ten o'clock descended by steps to the depth of three hundred and sixty feet perpendicular. We had likewise a numbers of guides with torches, which we found very useful; but, even with these assistants, we were several times under the necessity of halting, to examine the plans the inspectors keep of these quarries, that we might direct our course in the right road. I was disappointed in not being able to obtain one of these plans, which would have given the clearest idea of this most extraordinary place. At the entrance, the path is narrow for a considerable way; but soon we entered large and spacious streets, all marked with names, the same as in the city; different advertisements and bills were found, as we proceeded, pasted on the walls, so that it had every appearance of a large town, swallowed up in the earth.

'The general height of the roof is about nine or ten feet; but in some parts not less than thirty, and even forty. In many places, there is a liquor continually dropping from it, which congeals immediately, and forms a species of transparent stone, but not so fine and clear as rock crystal. As we continued our peregrination, we thought ourselves in no small danger from the roof, which we found but indifferently propped in some places with wood much decayed. Under the houses and many of the streets, however, it seemed to be tolerably secured by immense stones set in mortar; in other parts, where there are only fields or gardens above, it was totally unsupported for a considerable space, the roof being perfectly level, or a plain piece of rock.

'After traversing about two miles, we again descended about twenty steps, and here found some workmen, in a very cold and damp place, propping up a most dangerous part, which they were fearful would give way every moment. We were glad to give them money for some drink, and make our visit at this place as short as possible. The path here is not more than three feet in width, and the roof so low that we were obliged to stoop considerably.

'By this time, several of the party began to repent of their journey, and were much afraid of the damp and cold air we frequently experienced. But, alas! there was no retreating.

'On walking some little distance farther, we entered into a kind of salon, cut out of the rock, and said to be exactly under the Eglise de St. Jacques. This was illuminated with great taste, occasioned an agreeable surprise, and made us all ample amends for the danger and difficulty we had just before gone through. At one end was a representation in miniature of some of the principal forts in the Indies, with the fortifications, draw-bridges, &c. Cannons were planted, with a couple of soldiers to each, ready to fire. Sentinels were placed in different parts of the garrison, particularly before the governor's house; and a regiment of armed men was drawn up in another place, with their general in the front. The whole was made up of a kind of clay which the place affords, was ingeniously contrived, and the light that was thrown upon it gave it a very pretty effect.

'On the other side of this hall, was a long table set out with cold tongues, bread and butter, and some of the best Burgundy I ever drank. Now everything was hilarity and mirth; our fears were entirely dispelled, and the danger we dreaded the moment before was no longer thought of. In short, we were all in good spirits again, and proceeded on our journey about two miles farther, when our guides judged it prudent for us to ascend, as we were then got to the steps which lead up to the town. We here found ourselves safe, at the Val de Grâce, near to the English Benedictine convent, without the least accident having happened to any one of the party. We imagined we had walked about two French leagues, and were absent from the surface of the earth betwixt four and five hours.

'After we had thanked the inspectors and guides for their very great civility, politeness, and attention, we took our leave, to visit the English Benedictine convent, in whose courtyard, and within a few yards of their house, the roof of the subterraneous passage had given way, and fallen in to the depth of one hundred and ninety-three feet.

'Though there was some little danger attending our rash expedition (as some people were pleased to term it) yet it was most exceedingly agreeable, and so perfectly a *nouvelle* scene, that we were all highly delighted, and thought ourselves amply repaid for our trouble.

'I regretted much that I did not take a thermometer and barometer down with me, that I might have had an opportunity of making some remarks on the temperature and weight of the air. Certainly, however, it was colder at this time than on the surface of the earth. But Mr. Smeathman informed me, that when he descended the last winter in the long and hard frost he found the air much more temperate than above ground, but far from warm. Neither, however, had he a thermometer with him. I lamented too that I had not time to make more remarks on the petrifactions, &c.

'Mr. Smeathman observed, that when he descended, he found a very sensible difficulty of breathing in some of the passages and caverns, where the superincumbent rock was low, and the company crowded. This no doubt was much increased by the number of persons and of wax lights, but he does not apprehend that the difficulty would have been so great in rooms of equal dimensions above ground. We remarked too, when we descended, that there was, in some degree, an oppression of respiration throughout the whole passage.

'There were formerly several openings into the quarries, but the two I have mentioned, viz. the Observatory and the Val de Grâce, are, I believe, the only ones left; and these the inspectors keep constantly locked, and rarely open them, except to strangers particularly introduced, and to workmen who are always employed in some part by the King.

'The police thought it a necessary precaution to secure all the entrances into this cavern, from its having been formerly inhabited by a famous gang of robbers, who infested the country for many miles round the city of Paris.

'As to the origin of this quarry, I could not, on the strictest inquiry, learn anything satisfactory; and the only account I know published, is contained in the "Tableaux de Paris," nouvelle édition, tome premier, chapitre 5me, page 12me:—

'"For the first building of Paris, it was necessary to get the stone in the environs, and the consumption of it was very considerable. As Paris was enlarged, the suburbs were insensibly built on the ancient quarries, so that all that you see without is essentially wanting in the earth for the foundation of the city: hence proceed the frightful cavities, which are at this time found under the houses in several quarters. They stand upon abysses. It would not require a very violent shock to throw back the stones to the place from whence they have been raised with so much difficulty. Eight men being swallowed up in a gulf one hundred and fifty feet deep, and some other less known accidents, excited at length the vigilance of the police and the Government, and, in fact, the buildings of several quarters have been privately propped up; and by this means a support given to these obscure subterraneous places which they before wanted.

'"All the Faubourg St. Jacques, Rue de la Harpe, and Rue de Tournon, stand upon the ancient quarries; and pillars have been erected to support the weight of the houses. What a subject for reflection, in considering this great city, formed and supported by means absolutely at contradiction! These towers, these steeples, the arched roofs of these temples, are so many signs to tell the eye that what we now see in the air is wanting under our feet."'

The grandson of Charles White was lately well known in Lancashire as Captain White, many years master of the Cheshire hounds.

Dr. Barnes, F.R.S.

The Rev. Dr. Barnes is not much written of as a Lancashire force, but he certainly shows himself, in our Memoirs, to be one of the most clear-headed of the men in the Society in looking forward and seeing the defective education of the time and its results. He had become the minister of the Unitarian Chapel in Cross Street, a place made to continue interesting by the labours of Mr. Robberds, and still keeping its character under the care of Mr. Gaskell. We are told of very early proposals to erect a University in Manchester, long before the dates with which we have been occupying ourselves. The plan was formed in early times, when there were few people and little money. It was, unfortunately, unsuccessful, although the most of our universities, and until lately our public schools, were founded in days when the country was to a large extent uninhabited and when commerce scarcely existed. A university would perhaps have given, in the opinion of some, a broader basis to the manufactures of Manchester, which have been left in the hands of uneducated geniuses. This is partly the reason that so much credit has been given to the opinion that learning is prejudicial; but, on the whole, it has been good for the world that the useful arts and book learning have worked separately for a time, so that each has learnt to respect the other. Can we find the men who are now living with all the advantages of education doing their work in such a superior manner that they are entitled to look down upon their fathers? We know it is still true that the men who are self-educated come into the town and prosper, and too many educated men who have received the moneyed fruits of their fathers' labours give themselves to amusement or to idleness, and we believe to vice. Have we not heard that Manchester is a great centre of betting, the resort of unregulated intellects, or men who will not make exertion, who have no steady purpose, who have no desire to do good, but who wish to live well even at the expense of others,—men who seek to amass wealth by robbery, but in such a manner that they cannot be punished, for such is betting and mere speculation with the money of others.

Dr. Barnes wished to avoid the evils of want of education. All was right so far; right to seek to have our manufacturers better taught than they were, and not to leave us obliged, as we are now, to hurry forward schools for practical science in fear lest our prosperity should rapidly decay, on account of the greater care taken in the education of our neighbours. But had he succeeded, no man knows if the result would have been better; it may be that men would have been too far advanced in one direction, missing a stage of life. It may be that the idleness of abundance would have come soon, and a generation or two have been lost to labour. Wealth of nations is not always prosperity, and it is a question how far we are prosperous men; long-continued wealth produces idleness, except in noble or ambitious minds; a few shillings' increase weekly are as wealth to a poor man; and he was a wise man who, when asked what is enough, answered 'a little more.' Our newest æsthetic literature follows suit in loving externals—does its best to destroy high motive, and consolidates the foundation of selfishness.

When sin has no meaning man's conscience is guided by his success, when hope is a delusion caused by the nearness of some organs of the brain to others, producing a mistaken induction, when charity and tenderness are the consequences of an atavism which another line of development may teach us to despise, is it wonderful that we should cease to have respect for the body, especially if it is not our own; and is it, after all, any better than a galvanised carcase, excited by a fine spark which has no meaning, but runs off to perform a similar service to the nearest dog or reptile; and why not? Is not the reptile's life as important as our own? For what cares heaven about us or about itself either—the great unconscious, wandering, meaningless heaven that spins round, for ever the same, always at a new beginning, always at a new end, that would weary of its own existence if it only had feeling enough to weary, or sense enough to know how empty is its life? This is the dreary religion of to-day. Why teach our children morality?—let them get the best they can of the world. If they take from others, what matters it—these others are but for a day! But at least let us teach them the physical morality of science, let us teach them to take care of their health. Why? What matter how long they live, mere masses of tingling fibres—there are plenty more to take their place?

However, society advances by steps, and after a time of mere æsthetic selfishness, or that 'most beautiful' refinement with which people make a kind of satanic drawing-room for heaven where poetry of earth and sense displaces religion, we shall some day throw it all aside as trifling, and shall again say, 'My very heart and soul cry out, O living God, for Thee.'

Dr. Barnes returned to the education of Manchester in 1783, and read three papers on the subject, one of them being 'Proposals for establishing in Manchester a plan of liberal education for young men designed for civil and active life, whether in trade or in any of the professions.'[1] The next part was 'Constitution and Regulations of the College of Arts and Sciences in Manchester.'

The first paper was drawn up 'at the request of the society,' and was printed by them, and 'offered for the consideration of the public.' This resolution was passed on April 23, 1783, and on July 6 of the same year, the 'College of Arts and Sciences' was instituted.

We must give here some of the rules of the college.[2]

'We have mentioned it as principally accommodated to young men designed for a respectable line of trade. But those who are designed for the different professions, as well as those who have no particular profession in view, will probably find very considerable advantage from it, either as preparatory to the university, or to life in general. And there are many gentlemen, further advanced in age, who have sufficient leisure and disposition for such pursuits, to whom it would, possibly, be an agreeable circumstance to have the opportunity of spending two or three hours in a week in so rational and improving an entertainment.

'Strongly impressed with these ideas, the gentlemen who wish well to this scheme hope to see it prosecuted with zeal and perseverance. They conceive that it will be an honour to the town of Manchester to have within itself such an institution as that here proposed, and to take the lead among the other great towns of this opulent kingdom in establishing a plan which, it is not improbable, many others will be ambitious to follow.

'If, upon this general view, this institution should appear

[1] Vol. ii. p. 30. [2] *Lit. and Phil. Soc.*, vol. ii. p. 40.

worthy of the attention and patronage of the public, a more particular account of its extent and objects will be given in another paper, together with a distinct syllabus of the lectures proposed to be delivered in every separate department. And it is hoped that its commencement may take place the ensuing winter.

'N.B.—It is proposed that the lectures shall be delivered in the evening, or so as not to interfere with the regular hours of business.'

OFFICERS OF THE COLLEGE.

Patrons.

The Right Honourable the Earl of Derby, Lord Lieutenant and Custos Rotulorum of the county palatine of Lancaster.

Sir Thomas Egerton, Bart.
Thomas Stanley, Esq. } *Knights of the Shire.*

President.

Thomas Percival, M.D., F.R.S., & S.A., &c., &c.

Governors.

James Massey, Esq.	Charles White, Esq., F.R.S.
Rev. Thomas Barnes.	Mr. Thomas Henry, F.R.S.
Alexander Eason, M.D.	Mr. George Bew.
Rev. Samuel Hall, A.M.	Mr. Isaac Mosse.

'As a mark of respect to the Literary and Philosophical Society of Manchester, which has so fully discussed the merits, and so zealously encouraged the plan of this institution, that the present nine officers, viz. the presidents, vice-presidents, secretaries, and treasurer, be appointed governors of the college.

'It may not be improper to mention, that the scheme here proposed has been carried into execution with considerable success. During the two last winters, lectures have been delivered in different branches of science to numbers of gentlemen, who have thus given the most respectable sanction to the undertaking. And it may be added, that the gentlemen engaged in the office of prælectors, animated with the encouragement they have already received, hope to pursue their important object with vigour and perseverance, not doubting but that they shall continue to enjoy the patronage and support of the friends of science and of virtue.'

However, the spirit of Manchester was too strong, and the Literary and Philosophical Society was aiming at more than the working city could accomplish, or at least was willing to accomplish.

Dr. Barnes [1] seems to have been a wide-minded man, and to have had a clear vision of the importance of science, as well as the cultivation of the arts which made Manchester important. We see this from the paper he read (Jan 9, 1782), 'On the affinity subsisting between the arts, with a plan for graduating and extending manufactures, by encouraging those arts on which manufactures principally depend.' This plan consists in forming an institution devoted principally to chemistry and mechanics, but connected also with a museum. An account of this is better in his own words.

Dr. Barnes may be said to have followed on Mr. Henry's ideas, and developed plans still more practical. It would have been well if Manchester had taken the advice thus early given ; then the museum, with its collections of work and patterns, would have formed of itself a fine history of the town and all its labours. He writes :

[1] See vol. i. p. 84, Dr. Barnes.

'Let us now apply these observations.[1] I have ventured to chalk out the outlines of a plan, the sole object and principle of which is, the improvement of our manufactures, by the improvement of these arts on which they depend. Those arts are Chemistry and Mechanism. In an excellent paper, read to this Society some time ago, it was lamented, "that so few of our dyers are chemists, and of our chemists dyers." We may add, how few of our mechanics understand the principles of their own arts, and the discoveries made in other collateral and kindred manufactures? At this day, I am informed, not a single weaver in the Norwich trade understands the use of a fly-shuttle.

'But to proceed to our plan.

'The first object of this scheme is, to provide a public repository among us for chemical and mechanic knowledge.

'In order to this, I could wish models to be procured of all such machines, in the various arts, as seem to bear the most distant relation to our own manufactures. All the processes in those of silk, of woollen, of linen, and of cotton should be here delineated. These would make the most necessary and important parts of this collection. But to these might, with great advantage, be added, the astonishing effects of mechanic genius in other branches, which have not so apparent an affinity with our own.

'In this repository let there be likewise provided an assortment of the several ingredients used in dyeing, printing, etc., for the purpose of experiments.

'A superintendent will be necessary, to arrange, and to apply this collection to its proper use. He should be a man well versed in chemical and mechanic knowledge.

[1] See vol. i. p. 84, Dr. Barnes.

And let his province be, at certain seasons, and under certain regulations, to give lectures, advice, and assistance, to those who wish to obtain a better knowledge of these arts.

'Lastly; let the expense necessary to open and to support the scheme be defrayed by a subscription: and let every subscriber have the power of nominating one, or more, to receive the advantages of this Institution. . . .'

'This mechanic school would serve as a proper step of transition, from thence to the warehouse; and, perhaps, it might become a regular part of a young gentleman's preparation for business. How desirable a part it would be I will not here say. Other gentlemen present are much better qualified to decide upon the question. . . .

'Objections will, perhaps, have already arisen, which may appear strong, I hope not unanswerable. That of the expense I cannot allow to be of this number. Nor the difficulty of finding a proper person to superintend the Institution. Nor the regulations necessary to its internal management and conduct. If no objections stronger than these be found against it, I shall not deem it altogether Utopian.

'Something similar to this has been done by the Society of Arts. But the two plans are essentially different. They give premiums: but they have no lectures, or modes of instruction. Our plan would be desirable in every large town, and particularly in the centre of every important manufacture. . . .

He then adds: 'When I was engaged thinking on the plan, and, like the artist, enamoured of its imaginary beauty, I met with the following passage in Sully's Memoirs. My feelings in reading it I will not attempt to describe.

'He tells us that among the great designs of Henry

IV. which were prevented from being carried into execution by the untimely and tragical death of the great prince was the following.

'"There was to be," says Sully, "a Cabinet of State, in the Louvre, destined to receive whatever could tend to the knowledge of Finance, of Science, and of Art."

'After enumerating several of these, particularly relating to the army, such as lists, plans, charts, etc. etc., he adds: "I conceived a scheme, of appointing a large room, as a magazine, of models of whatever is most curious in machinery, relating to war, arts, trade, etc., and all sorts of exercises, noble, liberal, and mechanical; that all those who aspired to perfection might, without trouble, improve themselves in this silent school. The lower apartments were to hold the heavy pieces of workmanship; and the higher were to contain the lighter. An exact inventory of both was to be one of the pieces of the great cabinet."[1]

'What a pity it is that this whole plan was not carried into execution. It would not have been the least of the embellishments of the reign of Henry. It would have done honour to the prince and to the age. I mean not to disparage the utility of our modern collections of *fossils, shells, mosses, and insects.* They are the works of God; and therefore worthy of our highest admiration. But I can easily conceive that a scheme like this, upon a smaller scale, might possibly be applied to better use than many of those collections actually serve. In a town like this the opulence, and even the very existence of which depends upon manufactures, and these again upon *arts, machinery, and inventions*, a PUBLIC CABINET, devoted to this purpose, would be a source of great ornament and utility.'

[1] Sully's *Memoirs*, vol. v.

These ideas have been carried out with great fulness in Paris.

Manchester has always been aware of the importance of such advice, but it has not been much inclined to look forward, and to take it; it has looked to the next year perhaps, but seldom farther, and late in this century Salford moved a step in advance, and by great care the energy of some of its citizens has made a museum which is at least a very valuable portion of that which would long ago have existed had the advice of Dr. Barnes and Mr. Henry been adopted—an advice which this Society disseminated over Europe. The idea of museums was not quite new, i.e. cabinets existed of all kinds of curiosities, both natural and artificial, not applied however by manufacturing towns for their purposes, or at least to a very small extent, and scarcely known to scientific men.

As with the sanitary idea, Manchester began by thinking, but showed itself more of a speculative town at the time, instead of a practical one. The world had got little beyond the times of De Monconys, who published his travels in Europe and the Levant in 1666 at Lyons, and describes for us the various collections of wonders as well as the experiments he saw. Certainly there were museums in more than one town in England: many were absurd collections not understood. Even Sir Hans Sloane, who was earlier in action, had not risen up to Dr. Barnes' ideal. Dr. Barnes, who brought forward the plans for colleges and museums, was born at Warrington in 1747, and died July 8, 1810. He was above thirty-one years minister of Cross Street Chapel. (See 'Manchester Academy,' App. A.)

When the scientific men of Manchester were thus struggling for the welfare of the community around them, others were fighting for political liberty. In 1794 the Boroughreeve, Thomas Walker, was prosecuted by the Government. He had been appointed two years before president of the Constitutional Society, certainly not a very formidable title, and one savouring little of opposition to law.

A Political Episode.

In contrast to the work of the Society we give here a few extracts from 'Old Political Tracts,' sent by Dr. Bottomley, and more explicit than the allusions already made.

'Thomas Walker and Samuel Jackson were respectively president and secretary of the Manchester Constitutional Society. Two of the members of the Society being in Paris upon private business, they were desired by the Society to communicate with the Patriotic Societies of France, for the purpose of establishing a correspondence upon any occasion in which the rights, interests, and happiness of mankind were concerned. Such a correspondence was proposed on the part of the Manchester Society, and was acceded to by the Society of Friends of the Constitution in Paris, commonly known by the appellation of the Club of the Jacobins. The deputies of the Constitutional Society of Manchester were Thomas Cooper and James Watt, junior. They presented their address to the Society of the Friends of the Constitution, sitting at the Jacobins in Paris, on April 13, 1792. In the absence of the President this address was replied to by the Vice-President, M. Carra. In this address he says, "Already several civic feasts have been celebrated in almost every department of the empire, consecrating the alliance which we have sworn anew to observe with all the patriots of England in the persons of the deputies from the Society of the far-famed town of Manchester." This address was ordered to be printed, and was signed by Carra, Vice-President; Ducos and Saladon, Deputies of the National Assembly; Deperrey Roi, Doppet, Secretaries. A letter was also sent from the Society of the Friends of the Constitution at Paris to the Constitutional Society of Manchester. At the commencement it says, "Friends and Brethren, The affectionate address communicated to us by your deputies, Messrs. Cooper and Watt, has rejoiced the heart of every honest Frenchman, and of every true friend of humanity and philosophy." The letter is signed by Deperrey and Doppet, secretaries, and Carra, Vice-President; the date is Paris, April 14, 1792—the fourth year of liberty.

'These proceedings attracted the attention of Mr. Burke. In his speech made in the House of Commons April 30, 1792, he is reported to have expressed himself in substance thus: "That there were in this country men who scrupled not to enter into an alliance with a set in France of the worst traitors and regicides that had ever been heard of, the Club of the Jacobins. Agents had been sent from this country to enter into a federation with that iniquitous club, and those were men of some consideration here; the names he alluded to were Thomas Cooper and James Watt (here Mr. Burke read the address presented to the club of the Jacobins by those men on April 16). . . . He likewise could name others who avowed similar principles; for instance, Mr. Walker of Manchester."'

From the *Manchester Historical Recorder* I (Dr. Bottomley speaks) have taken the following notes:

1792. 'The premises of Messrs. Faulkner and Birch, printers of the *Manchester Herald*, destroyed by a political mob. The house of Thomas Walker, Esq., in South Parade, St. Mary's, was also attacked, and in self-defence Mr. Walker was compelled to fire on the mob. The attacked were attached to the cause of reform.'

1794. 'Thomas Walker, Esq., Mr. Collier, and others were tried at Lancaster on a charge of having conspired to overthrow the constitution and assist the French in the threatened attack upon this island. They were acquitted March 3, and returned triumphantly to Manchester.'

'Dunn, the principal witness against Mr. Walker, was tried for perjury, and sentenced to the pillory and two years' imprisonment.'

The Constitutional Society had its opponents, and Mr. Francis Phillips is mentioned as a bitter enemy of reform. Later, i.e. in 1808, he had the satisfaction of supporting his chief in his last struggles, Mr. Perceval the Prime Minister having fallen into his arms when shot in the lobby of the House of Commons.

As Dr. Bottomley remarks, these political feelings were carried into our Society, and we find that on October 7, 1791, Mr. S. Jackson moved, 'that the Society do write to Dr. Priestley, being an honorary member, expressing their concern at the losses he has sustained by the late disgraceful riots at Birmingham.' On October 21 this was postponed, and on November 4 a letter of resignation was received from Mr. Thomas Cooper, also from Mr. Watt, junior, Mr. Thomas Walker, and Mr. Samuel Jackson. Mr. Walker was previously very popular on account of his influence in having the fustian tax, which had been imposed by Pitt, repealed. (See p. 122, also under Thomas Cooper, p. 189.)

Dr. John Ferriar.

Dr. John Ferriar was a man of great force of character, and attained an eminence beyond the place of his practice. He was born at Oxnam,[1] near Jedburgh, in 1761; he studied in Edinburgh, and practised in Manchester. He was physician to the Infirmary and Lunatic Asylum. He died in 1815.

He contributed to the memoirs of the Society several of his papers; a letter has already been quoted regarding sanitary measures to be adopted in Manchester. An article in vol. iii., 'On the Vital Principle,' gives us a specimen of his power of reasoning and breadth of mind, and leads to conclusions generally accepted. He sums up, 'While so many doubts occur respecting the proof of a vital principle, and while the supposition includes so many difficulties, in its own nature, it is allowable to suspend our judgment on the subject till more convincing proofs of its existence shall appear than have as yet been offered to the public. At present it is evident that we gain nothing by admitting the supposition, as no distinct account is given of the nature or production of this principle, and as an investigation of facts seems to lead us back to the brain as the source of sensibility and irritability.

'In the course of this paper I have uniformly considered the action of the mind and brain on the body as identical, without reference to the question of materialism; because with respect to our facts, and indeed to all medical facts, the notion is sufficiently complete. I have also avoided all disquisitions respecting the peculiar nature of the ner-

[1] Vol. iii. The same family spelt the name as Ferrier. See life by J. E. Bailey, *Palatine Note Book*, 1882.

vous energy, convinced that in the present state of our knowledge it is of more consequence to examine one opinion, which is said to be supported by facts, than either to reject or advance many plausible hypotheses. I have purposely omitted to consider the application of the doctrine of a vital principle to pathology, as the subject would lead to disquisitions inadmissible by the rules of the Society.'

We see a true scientific treatment up to the point of knowledge of the time, whilst there is generally an absence of that scientific bigotry or perhaps superstition which throws so much suspicion on the reasoning of many scientific men when they enter on such subjects.

Dr. Ferriar's paper ' On Popular Illusions,' in vol. iii., is an interesting one, treating of demonology, magic, witchcraft, miraculous cures, and powder of sympathy, and he tells us many wonderful tales which have become to a large extent familiar to those who have read pretty full collections of such relations made in modern time, and we cannot but agree with his well expressed conclusion, giving our own meaning to his words. He says:

' Lastly, an acquaintance with the histories and arguments of demonologists produces a useful hesitation in assenting to evidence however specious; for in doubtful cases, however numerous the witnesses may be, it will always be remembered how frequently men have shewn themselves determined to see and believe things invisible and incredible.'

Dr. Ferriar amongst other subjects brings in mesmerism, and is in this case certainly not free from that kind of bigotry we spoke of, viz. the scientific, the result of want of far-seeing as all bigotry is. He does not seem to imagine for a moment that he may be wrong, and ascribes Mesmer's results to imagination, a word commonly introduced as a kind of magician's spell to explain everything that will not agree with presumptuous theories having weak foundations. The word imagination is used as for many years electricity has been used, a power wonderful enough, but itself as mysterious as anything that it is supposed to explain, and its use simply implies ignorance in most cases. After nearly a hundred years Mesmer found an expounder in Manchester. Dr. Braid examined the subject soon after he came from Scotland to settle here, when he formed the theory which he published in a volume on 'Hypnotism, or the Sleep of the Nerves.' At least it proved many long denied facts, and advanced an explanation so far. All orthodox men thought it prudent to laugh, but now that his theory comes back from Germany, although unacknowledged, and probably unknown to the new writer, it may bring more honour to the product of our own community. Dr. Braid was not looked on as sound here, was in fact despised by some as a quack, and he died before it was found by the public that he was a discoverer. What man can outlive the hatred of bigots? It is certainly very amusing to see men who have learnt the grosser and more superficial laws of nature known to our books refusing to believe anything which these laws do not account for. The most wonderful things in nature are done by laws for which we have no expression beyond statement of facts. The reformer is often pitied as a quack. We have many good working scientific men who bring forth their little laws in neat sentences to express their ideas of the chains by which they propose to bind nature—we do not object to their laws, but in most cases they may rather be compared to small currents or eddies in a great stream, in which nature carries everything along with it—the great law.

Dr. Ferriar wrote a volume entitled 'Essay towards a Theory of Apparitions,' many of which also are easily explained by the imagination method.

As a very curious instance of this class of explanation Dr. Ferriar gives (see Mem. vol. iii. p. 113) some account of Marcus Marci (a physician in Prag), who held 'that ideas are substantial and everywhere in the constituent atoms of their subject, although its organisation be destroyed. Thus spectres and redivivi were explained, without any other difficulty than that of believing the theory. It was a question amongst philosophers last century, how the raining of frogs could be explained; for that frogs were rained nobody presumed to doubt before Rhedi. Marci roundly affirmed that the ideas of frogs were brought down by the rain, and that they put on a covering of mud after their descent. This rain of ideas is a thought that would have been much celebrated in a poet. Sterne has hit on something like it, but the congelation of minds, which furnishes the subject of two very amusing papers in the "Tatler," is a stretch of fancy capable of making any poet's fortune. . . . That singular and beautiful appearance the Fata Morgana, was a happy confirmation of Marci's hypotheses; he supposed them to consist of the ideas of dead animals.'

Probably this is a perversion of Plato's theory of ideas, it certainly goes beyond all reason.

Another paper read by Dr. Ferriar is entitled 'Essay on the Dramatic Writings of Massinger.' This essay shows a great attention to and a full appreciation of the dramatic poets of England, and modern writers have given to Massinger the place which our author has assigned.

Dr. Ferriar complains of the neglect of the poet, and there certainly was no critical edition of his works till 1805, twenty-one years after this essay was written.

We are inclined to look on the literary criticism as good in the Society's memoirs. Criticism had a rich field; it did not require to enter into minute details to excite interest, and it attempted less than some have done since to adorn the poets by improvements, gilding refined gold and making a Shakspeare that would be new to the author.

Dr. Ferriar's comments on Sterne are very searching (see 4th vol. p. 84), and they show a great amount of varied and remarkably careful reading. He traces the ideas of Sterne as well as his language to various authors, but still defends his use of thoughts taken from others. He says, speaking of his own remarks, 'They leave Sterne in possession of every praise but that of curious erudition, to which he had no pretence, and of unparalleled originality, which ignorance only can ascribe to any polished writer' (the meaning of this may be asked or questioned). 'It would be enjoining an impossible task to exact much knowledge on subjects frequently treated, and yet to prohibit the use of thoughts or expressions rendered familiar by study, merely because they had been occupied by former authors. There is a kind of imitation which the ancients encouraged, and which even our Gothic criticism admits when acknowledged.' He says, 'The talents for so delicate an office as that of literary censor are too great and numerous to be often assembled in one person. Rabelais wanted decency, Sterne learning, and Voltaire fidelity. Lucian alone supported the character properly, in those pieces which appear to be justly ascribed to him.'

We cannot agree to this position given to Lucian, but we have often wondered why no edition of him has been spread among the public, and his power and beauty shown. And yet why do we wonder? The reason seems to be in the absurd idea that the exact words and all the words of an author ought to be given. And thus, when a great author is low enough, or we may add foolish enough, we prefer to say wicked enough, to be indecent, his powers are lost to the world simply because people will insist on nothing being reserved, whilst certain portions excommunicate the whole unless removed. But the world will learn to throw aside the evils of the good and the follies of the great some day, and detest low language even if it comes from the pen of a Shakspeare, hiding it as we would gladly have hidden his failings if we had seen him overpowered with wine. We have so many great and good teachers, that we are simply base if we pick up the vile portions of any one's thoughts, still baser if we write mean thoughts ourselves, stimulating vice. We hear of some quibblers defending their low ideas by saying that the Bible had some such thoughts. No honest man says this, because if honest he would read to prove it, and he would find no one place where the Bible rejoices in iniquity. The idea of selling low words for money was not invented in Jerusalem. It seems to rise and fall as a fashion, unguided by principle.

Dr. Ferriar's comments and other essays and verses were afterwards published in two volumes in 1812.

Although we have spoken of Dr. Ferriar as a literary man, his real value to Manchester was as a physician; his professional works were published in three volumes, entitled 'Medical Histories and Reflections.' These we have not seen, and it is out of our province to describe. We shall leave also behind stories of his professional jealousy when a new member of the medical world came into the field with a new medical idea or process. Strange it is how scientific men, seekers of truth by profession, object to any truth found out by others. They either steal it or try to depreciate it—dogs and bones. Great scientific knowledge is not always accompanied by high character, but it is very frequently accompanied by great greediness. There was once a delusion that intellect, nobleness, and love of truth went together—a wish—certainly not a wide observation. However, Dr. Ferriar is blamed for nothing more than jealousy.

Electricity among the Ancients.

We must not forget Dr. Falconer's 'Observations on the Knowledge of the Ancients respecting Electricity,' see vol. iii. p. 278. There we have an account of amber, whether from Liguria or the north, and of Lapis Lyncurius 'which attracts straws and leaves, copper and iron,' and of electric fishes, subjects now better known to the ordinary reader; we have however less known speculations suggested to Dr. Falconer by 'an ingenious and learned gentleman,' on the knowledge of the Etruscans, familiar also to Numa Pompilius, who is said to have drawn fire down from heaven. This statement is corroborated by the manner of his successor's death. Tullus Hostilius was killed, the ingenious gentleman supposes, by mismanaging the process of bringing down the lightning. This is a fair explanation of the matter, and in the words of Livy, 'tradunt ira Jovis sollicitati prava religione, fulmine ictum cum domo conflagrasse.'[1] Livy says of him 'that after examining the commentaries of Numa and finding there a description of

[1] B. i. ch. xxxi.

certain occult and solemn sacrifices performed to Jupiter Elicius, he set himself to execute these in private; but from some impropriety in the commencement and conduct of these operations, he not only failed of being favoured with any intercourse with any celestial beings, but was, through the wrath of Jove, excited by his being importuned with such irregular rites and ceremonials, struck with lightning, and consumed together with his palace.' We throw aside all these things in our new histories, and Numa Pompilius becomes an idea, like the frogs of Marcus Marci.

Dr. Falconer's extract from Lucan is also very interesting, saying that the Etruscan Aruns collected the fires of heaven, and buried them in the earth with sad murmur. 'What is this,' he says, although the words have inverted commas as if they were a quotation, 'What is this but the description of the use of a conductor to secure buildings from being struck by lightning?'

The words are:

> Dumque illi effusam longis anfractibus urbem
> Circumeunt, Aruns dispersos fulminis ignes
> Colligit, et terræ mæsto cum murmure condit.

It certainly reads as if the fire itself were collected, but we fear the critics and dictionaries are against Dr. Falconer, and consider that it was the place struck by lightning or the objects struck. *Fulgur*, we are told, is an object struck by lightning, and the *Bidental* a place struck by lightning: both, however, have a sacredness, or at least awe, attached to them.

In 'Lucan's Pharsalia,' translated by H. D. Riley, B.A., B. I. 585–599, we have—

'Of whom, Aruns, the one most stricken in years inhabited the walls of deserted Luca, well skilled in the movements of lightnings, and the throbbing veins of the entrails, and the warnings of the wing hovering in the air.'

B. I. 603–610.

'And while in prolonged circuit they go round about the emptied city, Aruns collects the *dispersed objects struck* by flames of lightning, and with a lamenting murmur buries them in the earth, and bestows a name upon the consecrated spots. Then does he urge onward to the altar a male with selected neck.'[1]

Still, without pretending to a critical knowledge of Latin, we must seek some evidence that *ignes* meant the things struck by fire. If we look at Smith's Dictionary, we find that the priests 'Bidentales' collected the earth and buried it in the ground with a sorrowful murmur, but the proof of this painful expression is the very passage in question, and we may yet ask if *condere fulgur* means the same as *colligere dispersos fulminis ignes.* Dr. Falconer seems to have found the truth hidden from the scholars unskilled in physics.

He then endeavours to trace the use of spears as conductors, and quotes Livy's account of a spear which burnt for two hours and was not consumed. He gives Plutarch's account of balls of fire that were seen on the points of the soldiers' spears, and refers to the lightning on ships' masts, and the fires of St. Elmo. This connects the worship of spears with fire-worship.

[1] Also see Riley: 'He alludes to the consecration of the 'bidental;' a name given to a place struck by lightning and thenceforward held sacred. Similar veneration was paid to the burial place of a person killed by lightning. Priests collected the earth, branches, &c., and buried them with lamentations. The spot was consecrated by sacrificing a two-year old sheep, which gave its name 'bidens' to the place. An altar was also erected, and no one was allowed to tread on, touch, or look at it. The altar might be repaired when fallen into decay, but it was sacrilege to extend its boundaries. Seneca mentions a belief that wine struck by lightning would produce madness if drank.'

A paper 'On the Nature and Utility of Eloquence,' by Mr. Richard Sharp,[1] shows the importance of that art in the field of *Probable evidence.* One is tempted to think here of Dr. (now Cardinal) Newman's 'Grammar of Assent,' and that wide region between demonstration and fancy in which character is formed and lives.

An account of some Experiments to ascertain whether the Force of Steam be in proportion to the Generating Heat. By John Sharpe.

On this Dr. Bottomley says:

'As a result of an experimental inquiry he came to the conclusion that when heat is applied to water—the water heats through the several degrees of the thermometer nearly in equal times; and when in a closed vessel, the same rule holds good, as well above the boiling point as below it. In another series of experiments he condensed in a still steam at different degrees of temperature; he concludes from the results that steam at the common boiling temperature, or within a few degrees above it, gives out as much latent heat as steam sent over at a much higher temperature, and most probably at any temperature whatever. On this paper Dalton has a note. He thinks it remarkable that the temperature of the water in the boiler increased in such proportion to the time of boiling. He would have expected the water to heat most quickly at first. He does not doubt the accuracy of the experiment, but explains it by supposing the common thermometric scale inaccurate; the degrees of the mercurial thermometer are progressively too small as they ascend.'

[1] Vol. iii. p. 307.

Theorems and Problems to elucidate the Mechanical Principles called Vis Viva. By John Gough.

Dr. Bottomley describes the paper thus:

'He starts with certain definitions of force and axioms. *Vis viva* he defines as "the whole force opposed by a body in motion to a retarding force which impedes its progress; and conversely, it is the whole force accumulated in a body by the action of any motive force which puts that body in motion." Also, he assumes that the *vis viva* of a body is equal to the quantity of resistance which it is able to overcome. Then follow certain theorems involving his definitions and axioms. In his method of solution he uses Euclid's doctrine of proportions and the fluxional calculus. His paper concludes with mechanical problems the solutions of which depend for the most part on the preceding theorems, such as the penetration of plastic matters by falling weights of known dimensions.

'Determination of centre of gyration, and centre of oscillation; ratio of forces necessary to draw out ductile cylinder of given proportions to other dimensions; determination of the velocity with which one ball must strike another so that it may break.'

A Demonstration of Lawson's Geometrical Theorems. By the late Rev. Charles Wildbore.

Dr. Bottomley says here:

'This paper consists of solutions by the late Rev. C. Wildbore to all the sixty theorems in the well-known pamphlet entitled, "A Dissertation on the Geometrical Analysis of the Ancients, with a collection of theorems and problems, without solutions, for the exercise of young students, 1774." These theorems have all been elegantly demonstrated before, in Leyburn's "Mathematical Repository."'

The author of the 'Dissertation' was the late Rev. John Lawson, B.D.

The theorems are proved after the manner of Euclid.

The Rev. George Walker, F.R.S.

The Rev. George Walker, F.R.S., became President of the Society after Dr. Percival's death. He had great personal influence. He was born in Newcastle-on-Tyne in 1735, was educated at Durham, acted as minister to a small dissenting congregation there, and afterwards at Yarmouth, then went as mathematical teacher to the Warrington Academy in 1772. He was famed at the time for his treatise on the sphere; but honour for a time found in all his places very little payment—at Durham less than fifty pounds per annum. He then went as minister to a congregation at High Pavement, Nottingham, in 1794.

His importance latterly increased in the region of politics; his collection of evidence showing the wasteful expenditure of the war, and of the general administration during the American war, was a powerful engine in raising up friends of Parliamentary reform, and his 'Dissenter's Plea' was in a similar direction said by Fox and others to be the best utterance on the subject.

He wrote, according to the desire of a number of Priestley's admirers, an address of sympathy with that philosopher, and many ministers signed it. He also drew up a petition in favour of Parliamentary reform, which was signed by three thousand persons, and presented to Parliament in 1793 by Mr. Grey.

He was invited to come to the Manchester Academy, and remained for some time; afterwards he retired to Wavertree, near Liverpool, and died when on a visit to a friend in London, in 1807. Manchester missed receiving him in his youth, because when invited there they could only offer him forty pounds a year. He was, however, given little more at Durham, and that small sum was not all paid. He seems, indeed, to have been compelled to struggle with poverty during most of his life.

Some of his writings are: on 'The Beautiful in the Human Form;' on 'Tragedy and the Interest in Tragical Representation;' on 'Hypocrisy;' 'Probable Arguments in favour of the Immateriality of the Soul;' on 'The Machinery of the Ancient Epic Poem;' on 'The Moral Influence of History;' on 'Natural and Moral Philosophy, and the Proper Meaning of Philosophy in both;' on 'Imitation and Fashion;' 'The Dissenter's Plea: a Defence of Learning and the Arts against some Charges of Rousseau's;' 'The Dissenter's Plea: or the Appeal of the Dissenters to the Justice, the Honour, and the Religion of the Kingdom against the Test Laws.'

In using the word dissenter in connection with the Manchester New College as in part with the Warrington Academy, and we may add with the Manchester Academy, we are really to understand Unitarians, who also frequently call themselves Presbyterians, a name which is not distinctive and is indeed confusing, and to which many persons object, as the opinions differ from those of the Presbyterian establishment. They are a body which have always had great influence in Manchester, partly having the roots from Warrington, a body always very clear in their aims, advanced in their views of education and of political liberty;

as to religious liberty, they admired that as non-established bodies always do. They have done much unquestionably to raise the intellectual standard around them, and they have always done their duty with precision towards their neighbours; yet they have not been popular, and indeed, in spite of their goodness, they have not been loved. Their cold and purely intellectual nature has not been attractive; the intellect and reason are not the highest part of man; these parts of man have not the highest aims, and have not the highest flights. This has nothing to do with the truth or otherwise of their doctrines; it only seems to be a fact that their doctrines attracted very quiet men, and wherever their college went it was small and cold, a spark ready to go out. There is no pillar of fire in their line of march, and yet with all this, who has written more beautifully of the Christian life or felt it more deeply than James Martineau? One feels that it is presumption even to sound his praise; every intellect must be impressed by his reason, and every heart deeply affected by his emotions.

That there are many contradictions in man is no new opinion.

Fasting.

The world has lately been interested in an experiment in New York by Dr. Tanner, on the time to which life may be prolonged without food. His limit was forty days, with the abundant use of water. There is a paper by Dr. Percival in vol. iii. on the effects of famine, wherein he quotes Morgagni *De Sedibus et Causis Morborum* as 'relating the history of a woman who obstinately refused to take any sustenance, except twice, during the space of fifty days, at the end of which period she died. But he adds, that she used water by way of drink, though in small quantities.' 'Redi, who made many experiments (cruel and unjustifiable in my opinion) to ascertain the effects of fasting on fowls, observed that none were able to support life beyond the ninth day to whom drink was denied; whereas one, indulged with water, lived more than twenty days.'—Vol. ii. p. 475.

Perception of Colour among the Ancients.

Thomas Cooper, the same who was in Northumberland in the United States along with Priestley, gives three papers on very different subjects: 'Observations respecting the History of Physiognomy,' vol. iii. p. 408; 'On the Foundation of Civil Government,' p. 481; 'Observations on the Art of Painting among the Ancients,' p. 510. In this he defends the ancients from a supposed ignorance of colouring, a subject which, although reviewed of late, is shown to be by no means novel. It has been said that the ancients had only four colours; he thinks the idea arises from misinterpreting a passage in 'Cicero:' 'In the paintings of those who used no more than four colours, such as Zeuxis, Polygnotus, and Timantes, we admire the outline and the features; but in Aetion, Protogenes, Nicomachus, and Apelles all is perfect,' evidently including colouring, and implying that the latter set used more than four colours; and Philostratus says, 'The ancients were satisfied with one colour, but the increasing progress of the art afterwards employed four; and from thence even more than that number' (p. 514).

He mentions the painting of flowers, peacocks, etc., also the delicate tints of the skin in one of Lucian's descriptions, also from Lucian he finds the painters Polygnotus, Euphranor, Aetion, and Apelles famous *for blending their colours* with taste and judgment, p. 539.

We might add that the whole region of colour can be made with three, and why should the ancients be thought not to understand colour if they used only four or even less; but if it is meant that they had only four including shades and mixtures, the text seems to deny it. If again it is supposed that because the names of the colours were few the perception of them was equally deficient, we may only look to Lancashire to find that wonderful appreciation of shade among her calico printers, whilst the words expressing colour had not increased except in a manner expressing their chemical composition when it was convenient. Manganese brown, for example, was still a brown. When tar colours arrived a new style of name was requisite for the beautiful shades, but it required no new organs to see them, no generation developed to appreciate them—every workman saw them at once—the power lay in the organism as unused to them as in the time of Homer, when probably it was finer than with us, as the Greek senses were keener and finer than ours as to the external appearance of objects. (See Dr. Schunck's paper in 'Memoirs' for 1881).

Of Thomas Cooper, Esq., we are told that he was a barrister at Manchester in 1792, but that he was compelled to leave his native country during the disgraceful riot in that year, retired to America, and settled in Columbia, where he died, May 11, in his eightieth year.

Cooper published in the Transactions of our Society a paper entitled 'Propositions respecting the Foundations of Civil Government.' To a subsequent reprint of that paper he attached the following note regarding female education;

in this age when women's rights are much talked about, it is not without interest :—

'Since these propositions were first published I have repeatedly considered the subject of the *rights of women*, and I am perfectly unable to suggest any argument in support of the political superiority so generally arrogated to the male sex which will not equally apply to any system of despotism of man over man. The first of these Propositions on Civil Government is just as applicable to women as men. The fact is, that we behave to the female sex much in the same manner as we behave to the poor. We first keep their minds and thus their persons in subjection, we educate women from infancy to marriage in such a way as to debilitate both their corporeal and mental powers. All the accomplishments we teach them are directed not to *their* future benefit in life, but to the amusement of the male sex; and having for a series of years with much assiduity, and sometimes at much expense, incapacitated them for any serious occupation, we say they are not fit to govern themselves, and arrogate the right of making them our slaves through life. Thus we too frequently wed playthings and not friends and companions, and we in our turn are the dupes of cunning, and the victims of all the petty passions as a just reward for the tyrannical maxims we are at such pains to inculcate. I have read the writings of Mrs. M. Graham, of Miss Wollstoncroft, of Mrs. Barbauld, of Mrs. Montague, Miss Carter, Miss Seward, Mrs. Dobson, Miss H. M. Williams, &c., in England. I have conversed with Theroigne, with Madame Condorcet, Madame Robert, Madame Lavoisier, &c., in Paris. What these women are other women might become. I have often felt my own inferiority, and often lamented the present iniquitous and most absurd notions on the subject of the disparity of the sexes. I have conversed with politicians and read the writings of politicians, but I have seldom met with views more enlarged, more just, more truly patriotic; or with political reasonings more acute, or arguments more forcible than in the conversation of Theroigne and the writings of Miss Wollstoncroft. Let the defenders of male despotism answer (if they can) "The Rights of Woman" by Miss Wollstoncroft.'

Dr. Ferriar addressed to him his essay entitled 'An Argument against the Doctrine of Materialism.'

Mr. Cooper was a great friend of Dr. Priestley's, and was his companion, in this country as well as in America. See also 'A Political Episode,' pp. 121 and 171.

Prehistoric Cremation in Scotland.

On October 4, 1793, see vol. iv. p. 226, an account of a rare method of cremation used in Scotland was read by Mr. Alexander Copland, of Dumfries. We are astonished at an attempt to prove that cairns are really places of sepulture, following Pennant, and the difficulty of accounting for the meaning of the word Strath Blane. We have now become almost familiar with Blane as a saint, and cairns as places for the dead. Fore-history has since become almost a science, still there is an instrument described in this essay which will be new even to many of its students.

Some instruments for cremation were found in a cairn in Galloway, near Knaer Castle. (The spot is not very exactly described.) One of them consisted of three rods set up so as to form a triangular stand, the rods meeting in the centre, and seven feet high. From this when used hung a chair by which the body was suspended, the fire being placed below on a triangular hearth. The iron found was in good condition, charred wood and spades were also found, and the whole apparatus served to indicate that the use was such as the author describes. A horse-shoe for luck was at the apex of the hollow cone formed by the three rods.

Meteorological Tables of Last Century.

Meteorology, a favourite study at the Society, is represented in the 4th volume by a series of observations from 1768 to 1793, by Mr. Hutchinson, Dockmaster of Liverpool, by observations made at Dover, by Mr. T. Mantell, surgeon, by Mr. Copland of Dumfries, by Mr. Peter Crosthwaite of Keswick, by Mr. Vernon at Middlewich, Mr. Gough at Kendal, the Rev. Mr. Wellbe (a contraction for Wellbeloved) at York, Mr. George Walker at Manchester, Mr. Thomas Blades at Garsdale, Lord George Cavendish at Chatsworth, Dr. Campbell of Lancaster, from Youngsbury near Ware by a lady, name not given, and Dr. Burgess of Kirkmichael. This series of communications on meteorology contains also a calendar of the times of birds and flowers at Dumfries. These observations were collected by Thomas Garnett, M.D., physician at Harrogate, and communicated to the Society by Dr. Percival.

In vol. v. part i. we have a remarkable mixture of papers. It seems to be the end of the first era of the Society, and the Society itself had apparently the same opinion. This part, which contains papers from 1794 to 1796, has less vigour in the mode of thought. Dr. Samuel Argent Bardsley begins with an essay on party prejudice, from which he wishes to keep the mind free; although he goes to the root of nothing, and shows neither great force nor insight, it is still the work of a well-read man, a calm thinker, a sound mind, and a graceful writer. What would the world do if it had no violent bigots? if all its men would listen calmly to the other side, their objects of dislike would have no chance of being destroyed. Millions of gentle pattings will never do the work of one blow.

Yet after this comes, as a great exception in this part, a paper by John Dalton—his powerful but gentle first introduction into the work of the Society—in an 'Essay on the Vision of Colours.' This is elsewhere spoken of—it was clear and new.

We have then an inquiry into the name of the founder of Owen Abbey, in Northumberland, by Robert Uvedale, M.A., of Trinity College, Cambridge.

'On the Benefits Arising from the Institution of Literary and Philosophical Societies,' by the Rev. Thomas Gisborne, Yoxall Lodge. It is abstract, and produces no account of results.

A Universal Written Character.—Dr. Anderson, of Glasgow, founder of Anderson College, brings forward his treatise 'On a Universal Character,' and makes us think of Melville Bell, of Edinburgh, and his work on 'Visible Speech,' and of his still more illustrious son, who has given us the telephone and the photophone. Another paper on this subject is by Dr. John Kemp.

Some of these writings show interesting workings of the mind, the influence exercised by the Society, and the vague sketchings of men who did not live long enough to find if they had begun that which had a useful terminus in nature. It may, perhaps, be unfair to call Graham Bell greater than his father, a man who is so successful in teaching the dumb to speak, an art begun in the seventeenth century, we believe, by Dr. Willis, one of those having an unknown future. This art was probably put on a firm basis for the first time in 'Visible Speech and the Science of Universal Alphabets, or Self-interpreting Physiological Letters for the Writing of all Languages in one Alphabet,' by Alex. Melville Bell, 1867. With these early teachings of his father, before leaving Edinburgh, Graham Bell's mind was sent from youth towards the goal sought —the production of speech by artificial apparatus. It would have been interesting if he had found the phonograph, as some such thing was evidently in the father's eye on his early inquiries; but one seeks and another finds.

The writer believes that societies for correcting spelling are beginning at the wrong end. Their methods will inevitably produce diversity and confusion, because they use letters to express the normal sounds to be advocated, whereas these letters will be interpreted in various ways. We must first have sounds that can be reproduced at will, and this can only be had from mechanism so constructed as to be readily repeated, and so described that persons at a distance may make and produce the same sounds. On this subject it will be interesting to read 'On the Pneumatic Action which accompanies the Articulation of Sounds by the Human Voice, as Exhibited by a Recording Instrument,' by W. H. Barlow, F.R.S. Proceed. Royal Soc., 1874. It was called also a Logograph.

Whilst speaking of the observation of the deaf, and the mode of instruction, it is interesting to think of an advance still greater, and indicating a mode by which not only the deaf but the blind may understand spoken language. The discovery has been quite forgotten so far as we know, and was made by a little girl, daughter of a minister at Geneva. It is described by Bishop Burnet in his letters to the Hon. Robert Boyle. That from Rome, Dec. 8, 1685, contains the account: 'There is a minister of St. Gervais—Mr. Gody—who hath a daughter that is now sixteen years old. Her nurse had an extraordinary thickness of hearing. At a year old the child spoke all those little words that children begin usually to learn at that age, but she made no progress; yet this was not observed till it was too late; and as she grew to be two years old they perceived then that she had lost her hearing, and was so deaf, that ever since, though she hears great noises, yet she hears nothing that one can speak to her. But the child hath, by observing the motions of the mouths and lips of others, acquired so many words, that out of these she has formed a sort of jargon, in which she can hold conversation whole days with those that can speak her own language. I could understand some of her words, but I could not comprehend a period; for it seemed to me a confused noise. She knows nothing that is said to her unless she seeth the motion of the mouths that speak to her; so that in the night when it is necessary to speak to her they must light a candle.'

This part of the girl's discovery is up to the present day, but the next goes far beyond so far as we know. 'Only one thing appeared the strangest part of the whole narrative; she hath a sister with whom she has practised her language more than with any other; and in the night, by laying her hand on her sister's mouth, she can perceive by that what she says, and so can discourse with her in the night. It is true, her mother told me, this did not last long; and that she found out only some short period in this manner, but it did not hold out very long.' (The Bishop's language here may require explanation, he does not mean that the person ceased soon, so far as we understand him, but that long sentences could not be read. The word *period* is used for *sentence.*) 'Thus this young woman hath merely by a natural sagacity found out a method of holding discourse, that doth in a great measure lessen the misery of her deafness. I examined this matter critically, but only the sister was not present, so that I could not see how the conversation passed between them in the dark.'

It would have been better if the Bishop had seen the girls conversing by touch, but in any case it is a science beyond our present aspirings.

'The Inverse Method of Central Forces' has no named author. It was communicated by Dr. Holme, and it may be left to Dr. Bottomley to give his account of the paper. Dr. Bottomley says, 'The author of the paper says that if it sustains anything original it is in the third proposition. In this he treats of the equation of the orbit described by a body acted upon by the forces tending to the same centre which vary as the *nth* and the 9th powers of the distance reciprocally.'

Dr. Theophilus Rupp discusses Priestley's experiments on air, and defends the new chemistry against Phlogiston, not the last defence, although the old theory was becoming weak.

'Experiments on the Oxygenated Muriat of Potash' are by Thomas Hoyle, Jun., originator of the famous printworks called by his name.

In the second part of vol. v., published in 1802, we seem to enter an entirely new region. Dalton comes in with freshness and force, and we pass as if from the mildness of untaught sentiment into the vigour of external nature.

We have Dalton on 'Evaporation and Springs;' 'On the Power of Fluids to conduct Heat;' 'Experiments and Observations on the Heat and Cold produced by the Mechanical Condensation and Rarefaction of Air;' 'Experimental Essays on the Constitution of Mixed Gases;' and 'Meteorological Observations made at Manchester;' and Mr. Banks adds, 'On the Velocity of Air issuing out of a vessel in Different Circumstances,' a subject also interesting to earlier as well as later members of this Society.

CHAPTER IX.

John Dalton.

WE have now given some slight account of the more active men who began this Society, with some notice of their labours and modes of thinking: men who seem to have come out of darkness, and who were conscious of coming into light. Their eyes were brighter than those of their neighbours; they look to us now like messengers first appearing on the top of the mountains bringing good tidings. The earliest are not, however, the angelic messengers themselves, the men of genius. Soon there arrived amongst them a man of much greater vigour; his education was meagre, he could not make Latin quotations with Dr. Percival, or search into early Classic writings with Dr. Falconer; his knowledge of Greek was but slight, and gained from a little-used Schrevelius; his manners were not formed amongst men who attended the Court; he kept no private carriage, and invited no one to dine with him. He did not even read much poetry, and he thought little in the region of metaphysics, although he practised Christian ethics and lived in harmony with all around him; but the whole force of his mind was directed to the explanation of natural phenomena. The Academy, which we consider an offshoot from Warrington, was in want of a teacher of mathematics, and applied to Mr. John Gough, of Kendal, a man of science and of talent, an explainer of nature although unable to look at its surface. He gave his advice.

John Dalton had learnt much from this gentleman, and had used his books and physical apparatus. Indeed, we may look on Gough as one of the early props of the Society, although living in Kendal, and as a man of mark of the time he stands described by Wordsworth in 'The Excursion':—

> Methinks I see him, how his eyeballs rolled
> Beneath his ample brow in darkness pained,
> But each instinct with spirit, and the frame
> Of the whole countenance alive with thought,
> Fancy and understanding; whilst the voice
> Discoursed of natural and moral truth,
> With eloquence and such authentic power,
> That in his presence humbler knowledge stood
> Abashed, and tender pity overawed.

Dr. Crompton, the friend of so many in Manchester, as well as their wise and kind physician, grandson of the inventor of the 'spinning mule,' which has done so much for Lancashire, received from Wordsworth a letter containing this passage: 'Your conjecture respecting that passage is remarkable. Mr. Gough, of Kendal, whom I had the pleasure of knowing, was the person from whom I drew the picture which was in no respect exaggerated. He was a most extraordinary person, highly gifted, &c. The sadness which the contemplation of blindness always produces, was in Mr. Gough's case tempered by admiration and wonder in the most affecting manner.'

Jonathan Dalton helped his cousin George Bewley, who had a school at Kendal, and John after some years followed. He had been keeping a school in his native place, Eaglesfield, nearly three miles south-west of Cockermouth, in Cumberland, having begun in 1778, when he was twelve years old; the school was held in the Friends' Meeting House. His grandfather had joined the Society of Friends, and he never left that community. His father was poor, living in a house with two small rooms, and weaving in a shop attached to the house in the old-fashioned way; still he was an educated man, and taught his son mensuration and navigation. His brother's death brought to him at a later period a small family estate, raising him out of labour.

Dalton at twelve was probably not small for his age, as he grew to be a powerful man; he had many struggles in the school, where he tried to maintain order among pupils older than himself, who challenged him to fight in the graveyard. Let us think of him helping Mr. Bewley in Kendal, becoming the friend of Mr. Gough there, and learning from him to make meteorological observations as well as to take an interest in the science, if it could then be called one. In Kendal he began to give lectures; this programme of lectures, given when he was 21 years old, would suit a whole college of professors. In after life, when by chance the circular containing the list of subjects fell in his way, he burst out into a loud laugh, and the laugh described to us reminds of Carlyle's, except that it was the only Dalton laugh we have recorded, of a violent kind; we can easily imagine the wonder he felt at his own early presumption.

His uncle, Mr. Greenup, barrister in London, discouraged the attempt to learn a profession such as that of the Bar or of medicine, being disinclined to help him, so John Dalton set himself to an independent study of nature, and worked his school and his studies with an assiduity which never ceased. It was hard work when the two brothers began their own school at Kendal, with some money borrowed from George Bewley and seven guineas from the father, to be repaid soon, whilst Mr. Lickbarrow lent them a guinea during their struggle, and Mr. Kendal lent two, and Mary the sister had to give up thirteen shillings and sixpence, and got paid in small portions, 'to Mary in part *0l. 0s. 6d.*' We do not know how much Mr. Benson lent, but borrowing soon ceased, and all was paid, and Mary went to stay with the brothers, who had seventy pounds to live on, for a year, seldom increased by more than five pounds for 'drawing conditions,' 'making wills,' or 'collecting rents.'

It is not at all probable that Dalton objected to live on these small means, but he did object to the narrow life, and had flight in view, he knew not where. He made barometers, thermometers, and taught himself by making meteorological observations as well as by careful study. He prepared a *hortus siccus* of plants near Kendal, arranging in orders and classes, but did not afterwards pursue botany. The title shows a certain command of the Latin tongue which is unusual considering his opportunities, but his memory was seldom at fault.

Before he left Kendal he became a frequent contributor to the 'Gentleman's Magazine,' answering questions, and especially those which were connected with mathematics, as we learn from an interesting memoir by Mr. T. H. Wilkinson, of Burnley, in vol. xii. series 2, of the 'Society's Memoirs.' He has been known to answer fifteen out of sixteen such questions, and he frequently received the prizes—volumes of the magazine. This habit he continued in Manchester for several years.

It must have been a bright day for Dalton when Mr.

Gough told him that he might go to the growing city of Manchester and be a professor practically in a new college, the Manchester Academy (Appendix B.). He arrived in 1793 with his 'Meteorological Observation and Essays,' ready or almost ready for publication. They were begun in 1788.

The works of Dalton are numerous, and a list need not be given here, as one may be found in the fuller accounts of his life. We shall look only on some of his greatest feats. He entered this Society as a professed mathematician; but this department ceased to be specially interesting to him, and the attention he had given to meteorology was such that hitherto his only long treatise was on that subject, and it was his first separate work published. His first paper printed in the memoirs, 'Extraordinary Facts Relating to the Vision of Colours,' was out of the direct course of his studies, but has been the foundation of a most valuable series of inquiries. The condition of vision analogous to Dalton's has been of late called colour-blindness, a plain and simple expression for the extreme condition, but by no means expressing the varieties. As the writer has elsewhere said, 'It is probable that there are many gradations, beginning with deficient colour sight and ending in dichromic, or perhaps monochromic or achromic vision, or true colour-blindness.' Dalton was short-sighted, but had powerful eyes that never wearied. Without this first discovery of Dalton's, railway night-signals would be seen erroneously in nearly ten cases out of a hundred, and one out of ten engine-drivers might be misled at every coloured lamp along the lines of rail. This first gift of Dalton to the Society is now a matter of national importance, and we may say that it is of value to all nations in which railways exist and to all who are interested in navigation, leaving little behind of the civilised world, to which it is a matter of indifference. In this place, however, we must not forget Bew's paper on blindness, see p. 100.

It was in viewing the skies that Dalton saw his earliest new truth. He thought of the air, why it was heavier and lighter; he held that it could not be so by being piled up more or less highly above us, at certain times, but that the change must take place in the lower portions of the atmosphere. This change he found to be in the amount of water in a state of vapour. We owe to him the explanation of barometric differences indicating the character of the weather, and the beginning of a new impulse to the study of climate, in reality the true beginning of meteorology.

On this subject we prefer to give the opinion of a distinguished meteorologist, Alexander Buchan. He says in his handy book of that science, 1868, p. 5:

'The publication of Dalton's "Meteorological Essays" in 1793 marks an epoch in meteorology. It was the first instance of the principles of philosophy being brought to bear on the explanation of the complex and varied phenomenon of the atmosphere. The idea that vapour is an independent elastic fluid, and that all elastic fluids, whether alone or mixed, exist independently; the great motive forces of the atmosphere. The theory of winds, with their effect on the barometer, and their relation to temperature and rain; observations on the height of clouds, on thunder, and on meteors; and the relation of magnetism and the aurora borealis, are some of the important questions discussed in these remarkable essays, with an acuteness, a fulness, and a breadth of view, which leave nothing to be desired.'

In fact Dalton brought to Manchester a new science in his pocket, and was not content to have made only one. A man like this would have brought fame to a city and to a nation even if he had ceased to write after giving us the one work.

It was when examining the air that Dalton was led to consider the condition of watery vapour amongst incondensible gases, proving that vapour rises from liquids with the same force 'at equal distances above or below the several temperatures at which they boil in the open air: and that force is the same under any pressure of any other elastic fluid as it is *in vacuo*.' The force of aqueous vapour he showed to be the same at the same temperature whether air was present or not. This was the establishment of the separate action of fluid bodies so far, and he then passed on to the separate action of all gases in a mixed state, thus accounting for the fact that they do not separate according to their specific gravities as they ought to do, the heavy gases falling down to the earth if they did not act independently. For this purpose he supposes the particles of each gas to repel the particles of its own kind, but not those of another gas. For example, 'the particles of A meeting with no repulsion from those of B farther than that repulsion which as obstacles in the way they may exert, would instantaneously recede from each other as far as possible in their circumstances, and consequently arrange themselves just the same as in a void space.'

The same would take place with the particles of B. 'Thus the two gases become rarefied to such a degree that their united forces only amount to the pressure of the atmosphere.'

We find here that he causes repulsion to do the work which primordial motion does in the hypothesis of David

Bernoulli, brought up again by Herapath, and so thoroughly studied out by Joule, Clausius, and Maxwell, as to be now almost universally held to be a quality of such molecules as the gases known to us are made of. After all, repulsion is a moving power if not motion, and the result is the same ; but still Dalton's idea does not explain so many conditions as that of Bernoulli would explain ; but Bernoulli did not use his ideas for the larger ends seen by Dalton. The idea of repulsion without contact is less intelligible than that of constant motion and impact. To attain repulsion it was necessary to have atoms, the old Greek atoms, the atoms of Lucretius, the atoms defined more exactly by Newton as to external qualities. To these, every exact thinker has been brought when picturing matter; if we give up atoms we come to indefinite bodies, and pass the boundaries of the intelligible. We do not say that there is nothing beyond this boundary. On the contrary, we know that there must be something, but every thinker that has passed into this land of the indefinite has been penetrated with the same quality, and lost himself in seeking even the smallest portion of rest for the soles of his feet ; even non-atomists find a stage in which atoms, or at least undecomposable molecules, physically the same to us at present, exist.

Dalton was led to seek 'a true theory of evaporation.' The separate action of vapour of water and other gases was an opinion held, as Dalton himself says, by M. Pictet and others ; but Dalton claims chiefly to have removed the last objection. He shows that the weight of the atmosphere has no ultimate influence on the evaporation of liquids, although the rise of steam is obstructed by the inertia of the particles of air.

It is not intended to give Dalton's long and elaborate inquiry on the force of vapour ; it is enough to say that the tables stood the test of many years, and have been of marvellous value to nearly three generations, besides stimulating inquiry in many directions.

Dalton might be wrong in fractions, but he was wonderfully clear in his great ideas, and showed himself a prophet and seer. It is strange how small are the facts out of which he brings great results ; with him a new science grows out of imperfect observations, and a new art from a defect in his eyesight.

As Dalton rises into power we approach his highest work, the development and establishment of the atomic theory, which first gave consistency to the long-discussed ideas regarding matter, and practically showed that if atoms did not form the basis of matter, it was clear that matter acted as if it did consist of such bodies. In 1803 Dalton dared to give the relative weights of these atoms. This is the great work of Dalton ; from that moment chemistry became a science, its leaves began to be legible, the meaning of combination was to a great extent understood, and weight, number, and measure were introduced as certainties into the conception of compounds. Transformations were explainable, and the *materia prima*—the abstract—has ceased to appear in books on the science. Lest any one should mistake the meaning of this, it may be said that there is no wish to deny the existence of a *materia prima*; on the contrary, we have held it from very early years to be a sound thought. Dalton had evidently the idea, and every chemist must hold it to be a probable source of our elements.

Before we attempt to give Dalton's position it may be well to give a short account of the theories before him as to the condition of matter. To avoid the trouble of rewriting, the author may take some few points of interest from a work of his own long out of print.[1]

Sketch of Atomic Theories before Dalton.

Thales held the earth to be living, and believed that all things grew from water. He was born about 580 years before Christ, but Van Helmont was born in 1557 A.D., or 2,158 years later, and he proved to his satisfaction that the growth of all things from water was real; and how few people can prove that it is not true!

Anaximenes believed that the principle of all things was in the air, which comprehended fire, water, and earth, and that all that is in the earth is merely the result of change in one and the same thing. But to perform these wonders strange mystic powers require to be given to air and water, and these have not been explained by the theorists.

Fire had an advocate in Heraclitus, of Miletus, who says that fire produces air, and causes those changes in the atmosphere which produce water, whilst by its action on the earth it produces land also, which is raised from the sea. But then this fire was a mystic power, as the air and the water had become mystic; explanations entirely wanting. We get a very meagre account of Anaximander from Diogenes Laertius, who says that the principle of all things was the infinite, which must be true; but he gives no further definition, and we are left to think that he saw pretty far into the difficulties, but not into a mode of clearing them.

Pythagoras made points to congregate, and called the

[1] See pp. 74–76. *Life of Dalton and History of the Atomic Theory up to his Time.* Printed by the Literary and Philosophical Society of Manchester, 1856; publishers Bailliere & Co., London. Ideas of matters up to the time of Lucretius and onwards.

origin of things numbers. This seems another mode of making atoms, the original power having a different name but explaining nothing. The five elements made in this way, by adding points, are perhaps fundamentally the five fingers, the image of the creative power of God, the great hand of the Phœnicians, a symbol of all this thought. On this subject we can point out the method in which a modern writer has reasoned, 'God has given man five senses for a fivefold sphere of action. He has given him five fingers for a fivefold instrument of industrial and artistic action, and five toes for a fivefold instrument of progressive action. He has given him a head and four extremities as the primary action of the corporeal system. Not without reason, and man being the noblest representative of the Divine creative agent, we should naturally give the precedence to the number five in the sphere of collective, social, and political progress, were it even superseded by some other number in the construction of irrational vertebrated animals. But when we find that all the superior orders of rational and irrational creatures are constructed on this fivefold principle, we are compelled to admit that, in the sphere of action, the number five must take the precedence as the fittest representation of providential movement.'

'The Gentile poets sang of the fifth age, the "Regna Saturnia," and the Jewish prophets took up the refrain and detailed the glories of the Redeemer's kingdom that succeeds the fourth. The fifth is the dominant in music, and is neither a local nor a sectarian idea in history or mythology. It is a poetic inspiration, a dramatic division of the course of time, universally known, familiar to all ages of the world, &c.'[1] This is probably the funda-

[1] See the *Divine Drama of History and Civilisation*, by the Rev. James Smith, M.A., 1854, pp. 6 and 8.

mental idea of all the philosophical systems which had five as a basis, whether in Europe or the East.

But Pythagoras was mathematical. The cube was the earth, the pyramid fire, the octohedron air, the icosahedron water, the dodecahedron the fifth element the same as Aristotle's ether, or that of the Sánkhya Philosophy.

Anaxagoras said that the number of things remains always the same. Here he had before him the continuity of matter, and if not of force alone, certainly that force which is inherent in matter. Besides this he considered that as gold consists of an endless number of small pieces of gold, so bone consists of an endless number of small pieces of bone. He thus lost the idea of diversity producible from a few simple bodies; he tried a theory of combination, but made a remarkably crude one; but a step aside is sometimes useful by showing danger.

Zeno of Elea had four elements, warm and cold, moist and dry, and Empedocles gave prominence to fire.

Zeno mentions concord and discord, which we may call attraction and repulsion, and Empedocles has similar ideas.

After all these earlier notions, each one attempting to make the whole out of the very few parts known roughly or conceived, we come to Leucippus, who seems first to have followed matter until he hunted it down to the smallest conceivable point, *an atom*. Who can go further on firm ground? Democritus explained the theory more fully. Plato was not definite on this question; the subject was extended by Epicurus; but Lucretius is in reality the great expositor of the idea of atoms as it existed among the most exact thinkers up to his time.

Lucretius has solid infrangible substances primary and eternal. He criticises and laughs at the earlier speculators. Still he speaks of atoms moved by themselves, acted on by forces, urged by secret impulse. Book I. 1023 :

> Sed quia multa modis multis, mutata, per Omne,
> Ex infinito, vexantur percita plagis,
> Omne genus motûs, et cœtûs experiundo,
> Tandem deveniunt in tales dispösituras,
> Qualibus hæc rebus consistit summa creata.

and in Book II. l. 132 :

> Prima moventur enim per se Primordia rerum,
> Inde ea, quæ parvo sunt corpora conciliatu,
> Et quasi proxima sunt ad vires principiorum,
> Ictibus illorum cæcis impulsa cientur ;
> Ipsaque, quæ porro paullo majora, lacessunt.

We confess ourselves to have been once much impressed by Lucretius, and, indeed, every one must admire the rare subtlety sometimes shown, and it is a fine lesson in psychology to observe in his writings how the mind works, but we now at least admire him only because of being one of the early pioneers ; we feel that he had not clear notions of an atom at all times, and this he shows when speaking of the soul—he seems to give it power in Book III. because of the smallness and subtlety of its atoms—why should smallness give power ? where is force ? One becomes at least tired of the wandering atoms of Lucretius and his conceited opinion of himself, thinking that he explains when he merely presents phenomena as difficult to imagine as ever.

He has no idea of combination, and his atoms go as they please, although he certainly says in one place that they do not. He does not see the necessity for laws of government, which shows a singular want of refinement of search.

In short, Lucretius got clearly to the existence of atoms and their permanence, he got clearly to forces agitating them, but he lost a great deal of his clearness in seeking a variety of atoms, and he had no distinct idea of any force. There is much confusion in speaking of the movements, and much contradiction even as to that great one, the inclination to fall, which he sees in an obscure way, and has no desire to seek a cause for.

It is somewhat unfortunate that in modern times we prefer the same confusion as to the *primordia rerum*, and think that when we have endued them with all power we have explained their action. We have then only arrived at the facts to be explained, and think we have done because we throw the difficulty aside. We might very properly call the unchangeable atom the Daltonian, since neither Newton nor Lucretius defined its work, and Dalton has made most use of it in science, forming not only a theory, but showing a law and an eternal one. There are, however, attempts to find in what manner this atom was made. Dalton had not this difficulty because he quietly gave it attraction, repulsion, heat, and elasticity and conducting forces, and was ready to add anything necessary to make it move. In doing this there is a manifest imperfection, because it makes the atom a compound when it is also supposed to be simple ; character is given, with organs to keep up the character, and, indeed, the characters revolve about the atom, doing all the work and leaving the atom useless. A similar gift of complex characteristics belongs also to the Lucretian and earlier view, and seeing this defect of reasoning Boscovich was led to push the atom out of his scheme of creation and be satisfied with centres of force.

The view that comes next to this, in reason if not in time, is the vortex atom, admired by Sir William Thomson, and made by the movements of a fluid itself non-atomic. This idea is of value so far that it gives us a mode of imagining in what way a great diversity of bodies simple to us may be made out of one truly simple *materia prima*, and in what way an infinite variety of combinations may take place, causing great diversity of character to appear in compounds. It does not by any means destroy the Daltonian mode of combination, neither does it settle the original difficulty of the ultimate constitution of matter. It shows in what way the Daltonian atom may serve the purposes of creation in the stage in which our chemistry acts, and removes the difficulties as to infinite divisibility, one stage behind the *present elements*, putting it beside all the other difficulties which are abundantly gathered round every attempt to comprehend the infinite.

We may leave without mention many centuries of imperfect thought, although of most interesting wanderings of the mind, names from Lucretius to Stephen Franz Geoffroi, born 1672. We do this that we may leap at once to the first ideas that promised a progress in the direction of exact quantity in combination, and of course to a sound chemical theory. Geoffroi drew up a table showing the order in which bodies separate each other from a given substance. 'Thus in the first column the fixed alkalies separate all the bodies below them from the acids. The volatile acids separate all except the fixed alkalies. The absorbent earths separate the metals, and the metals are separated by all the other bodies in the column.' This is a beginning of order, the first real attempt to make a table of equivalents by whatever name it is called.

The 'Encyclopedie Methodique,' 1786, gives Guyton

Morveau's chemical laws, which he himself thinks can scarcely be called laws, and as they are not essential to our purpose, we shall not repeat them here.

Dr. Cullen seems to have been the first who gave diagrams of double or elective attraction. These do not appear to have been published, but they were used by Dr. Black in his lectures, and the publication has been left for Bergman, to whom we readily grant equal originality and more energy in giving the idea to the world. He could not, however, explain how neutral salts could receive an excess of acid; in other words, he had no idea of addition by equivalent, and therefore could not comprehend an atomic theory such as Dalton's.

To Wenzel has often been given the honour of discovering reciprocal proportion, but we must conclude that he failed in his attempts to explain the mutual decomposition of salts, and considers that it is not complete. He seeks to explain affinity by the time of action, and says: *The affinity of bodies with a common solvent is in the inverse ratio of the time taken to dissolve.* Of this theory one may quote what is elsewhere said, 'He has made a theory of affinity and attempted to represent the force by a number. To attempt to give the numerical or dynamical ratio of every body to each other was an object of the very highest kind, and we must look on him as one of those less fortunate men who, when search was required in every direction, has had the wrong one assigned to him. He searched in the direction of time, and obtained a manifest fallacy; as bodies are constructed abstractedly he might be correct, but his theory cannot be introduced into science at present, and in the way he introduced it it is entirely a mistake. But he has done great service in early times in seeking for the distinct constitution of bodies, and in asserting the constancy of combination ; whilst he obtained numbers representing the constant relation of bodies to each other, he failed to see that they would be reciprocal.' Now the writer confesses that he ought to have said *exactly* reciprocal, and a few other explanations ought to have been added ; there was certainly a wish to be fair, and Wenzel got more than his share of space ; if not treated well, it is sad. To speak falsely of a man is a great error. Still he also must add that he would not have learned the laws of reciprocal affinity with any clearness from Wenzel, and more than that, he is not aware of any one who did.

Still to some extent the present writer repents and draws back his word. Wenzel has examples of reciprocal affinity in his book ; had he seen it in all its clearness, there would have been no room for scruples or inexactness. Dalton, with Wenzel's knowledge and no more, would have rushed to the full and complete law at once ; but Wenzel remained with ideas of measuring affinity by time, and thus obscuring his own knowledge. The general idea of a true, honest, working, scientific man is seen in him : a man without great genius floundering in the very current of his success.

Colonel Ross, the author of 'Pyrology,' has been fighting for the fame of Wenzel ; and when we look at all that has been written a fear of having done injustice comes over the spirit. But looking at one part of the book, Colonel Rcss is right, at another part he is wrong. Wenzel must, we still think, be held as having seen pretty well, but not with such force and clearness as to have taught the world. Three generations have disputed about his meaning. Dalton's meaning is without doubt, and contained in a few pages.

Indeed, if we consider Wenzel's words carefully, we may draw from them the conclusion that he sometimes argued from the principles of Dalton's atomic theory, scarcely conscious of it, and not sufficiently aware of his own progress. It is in this way that men dispute about discoveries in the past. Men sometimes use principles which are beyond their own understanding; they become the unconscious tools of nature.

There has been so much discussion on the question whether Wenzel discovered reciprocal combining proportion, that it is necessary to enter more fully on the subject; and the 'Life of Dalton and History of the Atomic Theory' will be more fully drawn upon.

'We now come to Wenzel, one of those men whose names have been brought forward as much-neglected philosophers, and to whom almost every writer on the history of science, who has had occasion to mention him in later years, has been anxious to award the due honour. We see his book constantly quoted. Some writers give us his words, others give us what appears such a clear explanation of his ideas that we feel no more to be wanting. I had been long anxious to obtain his works, but after advertising in Germany, and inquiring in several towns and large libraries in this country, as well as in France and Germany, I did not obtain the volume, and proceeded without it. I afterwards found that a duplicate copy existed at the Munich Royal Library, and was fortunate enough to obtain it, duplicate copies being generally disposed of. Having read it carefully over, I found no such passages as are imputed to him; and, therefore, read it still more carefully again, and then a third time, but they did not exist. Having written to two eminent historians of science for an explanation, I find that neither had seen the volume, but one of them informed me that the mistake had been rectified in a supplement to the "Handwörterbuch der Chemie und Physik."[1]

'The reciprocal saturation which results when two salts decompose each other is the discovery, the honour of which has long been given to Wenzel. It is a curious fact that not only does he not see this, but he sees and explains the contrary, as he shows us that in double decomposition something always remains unsaturated, but generally very little remains. One is sorry that, being so near a law, he had not the slightest conception of it. The most important part of his work, as far as our purpose is concerned, seems to me to be contained in the following sentences. The title of the work is "The Doctrine of the Affinity of Bodies."[2] I shall not give the original, although scarce, as the work, from the fact above stated, has lost its great importance.

'In the preface he says, "At first my only intention was to make for my own use a treatise which should contain the order of the ascertained affinities and the circumstances under which they acted, lest I should not be able to remember them. But it occurred to me that others might find it useful also, if it were more worked out. For this end I endeavoured to explain the cause and the law of

[1] It is by Dr. J. S. C. Schweigger, and has been since published as a pamphlet (*Ueber die Stöchiometrische Reihen im Sinne Richter's*, &c.), Halle, 1853.

[2] Carl Friedrich Wenzel, *Lehre von der Verwandtschaft der Körper*, Dresden, 1877.

affinity on a good foundation, and the circumstances under which the bodies combine as well as the true relation of their weights towards each other."

'Page 4. "It is of itself clear that any combination of bodies must have a constant unchangeable proportion, which can neither be greater nor smaller without some cause acting externally, because, otherwise, nothing certain could be decided on by comparing them. It therefore necessarily follows, that every possible combination of two bodies stands in the most exact relationship with every other, and this relation expresses the degree of combination."

'Page 9. "These smallest particles of each body have at all times, in a natural state, a determinate figure ; but the whole mass of the body takes a form according as chance or art gives it, without causing any change in the smallest particles, just as the tender fibres or tubes in a piece of wood remain always the same, although the whole piece may be in the shape of a ball or a cube."

'Page 10. "I examine the natural structure of some metals, I see certainly nothing more than that they are hard, solidly united heavy bodies, which become liquid in the fire at different degrees of heat, and lose their former connectedness (or cohesion), and without being heavier take up a greater or less space than before. This is enough to enable us to conclude that the figure of the smallest particles of metals is changed by the fire, and that the fluid condition of the whole mass and its altered specific gravity are the necessary consequence of this alteration of figure. For when the mass of a body without change of weight takes up a greater or less space, it is certain that it can take place under no circumstances except a change of figure in the smallest portions of the bodies. A thousand small cubes may be put into a smaller space than the same number of spheres of the same mass and weight, and the heap made by the spheres is not so great as if they were converted into stars, and so on. When the specific gravity is altered, no matter by what means, the figure and situation of the smallest parts can no longer remain the same."

'Page 20. "Besides change of figure, I know no sufficient reason for all that has been said; for if we completely banished the figure and viewed the properties of the body as something substantial in matter, I know not how we could explain without contradiction the everyday experience; or we must, as Snellius with refraction, explain it by the will of God, which settles the matter at once; but if my understanding is to lay hold of the method by which anything acts, this explanation will not be satisfactory."

'Page 28. "But we have remarked that any combination of bodies, on account of the figure of their parts, depends on static laws, and there it is proved that the motion of a weight is so much the slower the smaller the force is in comparison with it. Let us apply this to the present case and bodies will appear to us as so many weights, and their common solvent as a force which acts more slowly or more rapidly on one or the other. It follows, then, that the more rapidly a common solvent unites with a body, the greater must be its degree of combination, and we obtain therefore this law, (already given, p. 210.)

'"*The affinity of bodies with a common solvent is in the inverse ratio of the time taken to dissolve.*"

'Page 31. "We have now a universal law, according to which the affinity of bodies, or their rank in the series, is decided ; and we obtain at once this important advantage that we not only know that the union of a common solvent is greater or less with any body, but also how much greater or less it is, because the difference of the time of solution shows the difference of the combination. Therefore amongst a number of bodies, the combination of one with a common solvent may be considered as a quantity which may be expressed by a fixed number, if we take the smallest in such a series as unity; and by this means we are able to give a correct explanation of all phenomena."

'Page 46. "This important question then remains, why a solvent, when it is only moderately diluted, does not in the least attack certain metals, but as soon as another metal is dissolved in it, with which it naturally has a less affinity, a ready solution of the first takes place.'

'Page 47. "Because here the powers meet which assist each other."

'Page 72. "The circumstances under which this metal (iron) is dissolved by vitriolic acid are these, that the acid must not be strong. When both unite iron vitriol is formed, which loses the most of its acid in the fire, as well as by frequent solution in water. A small bored cylinder of Styrian steel of 102 grains was put into half an ounce of the spirit of vitriol diluted with an equal quantity of water, exactly as with the zinc experiments ; there remained $46\frac{3}{4}$ grains of steel, and $55\frac{1}{4}$ grains were dissolved in the half ounce of the spirit of vitriol."

'Therefore the relation of the hardest steel to the strongest vitriol is 175 : 240.

'Under *Application of the Doctrine of Affinity of Bodies*,[1] it is said, "This will best be shown by examples.

[1] Page 450.

'" Is it possible by Beguin's spirit of sulphur (a sulphide of ammonium chiefly) to decompose the luna cornua, or to separate the muriatic acid entirely without loss ?

'" To settle this question we require only the following experiments. Muriatic acid has a smaller degree of affinity with silver than with the volatile salt. Sulphur, on the other hand, unites with silver in preference to the volatile salt. The silver is not separated from the muriatic acid by the volatile salt on account of accidental circumstances, but this separation follows the moment any other body unites with the silver, if it has not the property of dissolving the silver. But sulphur is just such a body, and is therefore fitted for the purpose. If, then, the spirit of sulphur of Beguin is poured on finely powdered luna cornua, it is easily seen that the muriatic acid in the luna cornua must unite with the volatile salt in the spirit of sulphur, and the sulphur will unite with the silver. The new products that are formed by this separation can consequently be nothing more than common sal-ammoniac and sulphuretted silver."

' Page 452. " Another similar question arises by which the proportions of the mixture must be considered. How much cinnabar must be mixed with the luna cornua so as completely to separate the silver ?

'" The possibility of this decomposition may be shown in the same way as in the first case. If no particular experiment is made, it depends on the comparison only of the following propositions. Half an ounce of fine silver takes up $35\frac{1}{2}$ grains of sulphur. We may then calculate that for $180\frac{9}{16}$ grains of fine silver, $26\frac{3}{4}$ grains of sulphur are required. We know besides that cinnabar contains sulphur in the proportion of 65 to 240 of quicksilver, or 65 grains of sulphur united with 240 of quicksilver are to be met with in 305 grains of cinnabar, therefore $26\frac{3}{4}$ grains of sulphur are contained in $125\frac{1}{2}$ of cinnabar. This quantity of cinnabar, as regards its sulphur, will be sufficient for the decomposition of half an ounce of luna cornua.

'"But we must inquire if $125\frac{1}{2}$ grains of cinnabar contain as much quicksilver as will be sufficient to take in the muriatic acid which is saturated with the silver. Half an ounce of luna cornua contains $53\frac{7}{16}$ grains of muriatic acid of greatest concentration. In half an ounce of the caustic sublimate there are $58\frac{1}{3}$ grains of the strongest acid, which is saturated with 174 grains of quicksilver. From this proportion it is found that $53\frac{7}{16}$ grains of the strongest muriatic acid are required for $159\frac{2}{5}$ grains of quicksilver. Now as there are in cinnabar 240 grains of quicksilver united with 65 grains of sulphur, $159\frac{2}{5}$ grains of quicksilver require $43\frac{1}{6}$ grains of sulphur. Both together give nearly $202\frac{1}{2}$ grains of cinnabar. Consequently, from $125\frac{1}{2}$ grains of cinnabar, all the muriatic acid found in the luna cornua is not separated. We see from this that the muriatic acid of the lunar caustic rises in sublimation with the quicksilver out of the $202\frac{1}{2}$ grains of cinnabar as a caustic sublimate, whilst the silver remains united only with so much sulphur as it found in $123\frac{1}{2}$ grains of cinnabar."

'His smallest parts of bodies are not atoms, but molecules rather, or particles, as they change their form. He has made a theory of affinity, and attempted to represent the force by a number. . . . This failure at once removes him from the great discoverers, and places him among those honourable and valuable labourers in science whose names are read with respect by students, but who cannot be recognised by mankind generally, because the capacities of our minds are too small to retain more than the lives of a few of the most eminent.

'The doctrine of reciprocal proportion must be taken from him, and he can now no longer hold a place in the history of the atomic theory other than as the author of an intelligent attempt which has entirely failed.

'I feel sorry to leave him in this state, and a few kind words will do little good. I believe he would have preferred the truth ; the honour he received was not required by him ; the discovery was not claimed by him, he died in 1793, before it was known to be worth making. In his works he appears an honest, earnest man.'

Is this a fair summary after actually giving specimens of the neutral decomposition of salts ? These specimens occur as examples in the 'application of the doctrine,' but the doctrine is not quite expressive of these applications, and on the whole we cannot do better even now than come to the conclusion that Wenzel never expressed clearly the law of reciprocal proportion. We must not, however, forget an important sentence in his favour on the fourth page of his book. The translation has been given, p. 214. It may be well to give the original :—

§ 2. Dass eine jede Verbindung der Körper, eine bestimmte und unveränderlich bleibende Abmessung haben muss, die ohne äusserlich mitwirkende Ursachen weder grösser noch geringer werden, weil sonst auch nichts gewisses aus ihrer Vergleichung bestimmt werden könnte, ist schon an sich klar. Es folgt daher nothwendig, dass eine jede mögliche Verbindung zweier Körper mit jeder andern beständig in dem genauesten Verhältniss stehet, und dieses Verhältniss drückt den Grad der Verbindung aus.'

In 1775 Dr. Bryan Higgins of Dublin, lecturing in Greek Street, Soho, London, made such a remarkable advance in opinions on atoms that one wonders that for thirty years no one paid attention to him. Even now he is almost ignored.

He says, 'The attraction subsisting between elementary atoms is more forcible in one direction or axis of each atom than in any other direction, and there is a polarity in all matter whatever.'

How much theory this is the beginning of! How little has it been acknowledged!

7. 'That the attraction of bodies enumerated as distinct properties of matter or laws of nature, are nothing more than the sums of the attraction of their elementary atoms, or those forces concentrated in a certain degree by the pressure of repellent atoms, or those forces exerted to the greatest advantage in bodies whose primary elementary attractions are strongest, and whose primary elementary atoms are also arranged in polar order.'

Bryan Higgins started so well that we are astonished at his failure, but as William Higgins says of himself in 1791, 'Est quadam prodire tenus si non datur ultra;' even the second does not seem to have satisfied himself when he wrote as a Fellow of Pembroke College, Oxford, although he claimed more when he vindicated himself in 1814, writing as Professor of Chemistry to the Dublin Society. These men are not mentioned in some acounts of the period, but we have numerous quotations from men who had no idea of a science of chemistry long after it was fermenting in men's minds. The popular men of science for the time are often the favourite speakers of the time, who may or who may not have had real originality; if they have, so much the better. We demand some originality in our days.

We might say much of William Higgins, but to a chemist one sentence of his is enough, '*We must suppose that the ultimate particles of light inflammable air require two, or three, or more of dephlogisticated air to saturate them. If this latter were the case, we might produce water in an intermediate state, as well as the vitriolic or nitrous acid, which appears to be impossible; for in whatever proportion we mix our airs, or under whatever circumstances we combine them, the result is invariably the same.*'

Higgins wrote on phlogiston a book of about three hundred pages, but there are very few sentences about combination and atoms. He does not at first seem to have seen the value of these ideas, or to know that they furnish the beginning of all chemical law. He wished to draw attention to phlogiston, he lost the great truth he had in hand, he used words greater than himself, no one got the atomic theory from his books, and he himself let it lie dead. We must allow that he gave the first clear and satisfactory explanation of saturation. He was an original thinker, but he was one of the many who fell in the breach. Elsewhere the writer has said, 'I look on him as the first man who even in his imagination formed a correct atomic compound and gave a correct analysis, in spite of the thousands of previous speculations and the simplicity of the idea, but one who lost the opportunity of elevating his idea into a great law of nature.' [1]

Richter came next with laborious volumes. It is not our intention to discuss them. 'He found that there was a certain quantitative relation between all bodies, and he

[1] *Anfangsgründe der Stöchiometrie*, 2 vols. 8vo., 1792–3.

made out the laws so far, that when he knew the quantitative analysis of a salt, he could tell its quantitative decomposition with another; but he never saw it with sufficient clearness to be able to express the combining quantities each by its own distinct number, nor does he appear ever to have proceeded far enough to be able to assign a cause for the phenomena or to connect it with any fundamental idea.'

'He was the founder of the systematic study of Stoechiometry. He was an illustrator of one of its most important laws, and a defender of regularity in nature. His scientific life was laborious, his love of science sincere, and in all respects he seems to have been a man of high character. After reading his works, and coming occasionally on a sentence which makes us for the moment believe that he has discovered a greater law than we can now give to him, and finding that during his whole life he was just on the point of discovering the present atomic laws or laws of equivalents, one feels that perhaps he was the only man that deserved to discover them, having given himself up entirely to that purpose—another combatant who died before victory.'

So little hold had these ideas on chemists, existing as they did in a few minds groping uncertainly, that Berthollet in 1805 ('Journal de Physique,' vol. lix.) ridicules the idea of the molecules uniting by a leap from 0 to 9 to 12 to 25 per cent. Proust has actually to defend definite proportions against the backward thinking of Berthollet, who advocated the superior power of quantity without definiteness. It is strange how chemists still cling to this power of mere bulk, not seeing it as a law more allied to cohesion, if it be anything but cohesion. Still the two must meet somewhere.[1]

The following still holds good. 'It really is a melancholy thing to read these papers of Proust. . . . He saw[2] with great clearness that without such constant proportion the products of nature would lose their stability, and the characters of bodies could not be depended on for permanence. We have here no difficulty in judging how much he did, and how much he left undone, how far his mind was advanced, and how it had merely speculated. When he uses + 1, + 2, + 3 of proportions, he tells us that it is merely for illustration, he did not mean it to indicate the order of combination; he had, in fact, made no theory, at least found no law on the subject, although he clearly saw that it must be owing to some law of nature. He sought for constant proportions in combination, and sought well, but he had no idea of a constant quantity of oxygen found uniting with a constant quantity of every metal and making higher oxides by steps always of an equal altitude, although he proved that the rise may not be that of an inclined plane, but by "fixed terms." And yet it follows as a consequence, so closely in fact does it follow that we must put ourselves in the position of the early chemists of the century well to understand the difference. When we have taken that position, we then see how thin was the veil, although utterly impenetrable, that divided his opinion from the present, and prevented the acute, accurate, and logical mind of Proust from attaining to the great discovery. His determinate proportions are given as remark-

[1] The writer has shown that in the case of absorption of gases by charcoal definite laws are followed by cohesion, but proportions different from chemical equivalents are observed.

[2] *History of the Atomic Theory up to the time of Dalton*, p. 226.

able facts in connection with which he confessed to perceive no law.'

One cannot get a clearer notion of the indefinite or lawless constitution of the chemist's mind generally as to affinity than from a sentence in a volume by D. Friedrich Stromeyer. He says, p. 66, § 36 ('Grundriss Theoretischer Chemie zum Behuf seiner Vorlesungen entworfen von D. Friedrich Stromeyer,' Göttingen 1808), 'The affinity of a substance towards another is always in proportion to its chemical mass, which it brings with it for combination.'

Creation is full of wonders; we can fancy Euclid writing out his axioms; let us not inquire how long they took to grow and where they first took root, but let us fancy them quite easy so that anyone can see them, and some persons saying, well, anyone can understand that, but, like the schoolboy trying how small they can make a point, and still giving it size. Mediæval logicians gave wings to their imagination, and argued on the number of spirits which can dance on the top of this mathematical point, whilst the geometrician draws a line from it and makes people wonder how much space he has taken up. Algebra succeeds geometry. Both seek results that few can understand, and penetrate into regions as difficult of access to most human beings as the back of the shining moon. There has been no greater case of development in man's nature, even in his prehistoric and historic times together, than this mathematical one. The point and the line have become a world of thought, only in part as yet comprehended, but cosmic and other movements of creation have prepared our thoughts of geometry and algebra by making out the problems in deeds of infinite magnitude.

If mathematical truth has begun out of few axioms, so also have national and social laws. Let us think of the enormous mass of law-books possessed by all nations, the enormous number continually making and being unmade; and is it not still clear that in almost all cases 'Do as you would be done by' means enough? So with the great atomic law of Dalton; it must expand and become more complex, and other branch laws may be added, but it is an amusement to see the men who labour to get over the fundamental one making use of the same conclusions and darkening their own counsel. We find one writer calling Dalton's laws hypotheses, and Avogadro's a theory; where would Avogadro's have been without Dalton's? We find then isomorphism and isomerism thus exalted, but surely they also are developments of Dalton's thoughts. The forms of expression 'atomic volume' and 'specific heat of atoms' would not only not have been used, but probably the inquiries they indicate never would have been made without the fundamental idea of 'the weight of ultimate particles of bodies.'

It has been said that the farther we go in one direction the greater we prove the circle of knowledge to be, and it is added that the wider its range, the greater the part that is unknown; there may be a limit to that, but we may say that the farther the idea leads us the greater it must be, and the great generalisation made by Dalton has not only led us very far, but promises to lead us still farther and probably longer than any single idea given us in physical sciences.

The simplicity of Dalton's law threw all the specula-tions of the chemists to the winds and corrected their analyses. He saw simply that bodies combined by adding one unit or two or more units at a time. If you have nothing but penny pieces to pay wages with, you must give either one penny, or two pennies, or three, and so on; you cannot divide them. In a similar way one atom of iron unites with one or two atoms of sulphur, or any number with any number; but there are no broken atoms: and this is the whole of Dalton's theory. It has gone beyond the reach of theory—it is a fact; but there are men who try to get beyond it and call it a speculation. Astronomy has to deal with great masses, mechanics have small ones, chemists have smaller still; but they are so far as we know *atomic*, that is, not divided in our experience.

'Although Dalton rigidly held to the idea of atoms, he by no means supposed that we had attained the indivisible atom in our elements; at least he expressly reserved this point. What he speaks of is simply the ultimate particle that seems to act in our chemical processes. He used atom and particle.' The latest ideas of molecules entirely fit in with his reasoning. Those who think otherwise cannot be said to understand Dalton, and indeed, it is difficult to imagine what any one means who opposes his theory, which is fitted for a far greater amount of knowledge of matter than any one seems by any speculations to indicate at this present time.

The consequences of Dalton's great idea soon showed themselves to be that there was now one great law or theory in chemistry, so that it was for the first time fit to be called a science.

It may be said distinctly that the laws which made chemistry a science were first seen by Dalton and published by this Society. The first announcements of them are given here in his own words:—

On the Absorption of Gases by Water and other Liquids.
By John Dalton, October 21, 1803.

Page 286. . . . 'Why does water not admit its bulk of every kind of gas alike? This question I have duly considered, and though I am not able to satisfy myself completely, I am nearly persuaded that the circumstance depends upon the weight and number of the ultimate particles of the several gases. Those whose particles are lightest and single being least absorbable, and the others more, according as they increase in weight and complexity.[1] An inquiry into the relative weights of the ultimate particles of bodies is a subject, as far as I know, entirely new; I have lately been prosecuting this inquiry with remarkable success. The principle cannot be entered upon in this paper; but I shall just subjoin the results, as far as they appear to be ascertained by my experiments.' Here follows the first table of atomic weights.

Dalton's New System of Chemistry, 2nd edition.

Chapter iii. page 212. . . . 'Chemical analysis and synthesis go no farther than to the separation of particles one from another, and to their reunion. No new creation or destruction of matter is within the reach of chemical agency. We might as well attempt to introduce a new planet into the solar system, or to annihilate one already in existence, as to create or destroy a particle of hydrogen. All the changes we can produce consist in separating particles that are in a state of cohesion or combination, and joining those that were previously at a distance.

[1] 'Subsequent experience renders this conjecture less probable.'

'In all chemical investigations, it has justly been considered an important object to ascertain the relative weights of the simples which constitute a compound. But unfortunately the inquiry has terminated here; whereas, from the relative weights in the mass, the relative weights of the ultimate particles or atoms of the bodies might have been inferred, from which their number and weight in various other compounds would appear, in order to assist and to guide future investigations, and to correct their results. Now it is one great object of this work to show the importance and advantage of ascertaining the relative weights of the ultimate particles, both of simple and compound bodies, the number of simple elementary particles which constitute one compound particle, and the number of less compound particles which enter into the formation of one more compound particle.

'If there are two bodies, A and B, which are disposed to combine, the following is the order in which the combinations may take place, beginning with the most simple, viz.:—

1 atom of A + 1 atom of B = 1 atom of C, binary.
1 atom of A + 2 atoms of B = 1 atom of D, ternary.
2 atoms of A + 1 atom of B = 1 atom of E, ternary.
1 atom of A + 3 atoms of B = 1 atom of F, quaternary.
3 atoms of A + 1 atom of B = 1 atom of G, quaternary.
&c., &c.

'The following general rules may be adopted as guides in all our investigations respecting chemical synthesis . . .'

Page 214. . . . 'From the application of those rules to the chemical facts already well ascertained, we deduce the following conclusions: 1st. That water is a binary compound of hydrogen and oxygen, and the relative weights of the two elementary atoms are 1 : 7, nearly; 2nd. That ammonia is a binary compound of hydrogen and azote, and the relative weights of the two atoms are as 1 : 5, nearly; 3rd. That nitrous gas is a binary compound of azote and oxygen, the atoms of which weigh 5 and 7 respectively; that nitric acid is a binary or ternary compound according as it is derived, and consists of one atom of azote and two of oxygen, together weighing 19; that nitrous oxide is a compound similar to nitric acid, and consists of one atom of oxygen and two of azote, weighing 17; that nitrous acid is a binary compound of nitric acid and nitrous gas, weighing 31; that oxynitric acid is a binary compound of nitric acid and oxygen, weighing 26; 4th. That carbonic oxide is a binary compound consisting of one atom of charcoal and one of oxygen, together weighing nearly 12; that carbonic acid is a ternary compound (but sometimes binary) consisting of one atom of charcoal and two of oxygen, weighing 19; &c., &c. In all these cases the weights are expressed in atoms of hydrogen, each of which is denoted by unity. . . .'

Dalton's New System of Chemistry.

Chapter iii. page 216. . . . 'From the novelty as well as importance of the ideas suggested in this chapter, it is deemed expedient to give plates, exhibiting the mode of combination in some of the more simple cases. A specimen of these accompanies this first part. The elements or atoms of such bodies as are conceived at present to be simple, are denoted by a small circle, with some distinctive mark; and the combinations consist in the juxtaposition of two or more of these; when three or more particles of elastic fluids are combined together in one, it is to be supposed that the particles of the same kind repel each other, and therefore take their stations accordingly.'

CHAPTER X.

Intermediate Epoch.

THE early times up to Dalton have been perhaps sufficiently dwelt on, and it would less break the progress of discovery as begun by Dalton if we took a rapid leap to the time of Joule's earlier life. There was however an intermediate period, which we cannot at present examine fully. It has been impossible to give it that attention which it certainly deserves as being interesting to Manchester especially; but considering the time required, the later histories of Manchester which have appeared, and the fact also, which must be confessed, that the results did not promise to be so interesting to the present writer as those on which he has dwelt, although perhaps more so to others, feeling too that it touches too much on the memories of the living, it has been decided to pass over even more characters than we have hitherto neglected. Part of this intermediate time might be called the engineering period, and we shall begin with a notice relating to an eminent engineer of the earlier years, who probably did much to bring others after him.

James Watt, Junior.

For 1790 we find Mr. James Watt secretary of the Society along with Dr. Ferriar. This was the son of him who made the steam-engine a power in the world; he seems for a time to have represented his father in Manchester. There were at one time a few sheets written by him amongst the Society's papers, but they do not at present appear; and unfortunately the Society has none of that correspondence which it was once proud of. This is strange. The reason of the presence of Mr. Watt, junr., in this town seems to be shown by the allusion in the following letter: but he does not seem to have stayed long, and we know that he succeeded to his father's business, and lived a long and successful life. He was generally called Watt of Aston Hall.

It is of interest to read this letter, and Mr. Muirhead's remarks, as it shows distinctly that Watt had found the only true method of 'burning smoke,' namely, giving it heat and air at the same time. If this is attended to, smoke will be burnt; those who do not see this and depend on form and shape of brick or iron, are deceived. Those who give *heat and air* always succeed.

From 'The Life of James Watt,' by James Patrick Muirhead, M.A., 1858, *pp.* 304 *to* 306.

'It is astonishing,' writes his son Mr. James Watt to him from Manchester in 1790, 'what an impression the smoke-consuming power of the engine has made upon the minds of everybody hereabouts; nobody would believe it until the engine was set a-going, and even then they scarcely trusted to the evidence of their senses. You would be diverted to hear the strange hypotheses which have been started to account for it. However, it has answered one extremely good end: it has made your engines general topics of conversation, and consequently universally known, which they were by no means before in this country.' On June 14, 1785, Watt took out a patent 'for certain newly improved methods of constructing furnaces or fire-places for heating, boiling, or evaporating of water and other liquids which are applicable to steam-engines and other purposes, and also for heating, melting, and smelting of metals and their ores, whereby greater effects are produced from the fuel, and the smoke is in a great measure prevented or consumed,' which newly improved methods he describes to consist 'in causing the smoke or flame of the fresh fuel, in its way to the flues or chimney, to pass, together with a current of fresh air, through, over, or among fuel which has already ceased to smoke, or which is converted into coke, charcoal, or cinders, and which is intensely hot, by which means the smoke and grosser parts of the flame, by coming into close contact with, or by being brought near unto the said intensely hot fuel, and by being mixed with the current of fresh or unburnt air, are consumed or converted into heat, or into pure flame free from smoke.' 'I put this in practice,' he continues, 'first, by stopping up every avenue or passage to the chimney or flues, except such as are left in the interstices of the fuel, by placing the fresh fuel above, or nearer to the external air, than that which is already converted into coke or charcoal; and by constructing the fire-places in such manner that the flame, and the air which animates the fire, must pass downwards, or laterally, or horizontally, through the burning fuel, and pass from the lower part, or internal end or side of the fire-place, to the flues or chimney. In some cases, after the flame has passed through the burning fuel, I cause it to pass through a very hot tunnel, flue, or oven, before it comes to the bottom of the boiler, or to the part of the furnace where it is proposed to melt metal, or perform other office, by which means the smoke is still more effectually consumed. In other cases I cause the flame to pass immediately from the fire-place into the space under a boiler, or into the bed of a melting or other furnace.' He varied the figure or form and proportions of the fire-places, &c., but in all cases the principle was the same; the fresh or raw fuel being placed next to the external air, and so that the smoke or flame passed over or through the coked or charred part of the fuel.

'Secondly,' he goes on, 'in some cases I place the fresh fuel on a grate as usual, and beyond that grate, at or near the place where the flame passes into the flues or chimneys, I place another small grate, on which I maintain a fire of charcoal, coke, or coals which have been previously burnt until they have ceased to smoke; which, by giving intense heat and admitting some fresh air, consumes the smoke of the first fire.

'Lastly, be it remembered,' he concludes, 'that my said new invention consists only in the method of consuming the smoke and increasing the heat, by causing the smoke and flame of the fresh fuel to pass through very hot tunnels or pipes, or among, through, or near fuel which is intensely hot, and which has ceased to smoke, and by mixing it with fresh air when in these circumstances; and in the form and nature of the fire-places herein mentioned, described, and delineated; the boilers and other parts of the furnaces being such as are in common use. And be it also remembered, that these new invented fire-places are applicable to furnaces for almost every use or purpose.'[1]

The new ideas in the Smoke-Abatement Exhibition at Kensington, 1881–82, are fewer than at his time in this letter by Mr. Watt, and the knowledge is among few persons.

We are glad also to bring into the list of our contributors an American friend and Englishman, Benjamin Franklin.

Meteorological Imaginations and Conjectures. By Benjamin Franklin, LL.D., F.R.S., &c. Communicated by Dr. Percival. Read December 22, 1784.

'There seems to be a region higher in the air over all countries, where it is always winter, where frost exists continually, since, in the midst of summer on the surface of the earth, ice falls often from above in the form of hail.

'Hailstones, of the great weight we sometimes find them, did not probably acquire their magnitude before they began to descend. The air, being eight hundred times rarer than water, is unable to support it but in the shape of vapour, a state in which its particles are separated. As soon as they are condensed by the cold of the upper region, so as to form a drop, that drop begins to fall. If it freezes into a grain of ice, that ice descends. In descending, both the drop of water and the grain of ice are augmented by particles of the vapour they pass through in falling, and which they condense by their coldness, and attach to themselves.

[1] The specification, which was enrolled on July 9, 1785, is printed in the *Mechanical Inventions of James Watt*, 1854, vol. iii. pp. 115 to 121.

'It is possible that, in summer, much of what is rain, when it arrives at the surface of the earth, might have been snow when it began its descent; but being thawed in passing through the warm air near the surface, it is changed from snow into rain.

'How immensely cold must be the original particle of hail, which forms the centre of the future hailstone, since it is capable of communicating sufficient cold, if I may so speak, to freeze all the mass of vapour condensed round it, and form a lump of perhaps six or eight ounces in weight.

'When, in summer time, the sun is high and continues long every day above the horizon, his rays strike the earth more directly, and with longer continuance, than in the winter; hence the surface is more heated, and to a greater depth, by the effect of those rays.

'When rain falls on the heated earth, and soaks down into it, it carries down with it a great part of the heat, which by that means descends still deeper.

'The mass of earth, to the depth perhaps of thirty feet, being thus heated to a certain degree, continues to retain its heat for some time. Thus the first snows that fall in the beginning of winter seldom lie long on the surface, but are soon melted and soon absorbed. After which the winds that blow over the country on which the snows had fallen, are not rendered so cold as they would have been by those snows if they had remained. And thus the approach of the severity of winter is retarded and the extreme degree of its cold is not always at the time we might expect it, viz. when the sun is at its greatest distance, and the day shortest, but some time after that period, according to the English proverb, which says, 'as the day lengthens, the cold strengthens;' the causes of refrigeration continuing to operate, while the sun returns too slowly, and his force continues too weak to counteract them.

'During several of the summer months of the year 1783, when the effect of the sun's rays to heat the earth in these northern regions should have been greatest, there existed a constant fog over all Europe and great part of North America. This fog was of a permanent nature; it was dry, and the rays of the sun seemed to have little effect towards dissipating it, as they easily do a moist fog, arising from water. They were indeed rendered so faint in passing through it, that when collected in the focus of a burning glass, they would scarce kindle brown paper. Of course, their summer effect in heating the earth was exceedingly diminished.

'Hence the surface was early frozen.

'Hence the first snows remained on it unmelted, and received continual additions.

'Hence the air was more chilled, and the winds more severely cold.

'Hence perhaps the winter of 1783-4 was more severe than any that had happened for many years.

'The cause of this universal fog is not yet ascertained. Whether it was adventitious to this earth, and merely a smoke proceeding from the consumption by fire of some of those great burning balls or globes which we happen to meet with in our rapid course round the sun, and which are sometimes seen to kindle and be destroyed in passing our atmosphere, and whose smoke might be attracted and retained by our earth: or whether it was the vast quantity of smoke, long continuing to issue during the summer from Hecla in Iceland, and that other volcano which arose out of the sea near that island, which smoke might be spread by various winds over the northern part of the world, is yet uncertain.

'It seems however worth the inquiry, whether other hard winters, recorded in history, were preceded by similar permanent and widely extended summer fogs, because if found to be so, men might from such fogs conjecture the probability of a succeeding hard winter, and of the damage to be expected by the breaking up of frozen rivers in the spring, and take such measures as are possible and practicable, to secure themselves and effects from the mischiefs that attended the last.'

'Passy: May 1784.'

John Kennedy.

Towards the end of last century several Scottish youths came to Manchester and made themselves prominent as engineers, leaving descendants who are still interested in the prosperity of the town. Although many have since come, it is intended to mention only a few of the earliest. James Watt, Junior, has been mentioned as having remained here for a time as representative of his father. We may next mention Mr. John Kennedy, who became a member in 1803 and continued so to his death in 1855. He was a friend of Watt, of Dalton, and of Henry, as well as other eminent men, and his house, from 1822, was a prominent one in Manchester, standing at the southern end of Ardwick Green, ready to welcome talent from all quarters. Mr. Kennedy was said by one whose name at the time was the oldest in the directory of business men in

Manchester to be the only man who had retired from business in the town who had made a fortune and still had remained in the same house. This may have been owing to the fact that the house was being only very slowly surrounded, and in such cases the residents scarcely observe the change. Trees, however, are still numerous in the garden, and there is no dwelling house of the larger size equally near the Exchange.

Mr. Kennedy was the third son of a family of Kennedys who had been landed proprietors in the Stewartry of Kirkcudbright for nearly four hundred years. At the age of fourteen he went south, attracted by another boy from the same neighbourhood, named Adam Murray, and they both became apprentices to Messrs Cannan and Smith, at Chowbent in Lancashire. Afterwards Mr. Kennedy was nearly the first to establish cotton-spinning mills driven by steampower. Before this, however, he, in partnership with Messrs. Sandford and McConnel, had been a maker of machines for spinning cotton. He was considered a good mechanist, making several improvements in the mule, and being the first to invent the differential motion in the jack-frame. Mr. Kennedy had kind and engaging manners, and he always gave a hearty welcome to young men who were endeavouring to get on in the world. He left six daughters and one son, of whom one daughter (Mrs. Chadwick) and the son alone survive. The son, Mr. John Lawson Kennedy, is a member of the Society ; the surviving daughter is Mrs. Chadwick, and we are glad to connect with the Society the name of such a man as her husband, Edwin Chadwick, C.B., who has rightly been called the father of sanitary reform, and who was born in this district. It would be difficult to find any man who has done so much to transform the habits of the whole population of this and the most advanced of other countries, or who has done so much to remove sorrow and pain and raise the standard of cleanliness, comfort, and life.

We have, however, a more direct reason for mentioning another son-in-law, Mr. Samuel Robinson; he has been a member of the Society since 1822. He was in business in Dukinfield, but has long lived retired: he is of a good family, a scholar, little known to the public, although his friends esteem him highly. However, he cannot be spoken of much, as he is among us to speak for himself. His knowledge is among such studies as few men here cultivate, being especially the Persian poets, from whom he has drawn many beautiful pieces, translating them in a graceful style, and we do not doubt with full appreciation, impressing deeply his friends with his skill, his refinement, and goodness. He has been brought incidentally among engineers, although he could only be called a user of machinery. He was prominent in advising the evening lectures at Owens College, which have been a great success. He now keeps very closely to his house at Wilmslow.

Peter Ewart.

Mr. Peter Ewart was long a prominent member of this Society, being elected in 1798. He bridged over the time from Percival and the early founders to 1835, when he left Manchester to become chief engineer and inspector of machinery in the Government Dockyards at Woolwich. Mr. Ewart was born at Troquair Manse, May 14, 1767. We learn from Dr. Charles W. Henry's account that the six sons of the minister of Troquair in Dumfriesshire all rose much above their original station. One was British Minister at the Court of Berlin, another an eminent merchant in Liverpool and the friend of Canning; the youngest, Peter, was obliged to work his way from the place of apprentice in the workshop to which he had been sent after showing an uncontrollable taste for watch-making, clocks, wheels, and all the connection of machinery. He was first put to work with Mr. Rennie, at Musselburgh, and then employed at Soho with Watt and Boulton. The character of Mr. Peter Ewart must have stood high, as the writer remembers well that the memory of that engineer sounded pleasantly in the ears of the elder men who knew him well. It is not possible to tell much of him, but we can imagine what he was from the following letter, which is so touching, and shows such enthusiasm as most men at present would not dare to evince; they would be ashamed to be so natural. It is well that there was such a man as Dr. Currie to admire, such a firm as that of Mr. Oldknow of Stockport to devise plans, and such a man as Mr. Ewart to carry them out so heartily and lovingly. This is the letter.[1]

Dr. Currie to W. Wilberforce, Esq.

Liverpool, April 23, 1793.

'Dear Sir,—If in the long letter which I wrote to you two days ago, there appears a good deal of unguarded warmth, the following circumstance will explain, though perhaps not justify it.

'I was sitting in my study on the evening of Saturday reflecting on public affairs, when a young man called to drink coffee with me, a manufacturer of Stockport, near

[1] From Dr. Henry's *Biographical Notice of the late Peter Ewart, Esq. Lit. and Phil. Soc. Mem.*, 2nd series, vol. vii. p. 121.

Manchester. After giving a picture of the general distress there, he informed me of his own situation in particular, and of the business which brought him to Liverpool.

'He said that the house of which he is a partner employed about 1,500 hands, all of whom are now idle, or, as the phrase is, off work. That previous to their being discharged he and his partner had struggled on from one week to another in hopes that the times would mend and a demand, more or less, come for their goods. That, in this hope, they had gone on for the last three weeks, and not having a sufficient quantity of money to pay the people their full weekly wages, they had prevailed on them to accept about a third of the sum, as this, with economy, might suffice for subsistence. In procuring the money for this purpose, he told me, they had been reduced to extraordinary difficulties. Formerly they sold their goods in large quantity, but now they determined to supply the retailers themselves with a single piece, or even less; and, provided they paid them in specie, at almost any price. Accordingly, having goods in their warehouses that suited the home market, they fitted up a light cart and sent a young man with it full of goods, to supply the retailers in every part of the country, and bring home the specie every Saturday, whatever might be the loss. The expedient succeeded for about three weeks, but had now failed, and he was come to Liverpool to try if by any possible means he could raise a few hundred guineas to get over another week and keep his people alive. He told me that he and his partner had been constantly amongst them, and by entering into all their distresses, had prevailed on them to be extremely patient and reasonable. At their last meeting they had agreed to wait this young gentleman's return from Liverpool, and what money he was able to raise, they had consented should be laid out in oatmeal, which being boiled up with water, potatoes, and some of the coarser pieces of beef, should be shared out in fair proportions among them, and thus in the cheapest manner provide for their subsistence. As the house had many thousands owing them in Liverpool, though he knew there was no hope of any considerable debts being paid, he had no fear of not being able to procure the sum immediately wanted. He had been using every effort for two days, and had actually threatened to arrest two of our principal merchants on the Exchange, but he had not been able to raise a single guinea. How he was to face the poor people he knew not, each of whom had four to six weeks' wages due. But he could appeal to heaven for the anxious exertions which he had made to relieve distresses which he could neither foresee nor prevent. As I looked at this young man, I perceived that his countenance seemed actually withered with care and sorrow. He is not a common character; he was the apprentice of Messrs. Boulton and Watt, and has an extraordinary degree of the most useful knowledge of every kind. He is modest, virtuous, and prudent, of astonishing application, and, in a word, one of the first young men I ever knew. These qualities recommended him to the notice of the manufacturers, among whom he exercised his profession of a mechanic and engineer. He had offers of partnership from the first houses there, and was actually taken into the house of Mr. Oldknow, of Stockport, about a year ago, at that time perhaps the first establishment in Lancashire. Mr. Oldknow you must have heard of as the original fabricator of muslin in this country, and a man of first rate character. He has laid out a property of 50,000*l.* on building and machinery alone. His partner (the young gentleman I speak of) is named Ewart, the younger brother of Mr. Ewart, the late Envoy at Berlin. It is men such as these that are reduced to such extremities.'

The paper of Mr. Ewart on moving force attracted a good deal of attention, and Dr. James Bottomley has been good enough to give a full account of it, and it may be succeeded by the discussion of the same subject, written at a previous period, by Eaton Hodgkinson, F.R.S.; and first the compendium and remarks by Dr. Bottomley.

On the Measure of Moving Force. By Peter Ewart. Vol. II. (2nd series), p. 105. *Account by Dr. James Bottomley.*

In this paper Ewart notices the views of both the schools of Natural Philosophers—namely, those who took as the measure of moving force the mass × velocity, and those who took as the measure the mass × square of velocity. He compares the statements of Hooke, Huygens, Newton, John Bernouilli, Leibnitz, and he also adds the opinions and experiments of Dr. Wollaston and Smeaton the engineer, for whom such questions had a practical importance. Smeaton's experiments showed great want of agreement between the prevalent theory and practical results, nevertheless the mechanical principles of force continue to be treated nearly as before. Attwood also agrees with Smeaton, that the momentum is not as the quantity of matter into the velocity. Attention is called to the non-applicability of this measure of force in the case of bodies revolving round fixed axes. Attwood thinks that neither of the measures of force is capable of general application, and also that theoretical views of force have had little effect on the construction of machinery, owing their origin and improvement to long experience of repeated trials. Ewart demurs to this; neither does he think that Attwood is supported in his opinion by the history of useful discoveries in machines, giving us examples of men who were both scientific and ingenious, Huygens and Hooke. Smeaton also availed himself of a just theory in applying water to the best advantage as a moving power. Ewart then proceeds to state some of the difficulties which have occurred to himself and others in the application of the common doctrine of moving force, and describes some particular instances where the difficulties occur, and gives from approved writers on mechanics such observations as appear to have been given in explanation of the points in question. He then gives several examples of force producing motion in bodies from a state of rest, also examples of motion destroyed and of motion transferred from one body to another. He expresses his disappointment that Emerson does not give that information which one might have expected from his analytic skill. Emerson even thinks that *vis viva* ought not to pass for a principle in science. Attwood points out where Emerson, in the solution of a problem, is led into error by a neglect of this very principle. Some mathematicians have regarded the question of momentum or *vis viva* as a measure of moving force as a dispute about words. Ewart quotes Prony to the effect. Dr. Milner of Cambridge contends that the dispute is not merely verbal. Dr. Wollaston thinks that the conception of a quantity dependent on the continuance of a given *vis motrix* for a certain *time* may have its use when correctly applied in certain philosophical considerations, but the idea of the same force exerted through a determinate *space* is of greater practical utility, as it occurs daily in the usual occupations of men. Wollaston's views closely coincide with those of Smeaton. The Edinburgh Reviewers, however, on Wollaston's essay, adopt a different doctrine. The opinion of Laplace on the question is quoted, 'La force peut être exprimée par une infinité de fonctions de la vitesse qui n'impliquent point contradictions, il n'y en a point par exemple à la supposer proportionnelle au carré de la vitesse.' Laplace thinks the law of inertia and the law of force proportional to the velocity, are the most natural and most simple principles imaginable, that they are derived from the very nature of matter, and that they are the only facts which the science of mechanics borrows from experience. In connection with the measure of moving force reference is made to Smeaton's work on water-wheels. Ewart thinks Smeaton's four maxims on undershot wheels may all be comprehended in one expression, thus: that in cases where the maximum effect is produced it is nearly as the quantity of water multiplied by the effective head. Ewart refers to some experiments of Bossut on water-wheels, giving results agreeing very nearly with Smeaton's conclusions. Borda and Waring attempted to show that the force of the water against the wheel is not proportional to the square of the velocity with which it strikes the wheel, but that it is in the simple ratio of that velocity. Ewart objects to Waring's demonstration, leading he thinks to the conclusion that we may double the power of any undershot wheel (whatever may be its velocity) by merely doubling the number of its floats or planes acted upon by the water. Ewart also objects to some experiments of D'Alembert, Condorcet, and Bossut, as not sufficiently comprehensive and admitting deductions of an arbitrary kind. He mentions some experiments of Don Juan and M. Buat, on the pressure of moving-water on planes; their results do not agree with the ordinary theory. Smeaton's observations on these matters, although neglected by authors, have not been lost to practical men, and have led to the disuse of undershot wheels, which about fifty years ago were more prevalent but are now rarely met with. Smeaton's principle was to apply the water so that it should act more by its weight than by its impulse, an advantage being thereby gained. The Edinburgh Reviewer objects to the opinion of Mr. Smeaton; allusion is made to the doctrine of the Cartesians, which was also maintained by Leibnitz and John Bernoulli, that motion could not be lost, for the same quantity of motion or of force, it was said, must be always preserved in the world. With reference to the principle Ewart states, 'It has never been questioned that motion may be generated, accelerated, or retarded in a variety of ways, and there appears to be no good reason for supposing that it may not be destroyed as well as generated.' Ewart then refers to some arguments of Maclaurin's that have always been considered the strongest that have been brought against the principle of *vis viva*.

These arguments are contained in a treatise that obtained the prize of the Royal Academy of Science at Paris in 1724. Ewart thinks that Maclaurin and Bernouilli reason from different principles; he also gives some remarks of Dr. Milner upon the paper to the same effect. Ewart then proceeds to the consideration of change of figure. Smeaton, he says, was the first who subjected to actual measurement the force spent in producing change of figure in the collision of non-elastic bodies. His dissertation, however, has been almost totally neglected by succeeding writers. Of the illustrative experiments brought forward by Ewart one was suggested by Dalton. It is stated in order to show that the same effect is produced by the same force whether it act by gradual pressure or by sudden percussion. It treats of the impact of a prism fixed at one extremity upon a piece of clay, the impression is the same at whatever distance the clay is placed from the centre of motion. Ewart thinks 'that great misunderstandings respecting the subject have arisen from the various senses in which the terms have been taken must be acknowledged, but it cannot, I think, be reasonably contended that the whole has been merely a dispute about words.' He also thinks it was a misfortune that the principle of *vis viva* was brought forward in opposition to the Newtonian doctrine of force. Ewart does not regard it in opposition but rather as an extension. In order to have the history of this measure we must go as far back as Galileo. Mr. Robins and Maclaurin seem to ignore this and regard it as a new doctrine brought forward by Leibnitz and his followers. Ewart says as far, therefore, as the measure of force which is composed of the pressure into the space through which it acts can be applied to the estimation of the force of moving bodies, it is properly speaking the doctrine of Galileo and Newton. The same principle has been still further extended and applied to explain the phenomena of force producing changes of figure in masses of matter. Ewart states 'all our notion of force appears to be derived from pressure as it is perceived by the sense of touch. When a mass is moved by pressure the pressure must also move—unless the pressure follow and act upon the mass through some portion of space no motion can be produced. If pressure be increased in the same ratio that the space through which it acts be diminished, or *vice versa*, the same effect will still be produced. The space therefore compensates for the pressure and the pressure for the space, and when taken together they constitute a determinate measurable quantity of moving force, but in determinate quantities which are always proportional to the moving force by which they are produced. The word Force has been ambiguously used. The force of a body in motion and a quiescent pressure are different in kind. Leibnitz and his followers adopted the distinct terms, *vis* and *vis viva*. Wollaston prefers *impetus* to *vis viva*, but he sometimes uses *energy* in the same sense. Smeaton uses the term *mechanical power* to express the product of the pressure into the space through which it acts, or the product of the mass into the square of the velocity. Ewart thinks that in this sense *moving force* would be a convenient term for action of moving pressure. It need not be confounded with *motive force* or the pressure uncombined with the space or time through which it acts. Moving force might be defined as 'moving pressure producing change of velocity or change of figure in masses of matter.' The duration of a moving force cannot be taken generally as an element in the estimation of its quantity. There appears to be no more reason for taking duration as the general measure of a moving force than for taking temperature as the general measure of heat. Ewart then refers to expenditure of moving force in overcoming cohesion of particles of fluid, he refers to the case of a jet of water issuing from a hole in the containing vessel—this had been considered by John Bernouilli in his 'Hydrodynamics. Newton also considered it ; his solution in later editions of the 'Principia' differing from that in the first. To measure the repulsive action on the water in the opposite direction to the jet Newton suggested that the vessel should be suspended like a pendulum ; it will then recede from the perpendicular in the opposite direction to the jet. Ewart made some experiments of the kind, and obtained results nearly agreeing with what it was concluded to be by Bernouilli and Newton. The results also agree with the explanations that have been given of moving force. Upon the same principle an easy and simple explanation may be given of the action of the hydraulic machine called Barker's Mill. The theory of this machine has engaged the attention of many mathematicians, and Euler has furnished two treatises on it to the Memoirs of the Berlin Academy—his demonstrations are complicated. Mr. Waring in America has given quite a different theory. Ewart's own explanation is different from any other ; alluding to the maximum effect produced by machines, Ewart observes that in the actual construction of machines it is necessary to aim at a maximum quite different from that which is usually proposed in books on the theory of machines. By proceeding on the principle that when a weight is raised from one point to another in the least time the maximum effect is produced, many erroneous conclusions have been drawn respecting the proper construction of machines ; Ewart mentions an example in the case of overshot wheels. Ewart next refers to a case brought forward by Dr. Wollaston involving collision and change of figure, which has been understood to prove that the force of a body in motion may be properly estimated either by the duration of its action or by the space through which it acts according to the particular views which may be taken of the phenomena. Ewart thinks that it admits of the same explanations as some of those which have already been examined.

Ewart concludes with a simple application of the principle which he endeavours to support, and the resolution of compound moving forces.

Having given the above remarks on Mr. Ewart's paper, we add also Mr. Hodgkinson's, written some years earlier than the above.

Some Account of the late Mr. Ewart's paper on the 'Measure of Moving Force,' &c., by Eaton Hodgkinson, F.R.S. (read April 30, 1844), *pp.* 138 *to* 144, *Vol. XII.*

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The subject of this paper formerly caused a great controversy among mathematicians, which continued for thirty years or more, and was then dropped about a century ago. Since which time an idea has been generally entertained that it was only a dispute about terms.

The advocates on one side, including Leibnitz, the Bernouillis (John and Daniel), Hooke, Huygens, Wolfius, Gravesande, Musschenbroek, &c., maintained that the force of bodies in motion ought to be estimated by the quantity of matter multiplied into the square of the velocity; whilst the other side, called Newtonians, and including the names of Maclaurin, Pemberton, Desaguliers, Clark, Jurin, and

Robins, contended that the force was as the quantity of matter multiplied simply by the velocity.

To explain the reason of these opposite opinions, Dr. Wollaston, in his lecture on the Force of Percussion (Phil. Trans. 1806) proposes the following experiment:

'Suppose a ball of clay to be suspended at rest, having two similar and equal pegs slightly inserted into its opposite sides; and let two other bodies A and B, whose weights are as 2 to 1, strike at the same instant against the opposite pegs, with velocities which are in the proportion of 1 to 2. In this case the ball of clay would not be moved from its place to either side; nevertheless, the peg impelled by the smaller body B, which has the double velocity, would be found to have penetrated twice as far into the clay as the peg impelled by the larger body A.'

The results of this experiment were admitted by both parties; but they reasoned upon them differently. The party termed Newtonians asserted that as the clay is not moved, it is a proof that the forces of impact of the two balls were equal; as they would infer from the momenta being equal. Their opponents, on the other hand, maintained with equal confidence that the unequal depths to which the pegs had been driven was a proof that the causes of these different effects were unequal; as might be inferred from considering the forces as proportional to the squares of the velocities. One party drew their conclusions from the fact that equal momenta can resist equal pressures during the time. The other party took into consideration the spaces through which the same moving force was exerted; and as these were as 2 to 1, or as the product of the weight of each striking body and the square of its velocity, they concluded that the *vis viva*, to which this is proportional, was the proper measure of the effect of a body in motion.

The main object of Mr. Ewart's paper, in accordance with the conclusions of Smeaton (Phil. Trans. 1776), Dr. Wollaston, and others, was to show that if a constant pressure applied by any agent were multiplied by the space through which it acted, the result, being in a given proportion to the *vis viva*, was the most natural measure of moving force. He urged that if the effects of pressures were estimated with regard to the spaces through which they passed, instead of the velocities for a certain time, they would apply, as a measure of work done, in all the cases of practical mechanics; and would, he contended, remove many inconsistencies and errors from the reasonings upon questions occurring in them. He gives illustrations of his statements from almost every branch of practical mechanics and hydraulics; pointing out discrepancies, and solving various problems according to the principles he had assumed. He compared the conclusions from the common theory of fluids with the results of Smeaton's experiments on water-wheels (Phil. Trans. 1759), arriving at interesting conclusions; but the more recent investigations on this subject by Poncelet and others, with the very important experiments of the committee of the Franklin Institute, upon wheels of 20, 15, 10, and 6 feet diameter—together with those of M. Morin, on the turbine of M. Fourneyron—have placed all others in the shade. Mr. Ewart made many experiments on the reaction of effluent water, and applied the results of his researches on this subject to the solution of the problem of the recoil engine, known by the name of Barker's Mill. . . .

Mr. Ewart adduces, in his paper, several cases which he conceives not to be explicable according to the principles maintained by the advocates of the opposite measure of moving force to that which he adopted; and if the difference between them had been as great in reality as it was in words, there is little doubt his conclusion would have been just. Both parties seemed to be right, and to obtain correct results, when they reasoned consistently with their hypothesis; but there required a little adjustment between them. The arguments for adopting, under some distinct denomination, the product of the quantity of a pressure by the space through which it acted were very strong. It was evident that such a measure of effect produced would have a most extensive application.

This measure had been used by Watt to estimate the effects of steam engines; it had long before been adopted by Smeaton; and writers on mechanics had become prepared, both in this country and on the Continent, for the introduction of such a value. It has, therefore, been adopted by the most eminent writers on mechanics, both theoretical and practical; and without making any change in the received definitions of momentum and moving force, which depend on the mass multiplied by the velocity.

Sir William Fairbairn, Bart., F.R.S., &c.

Sir William Fairbairn is the best known of the engineers who have adorned the Society. He was born in Coldstream in 1789. His life by Dr. Pole, F.R.S., says that he was born in Kelso, but the present writer had Coldstream from Mr. Fairbairn himself. He was self-educated, and one feels it a matter of great wonder that such a struggle as we find depicted in his autobiography could have ended in showing such a fine specimen of a man, such pleasant, gentle manners, so much general knowledge. We cannot say that he was a learned engineer, still he read much and had good taste; we cannot say that he had scientific knowledge of an exact kind, indeed, he was sadly deficient in it, but he had an instinct and an insight that was of more value than any amount of education. A good mechanical head will invent machinery without any *exact* knowledge of any laws of physics, and calculate without any teaching in algebra or mathematics. There is something which colleges teach us to neglect, and that something was retained by William Fairbairn. This wonderful instinct made him one of the best known engineers, and led him to make improvements in every department he touched. His work has been so fully dwelt upon that it is only necessary to refer to their published account, and to the great tubular bridge at Menai, as well as the hundreds that have been built since, of course some of them improved. Much more would be said of Sir William Fairbairn could we not refer to his own most interesting account of himself contained in Dr. Pole's admirable volume. He was quite aware that there were times when instinct required the aid of science, and he knew well that without Mr. Eaton Hodgkinson or a man of equal powers his calculations would be insufficient. He was a most lovable man, gentle and agreeable as well as handsome, and with a force of character nevertheless which raised him to a high station. People instinctively believed in him, and he instinctively seemed to see into the minds of men as well as into the character of his work without the intellectual training so necessary to lesser endowments. If he was a little vain of his progress, it is only that which nearly all men who have risen so rapidly are blamed for showing. The long dispute as to the honour which he received from his work at the Menai tubular bridge, and which some considered to belong solely to Eaton Hodgkinson, we cannot enter upon; certainly, however, all who knew both the men must feel that the abilities of the latter were not of a kind which would have enabled him to bring important public undertakings to a practical conclusion.

Eaton Hodgkinson, F.R.S., &c.

The life of Mr. Hodgkinson must be treated also in a few lines according to our habit here, and we must at least tell that he was born at Anderton, in the parish of Great Budworth, Cheshire, on February 26, 1789, and that he died at Eglesfield House, Higher Broughton, Manchester, in 1861. His father had a farm, and his mother was left to continue it and keep her three children, being a widow when Eaton was only six years old. It is said that he got nervousness and hesitation of speech by maltreatment at the Northwich High School, whither he was sent in preparation for Cambridge by the advice of his uncle the Rev.

Henry Hodgkinson, rector of Aberfield, Berkshire. He was removed to another school, but instead of showing an inclination to the usual study of languages he seems to have given up everything for mathematics. He was obliged very early to assist his mother in attending to the farm, and at length to leave it, taking all the family into Salford, Manchester, where a business was begun which obtained for him a competency. He continued his mathematical studies and became the leading authority on the strength of materials and the mode of calculating. The labours of a lifetime seemed to culminate in formulæ for the purpose, and the most striking instance of their use was in the successful erection of tubular bridges.

We may be satisfied to quote Mr. Robert Rawson, who knew him well, and who may be trusted as a competent judge to sum up his work.[1]

'The strengths of long pillars of cast iron, wrought iron, cast steel, and Dantzic oak of the same dimensions, are in proportion to the numbers 1,000, 1,745, 2,518, 109. Cast iron is not reduced in strength when its temperature is raised to 600°.

'The sets in cast iron beams vary nearly as the square of the force of deflection; hence any force, however small, will injure the elasticity of cast iron. The strength in tons of beams approaching the best form is measured by the formula, 2166 $ad \div l$, where a = area of section of bottom flange in the middle, d = the depth in inches of the beam, and l = the distance between supports.

'A general investigation of the position of the neutral line is given on the principle that the forces of extension and compression of a particle vary as a function of its

[1] See an account of him in vol. ii. 3rd series, *Lit. and Phil. Soc. Mem.*

distance from the neutral line. This includes every hypothesis which has been proposed in order to compute the strength of material bodies subjected to strains.

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'When, therefore, Mr. Stephenson was engaged in the novel construction of the Conway and Britannia tubular bridges, he requested the assistance of his friend Mr. Hodgkinson in fixing the best form and dimensions of tubes. The experiments which were devised and carried out by Mr. Hodgkinson with a view to answer the above questions are recorded in the report of the Royal Commissioners appointed to inquire into the application of iron to railway structures.

'Mr. Hodgkinson, by these experiments, sought :—

'1. To ascertain how far the strain upon a square inch at the top and bottom of the tube would be affected by changing the thickness of the metal, the other dimensions being the same.

'2. To obtain the strength of similar tubes.

'3. To find the strength of tubes of various forms of section in the middle, and to furnish means of judging of the proper proportions of the metal in the bottom, top, and sides of the tube.

'4. To ascertain the relative strength of uniform tubes to bear a weight in all parts of their length ; and whether tubes, tapering in thickness from the middle towards the ends, according to theory, would be equally strong in every part.

'5. To obtain the resistance of the tubes, previously tried vertically, to bear a side pressure with an intention to ascertain the effect of the wind upon a tube.

'6. To ascertain the strength of small tubes of different forms of section to resist best a force of compression applied in the direction of their length.

'7. To ascertain the resistance of wrought-iron plates to a crushing force in the direction of their length.

'8. To determine the strength of tubes to sustain impact, with reference to riveting.

'9. To determine, by bodies let fall upon tubes, the probable effect, if any, of trains rushing rapidly upon tubular bridges, to produce resilience, or springing up at the ends.

'10. To determine the transverse strength of tubes stiffened in the top with cast iron, joined with wrought iron, to increase the resistance of the top to a crushing force.

'It was impossible that such assistance in the execution of a novel design could be lightly esteemed or inadequately appreciated by the great engineer. Hence, in the history of these tubular bridges, where Mr. Stephenson is anxious to record the merits of his assistants, he frankly acknowledges his deep obligations to the mathematical philosopher '*for devising and carrying out a series of experiments which terminated in establishing the laws that regulate the strength of tubular structures, in a manner so satisfactory that I was enabled to proceed with more confidence than I otherwise should have done.*' (See vol. i. p. 35, of the 'Britannia and Conway Tubular Bridges,' by E. Clark, Esq.)

'This declaration of Mr. Stephenson completely disarms all future praise or detraction with respect to the part which Mr. Hodgkinson took in the execution of the tubular bridges. It places him before the public in his right position as a most important contributor to the success of an enterprise which will represent the engineering skill of the present time, and will be the admiration of future ages. E. Clark, Esq., who superintended the building of the tubular bridges, speaks in the highest terms of Mr. Hodgkinson's labours in fixing the proper dimensions of the bridges.

'We are indebted to him also for nearly the whole of the mathematical calculations in reducing the experiments which were made into a form fit for application to a large structure. But we are also indebted to Mr. Fairbairn for a great portion of the practical construction of the bridges.

'The answers given by Mr. Hodgkinson to his inquiries, and which rendered such signal service to the engineer in the execution of his novel design, are as follows :—

'1. The value of (f) the strain upon a square inch at the top or bottom of the tube is constant in material of the same nature, while it varies from 19, 14, to 7¾ tons when the thickness of metal varies from ·525, ·272, to ·124 of an inch. The determination of (f) is the chief obstacle to obtaining a formula for the computation of the strength of tubes of every form.

'The strength of the Conway tube was calculated to bear 1,084 tons when the value of (f) was taken at 8 tons and the deflection about 15½ inches in the middle.

'2. The strength of similar tubes was somewhat lower than the square of their linear dimensions, being about 1·9 power instead of the square.

'3. The tubes may be reduced in strength and thickness towards the ends corresponding to the ratio indicated by theory, viz. that the strain at any point of the tube is proportional to the rectangle of the two parts into which that point divides the length of the tube.

'4. The power of the tube to resist a vertical strain is to its power to resist a strain on its side, as from the wind, as 26 to 15 nearly.

'5. The resistance of tubes to crushing follows the law of cast iron pillars when the crushing force is not more than 8 tons per square inch. It appears, however, that cast iron was decreased in length double what wrought iron was by the same weight; but the wrought iron sunk to any degree with a weight of 12 tons per square inch, while cast iron required double the weight to produce the same effect.

'6. The power of plates to resist buckling varies nearly as the cube of the thickness. Mr. Clark refers to this property as being most useful in the construction of the tubular bridge.

'7. The tube bent by pressure had borne a deflection of five inches without serious injury; but its riveting was destroyed by repeated impacts deflecting it through less than one inch.

'8. Resilience is perceptible, but very small.

'9. The introduction of cast iron on the top of the tube would be attended with advantage in resisting the force of compression. Practical objections, however, of a serious nature prevented Mr. Stephenson from availing himself of the power of cast iron to resist compression. He thought it advisable to increase the thickness of wrought iron to resist compression, rather than use a combination of wrought with cast iron. It may be stated that Mr. Stephenson has used cast iron, for the purpose recommended by Mr. Hodgkinson, with success in tubes of smaller dimensions than the Conway tubes.

'In 1847 Mr. Hodgkinson was appointed one of the

Commissioners to inquire into the application of iron to railway structures; and during the space of two years the whole of his time and abilities were devoted to the subjects of this inquiry. The exertions, both physical and mental, which he made at this period for the advancement of engineering science were so great as materially to affect his health and prostrate his powers. Immediately after the publication of the Commissioners' Report in 1849, he sought the restoration of his exhausted faculties by a tour on the continent of Europe.'

He was for some years Professor of the Mechanical Principles of Engineering at University College, London (Lecturer from 1847 to 1853 inclusive). His hesitation in speech greatly prevented his public usefulness as a teacher, and prevented that display of power which he evidently possessed. A marble bust of him is in the meeting-room of the Society, and admirably gives the gentle and pleasing expression of his countenance. He was President during the years 1848–50. The full account by Mr. Rawson will be read with profit by engineers.

John Fred. Bateman, F.R.S., &c. &c., is the son-in-law of Sir Wm. Fairbairn, and engineer to some of the greatest waterworks in the world, that of Manchester to which the water is brought from Woodhead, and that of Glasgow to which the supply comes from Loch Ketturin. He is now occupied with the still greater scheme, namely, bringing water from Thirlmere. He began his career in this Society, and we hope he will see his present great labour prosper in his hands—that is, if it ought to be accomplished. It does, however, strike one as strange that a county much too wet should ever be in water. We are imperfect in our modes of keeping, and probably equally so in our modes of using it. Mr. Bateman left the Society when he went to London—he was formerly a very constant attendant, and gave us many papers on rainfall and rain gauges—but being still alive no more can be added.

Sir John Hawkshaw, another eminent engineer, has left Manchester, but is still a member.

CHAPTER XI.

William Sturgeon and others.

WILLIAM STURGEON, the electrician, as we may call him, or physicist, was born in Lancaster, and spent his time from 1838 to his death, December 8, 1850, in close relations with the Society, and it was here that he collected his works for publication. He was born in 1783, and as we learn from a graphic account by Dr. Joule, was reared under circumstances peculiarly suited to make a man rough, selfish, and unintellectual. To keep his father, a clever man but an idle shoemaker, poaching fish and rearing gamecocks when starving the family, was the painful work of the young Sturgeon, and to the very last he had a life of labour and poverty. The work he did was nevertheless surprising, and we give here a full list of his papers, although not done in any other case, because he was one of those men too neglected, both by the higher class of scientific men of the time and by the Societies in which they were. It is sad to think that scientific men see no better than the public where real merit exists—surely this is nonsense, scientific men must see where science exists—well let it be so then : they are not very well able to bring forward those who are neglected, or are they willing if able ? It is to be feared that they are as other men, self being served first. It is true that at last he was seen by men of scientific eminence, and notably by our President, Mr. Binney, who although not an electrician was doing the work of others, and induced the Government to allow Mr. Sturgeon fifty pounds per annum when he was old. Here also we have to make complaints : to him who hath shall be given. A sum so small would not have been offered to a man who had been fairly prosperous, but to a man who had suffered all his life this sum was to set a seal on his poverty and to continue his depression. But it is not intended to write his life. Dr. Leigh (now Medical Officer of Health for Manchester) and Dr. Joule have written of him, and they knew him better than the writer of this did. It is enough then to add from their accounts the following, and first from John Leigh, F.R.C.S., &c., as it appeared in the 'Manchester Examiner and Times,' December 14, 1850.

'It was during his connection with the artillery that, as he once described to the writer of this brief notice, his attention was awakened, and his curiosity quickened, by the phenomena of a terrific thunderstorm. The whole phenomenon was a mystery to him, but he determined to become better acquainted with the wonderful agent that had so strongly excited his awe and admiration—a power that, in an instant, could rend rocks and rive trees, and yet whose visible existence was nowhere. The few books he was able to obtain afforded him little information, and even the perusal of those showed him that, in education, he was deficient in the elements essential to a physical investigator. With an energy and perseverance that characterised him through life, he resolved to overcome these difficulties ; and he set about it in a manner that indicated the high order of his mind. He began at once the study of mathematics, of which he obtained an excellent knowledge ; he then cultivated the Latin and

Greek languages to a sufficient extent to enable him to understand the meaning and origin of scientific terms, and coin for himself such as he needed. French, German, and Italian, he studied with much assiduity, that he might read the researches of the great continental philosophers. These languages, indeed, he read with considerable facility. Thus prepared, he entered on the study of natural philosophy, of which he obtained a sound knowledge; nevertheless, the phenomena of electricity and magnetism had ever the greatest charm for him. . . .

'It is difficult to conceive a more unfavourable social position for the formation of a scientific character than that of a private soldier,—the constant and wearying routine of duty, the want of privacy, the difficulty at the time of which we write of obtaining a fit supply of books, and the incessant temptations offered by companionship and a soldier's habits; and yet, surrounded by such difficulties, exposed to such temptations, and in such a position, did Mr. Sturgeon master the numerous branches of knowledge, the possession of which gave to his researches and their exposition a clearness and precision that had scarcely ever been surpassed. Simple-minded and clear himself, imbued with an ardent love of truth, he had an utter abhorrence of scientific quackery, and never failed to express his contempt for those who substituted a pretended knowledge for its reality. He was exceedingly happy in devising experiments and contriving the necessary apparatus, as may be seen by referring to Dr. Frances' "Dictionary of Scientific Instruments," and quick in perceiving the relations of the facts which he educed; and though it may be said that he never succeeded in the enunciation of a great law, yet no man has contributed to science a greater number of isolated discoveries of equal value and importance, or left behind him a greater number of instruments for others to work with. Some conception of his great labours and numerous contributions to science may be formed from the subjoined list of his papers :—

'1. An improved method of exhibiting M. Ampère's rotating electro-magnetic cylinders, by employing a horseshoe magnet instead of a bar magnet, as previously used. —*Phil. Mag.* Sept. 1823.

'2. On new electro-magnetic experiments.—*Phil. Mag.* Feb. 1824.

'3. Electro and thermo-magnetic experiments.—*Phil. Mag.* April 1824.

'4. Description of a rotatory thermo-magnetic apparatus.—*Phil. Mag.* April 1824.

'5. On electro-magnetism.—*Phil. Mag.* Oct. 1824.

'6. On a new mode of showing the action which a magnet exercises on metallic discs ; and on a novel phenomenon discovered thereby.—*Edinburgh Phil. Journal* and *London Phil. Mag.* August 1825.

'7. Description of a complete set of improved electromagnetic apparatus.—*Trans. Soc. Arts* for 1825.

'8. On the ignition of gunpowder by the electric discharge, and on the transmission of electricity through water.—*Phil. Mag.* June 1826.

'9. On the inflammation of gunpowder and other substances by electricity, with a proposal to employ the term momentum as expressive of a certain condition of the electric fluid.

'10. Recent experimental researches in electro-magnetism and galvanism.—Published by Mr. Sturgeon, in 1830.

'11. An account of an aurora borealis observed at Woolwich, on the night of January 7, 1831.—*Phil. Mag.* 1831.

'12. On thermo-magnetism of homogeneous bodies.—*Phil. Mag.* for July and August 1831.

'13. On electro-magnets.—*Phil. Mag.* 1832.

'14. On the distribution and retention of magnetic polarity in metallic bodies.—*Phil. Mag.* April and May 1832.

'15. On the distribution of magnetic polarity in metallic bodies.—*Phil. Mag.* 1832.

'16. On the theory of magnetic electricity.—*Phil. Mag.* 1832, and *Annals of Electricity*, vol. i.

'17. Description of an aurora borealis seen at Woolwich on the evening of December 22, 1834.—*Phil. Mag.* Jan. 1835.

'18. Description of a thunder-storm, as observed at Woolwich on June 14, 1834, with some observations on the cause of the deflection of the electric clouds by high lands, and an account of a peculiar phenomenon exhibited by means of a kite elevated during the storm.—*Phil. Mag.* Dec. 1834.

'19. Researches in electro-dynamics, experimental and theoretical.—*Annals of Electricity, Magnetism, and Chemistry*, vols. ii. and v.

'20. On electro-pulsations and electro-momentum.—*Phil. Mag.* Aug. 1836. On October 1, 1836, Mr. Sturgeon commenced a new scientific journal, called "The Annals of Electricity, Magnetism, and Chemistry," and continued it, under his own superintendence, through ten octavo volumes.

'21. Description of an electro-magnetic engine for turning machinery.—*Annals of Electricity, &c.* Oct. 1836.

'22. Description of two novel and brilliant electrical experiments well calculated for the lecture table.—*Annals of Electricity, &c.* Jan. 1837.

'23. An experimental investigation of the laws which govern the production of electric shocks, and other phenomena, by a single pair of metals.—*Annals of Electricity*, vol. i.

'24. Application of the theory of magnetic electricity, and of the laws of electro-magnetism, to the explication of phenomena.—*Annals of Electricity*, vol. 1.

'25. An inquiry into the attributes of the galvanometer, and how far its indications may be depended upon in electro-dynamic researches.—*Annals of Electricity, Oct.* 1836.

'26. An experimental investigation of the influence of electric currents on soft iron, as regards the thickness of the metal requisite to a full display of magnetic action, and how far these pieces of iron are available for practical purposes.—*Annals of Electricity, Oct.* 1837.

'27. Experimental and theoretical researches in electricity. Read before the London Electrical Society, Dec. 5, 1837.

'28. An investigation of the causes of the fracture of glass during an electric discharge, and on the mode of protecting it. Read before the London Electrical Society, Jan. 6, 1838.—*Annals of Electricity*, vol. ii.

'29. Researches in electro-dynamics, experimental and theoretical.—*Annals of Electricity*, vol. ii.

'30. Experimental and theoretical researches in electricity. Read before the London Electrical Society.

'31. Description of three different instruments for open-ing and shutting the battery circuit of an electro-magnetic coil machine.—*Annals of Electricity*, vol. iii.

'32. Description of an aurora borealis which appeared in London on the evening of September 29, 1838.—*Annals of Electricity*, vol. iii.

'33. Experimental and theoretical researches in electricity and magnetism. Read before the London Electrical Society, December 4, 1838.

'34. Experimental and theoretical researches in electricity and magnetism.—*Annals of Electricity*, vol. iv.

'35. On the use of voltaic electricity in electro-gilding and silvering.—*Annals of Electricity*, vol. iv.

'36. Description of an aurora borealis observed in London.—*Annals of Electricity*, vol. iv.

'37. Description of an original cast-iron voltaic battery, and an account of some of its performances.—*Annals of Electricity*, vol. v.

'38. Experimental and theoretical researches in electricity and magnetism.—*Annals of Electricity*, vol. v.

'39. Results of galvanic experiments made on Clapham Common in the autumn of 1838.—*Annals of Electricity*, vol. v.

'40. Experimental and theoretical researches in electricity and magnetism, &c.—*Annals of Electricity*, vol. vi.

'41. Examination and report of the effects of lightning on St. Michael's Church, Liverpool.—*Annals of Electricity*, vol. vii.

'42. Experimental and theoretical researches in electricity, magnetism, &c.—*Annals of Electricity*, vol. viii.

'43. Description of an aurora borealis seen at Manchester, on Wednesday, April 5, 1843.—*Annals of Electricity*, vol. x.

'44. On some peculiarities in the magnetism of ferruginous bodies.—*Manchester Memoirs* for 1845.

'45. On a peculiar source of deterioration of the powers of magnetic bars. Read before the Royal Society, May 1845.

'46. On the electro-culture of farm crops.—*Transactions of the Highland Agricultural Society.*

'47. An experimental investigation of the magnetic characters of simple bodies, metals, metallic alloys, and metallic salts.—*Memoirs of Manchester Literary and Philosophical Society*, 1846.

'48. Three accounts of the aurora borealis; and on the formation of clouds as observed in the locality of Kirkby Lonsdale.—*Memoirs of Manchester Literary and Philosophical Society*, vol. viii.

'49. On lightning and lightning conductors. March 21, 1848.

'50. On the peculiarities of the thunder-storm which occurred in this neighbourhood on July 18 last; posthumous paper, date uncertain.—*Manchester Lit. and Phil. Soc.*, read March 4, 1856.

'Mr. Sturgeon has also published two elementary treatises, one on electricity, the other on galvanism, besides some smaller works, the last of which was entitled "Practical Instructions for the Protection of Persons and Property from the Effects of Lightning."

'For a set of improved electro-magnetic apparatus, Mr. Sturgeon received, in 1825, the large silver medal of the Society of Arts, together with thirty guineas.

'The following statement of some of his most important discoveries, in a letter from the pen of the most distinguished physicist now left to us in Manchester, is an admirable testimony to his great scientific merits, and cannot be read without interest :—

'"My dear Sir,—I have sifted Mr. Sturgeon's claims to the utmost. I have examined all the periodicals likely to throw light upon the history of electro-magnetism, and find that Mr. Sturgeon is, without doubt, the originator of the electro-magnet, as well as the author of the improved electro-magnetic machine. The electro-magnet described by Mr. Sturgeon in the 'Transactions of the Society of Arts for 1825' is the first piece of apparatus to which the name could with propriety be applied. Arago, and Ampere, and Davy had already, it is true, magnetised steel needles by passing currents of electricity along spirals surrounding them, but it does not appear that they observed the phenomena with iron needles, nor that they had any knowledge of the suddenness with which the polarity of soft wrought iron might be reversed by a change in the direction of the current. It appears, therefore, quite clear that to Mr. Sturgeon belongs the merit of producing the first electro-magnet constructed of soft iron, as well as that of ascertaining its peculiar and most remarkable properties. *Hence it was that M. Jacobi, of St. Petersburg, claimed for Mr. Sturgeon, in conjunction with Professor Œrsted, the discovery of the electro-magnetic engine.* Mr. Sturgeon's claims with regard to the magneto-electrical machine appear to me to be equally well established. He was the first who devised and executed an apparatus for throwing the opposing currents into one direction, thus accomplishing for this machine exactly what Watt accomplished for the steam engine. Beside this, he is beyond dispute the author of the systems of solid brass discs and insulators, going by the name of 'commutator' on the Continent, and 'unitress' in America ; an apparatus now universally employed in every magneto-electrical machine. Mr. Sturgeon was without doubt the constructor of the first rotary electro-magnetic engine.

'"The use of amalgamated zinc plates in the voltaic battery was originated by Mr. Sturgeon. It is an improvement of such value that it has been universally adopted ever since, although all other arrangements of equal date have been superseded.

'"Mr. Sturgeon's discoveries in the thermo-electricity and magnetism of homogeneous bodies are very important, and have placed his name higher than that of any other philosopher who, after Seebeck, has cultivated thermo-electricity.

'"The above is only a very imperfect abstract of a small part of Mr. Sturgeon's discoveries and improvements in magnetism, electricity, and the kindred sciences. Though not himself the author of extensive generalisations, he has been signally useful in preparing the way for them, and in carrying them out practically; and I know not of one individual who, under equal or even less disadvantages, has contributed so eminently to the advancement of these highly interesting and useful sciences.

(Signed) JAMES P. JOULE."

'Soon after he left the army, Mr. Sturgeon was appointed Professor of Natural Philosophy in the Military Academy at Addiscombe, where he continued to lecture until he came down to Manchester to superintend the Victoria Gallery of Practical Science. The pressure of the times very soon necessitated the discontinuance of this institution, and Mr. Sturgeon was then unhappily deprived of any means of existence but the very precarious one arising from occasional courses of lectures. After struggling with difficulties which would have weighed many men down, he was at length, by the intercession of his friends, placed by Lord John Russell on the civil list for a pension of 50*l.* per annum, but which he has lived a very short time only to enjoy, having but received one year and one quarter's allowance. Some time ago, he resolved on collecting his numerous papers together, and publishing them in one handsome quarto volume, which has been a short time before the public, and as a specimen of provincial typography has seldom been equalled.

'After tracing his career, and contemplating the many valuable discoveries he gave to his country, it is painful to think that his last years were embittered by privations and pecuniary anxieties, that must have preyed upon his mind, and destroyed his comforts, and that, at last, he has left a wife and her daughter totally unprovided for. There is little inducement held out in this country to the cultivation of science, whilst the scientific men of other countries are ennobled, honoured, and placed in comparative affluence, as witness Professor Œrsted, a labourer in the same field with poor Sturgeon. Here they are neglected, unrewarded, and left to pine in poverty and want. The world uses their discoveries, heedless that the head that gave them moulders in the grave, the victim of its own mighty efforts, and of their ingratitude.

'In the "Athenæum" of November 23, 1850, is the following paragraph :—" At Copenhagen, Dr. Œrsted, the well-known discoverer of electro-magnetism, has been celebrating the fiftieth anniversary of his appointment at the Royal University of that city. We English are not accustomed to have our literary men spoilt, as they spoil them in Denmark and some other civilised countries. All ranks contended to do the philosopher honour on this occasion. The king sent him the Grand Cross of the Order of Dannebrog. The university sent new insignia of his Doctor's degree, including a gold ring, whereon a cameo bears the head of Minerva; and the citizens presented him with a beautiful villa, situated at Fredericksburg, in the outskirts of Copenhagen. King and people agree in a strange estimate of the value and status of the scientific man, according to our insular notions. We do not see how they could have improved on this sort of testimonial if he had gained a battle. Dr. Œrsted is upwards of eighty years of age."'

Dr. Joule has viewed the matter from another point; his account of Sturgeon's discovery is of importance, establishing the scientific position of the too much forgotten discoverer.

After describing Mr. Sturgeon's improvements on the voltaic revolving machine, the result of discoveries by Œrsted, Faraday, Ampère, and Barlow, Dr. Joule says: (see 'On the Life and Writings of the late Mr. William Sturgeon,' by Dr. James Prescott Joule, F.R.S., &c., Mem. of the Lit. & Phil. Soc., vol. xiv., 2nd series, p. 59.)

'In 1824 Mr. Sturgeon began to give the fruits of his investigations to the public in the leading scientific periodical of the day. In that year, no fewer than four papers of great merit appeared from his pen, on the subjects of electro and thermo-electricity, in the pages of the "London Philosophical Magazine."

'In 1825 he published in the "Transactions of the Society of Arts" the description of a *complete set of novel* *electro-magnetic apparatus.* The great merit of this apparatus consisted in the improved adaptation of the magnets, batteries, &c., to one another, by means of which Mr. Sturgeon was enabled to perform, with a voltaic battery of the size of a pint pot, experiments which had previously required the use of a cumbrous and costly battery. The Society of Arts testified their sense of the importance of this contribution by awarding to its author their large silver medal, with a purse of thirty guineas.' . . .

'About this time Mr. Sturgeon made his great discovery of the *soft iron electro-magnet,* and having observed the high degree of polarity acquired by a straight bar of iron on making a current of electricity to circulate around it, as well as the suddenness with which the direction of polarity could be reversed by changing the direction of the current, he proceeded to construct electro-magnets on the same principle, but bent into the form of a horse-shoe, so that the poles, by being brought near one another, could concentrate their action on any given object. *This soft iron electro-magnet has entered into the structure of every form of electric telegraph.*

'Passing over several highly valuable communications to the "Philosophical Magazine," which, even at this day, would amply repay a careful study, we find him, in 1830, publishing a pamphlet, entitled "Experimental Researches in Electro-Magnetism, Galvanism, &c.," comprising an extensive series of original experiments. In this work Mr. Sturgeon first pointed out the superior effects to be derived from the use of amalgamated plates of rolled zinc in the voltaic battery, instead of the unprepared cast zinc, then in general use. He prepared his plates by dipping them first into a dilute solution of acid, to cleanse their surfaces, and afterwards plunging them into mercury. He showed that plates prepared in this way do not effervesce in dilute sulphuric acid, as the unprepared plates do, and, in consequence, require to be much less frequently renewed than the latter; whilst, at the same time, the electric current produced is much more intense and constant. It is a remarkable fact, that no further improvement has been effected in the preparation of the positive plates of the galvanic apparatus, and that Mr. Sturgeon's amalgamated zinc plates are, at the present day, employed in every form of improved battery, whether patented or not.

'In our chronological arrangement of Mr. Sturgeon's discoveries, we may next note a highly valuable paper on the *Thermo-Magnetism of Homogeneous Bodies*, a work the merit of which can only be duly appreciated by those who are acquainted with the extreme minuteness of the currents of which it was the object to discover the existence and direction. By a happy combination of industry and sagacity, our author succeeded in proving that electric currents can be developed in any individual mass of pure metal by a mere disturbance of temperature at some particular point, and that the direction of those currents is determined by the position of the point of greatest heat and the crystalline structure of the metal—a fact of the highest importance, and which, along with others developed by him about the same time, paved the way to Dr. Faraday's celebrated discovery of magnetic-electricity.

'In 1836 Mr. Sturgeon communicated a paper to the Royal Society, which contains the description of a perfectly original *magnetic electrical machine*,[1] in which a most

[1] This instrument is the precursor of the variety of modern dynamo-electric machines employed for the electric light, electro-plating, telegraphing, &c.

ingenious contrivance was adopted for *uniting* the *reciprocating* electric currents developed, so as to give them one uniform direction. By this contrivance Mr. Sturgeon succeeded in producing all the effects due to ordinary voltaic currents, by means of the action of magnets on rotating coils of wire. In the same year the great industry of Mr. Sturgeon was rewarded by two other important inventions. The first of these was that of the *electro-magnetic coil machine,* an instrument devised for the purpose of giving a succession of electric shocks in medical treatment, and which has been generally preferred by medical men to all others intended for similar purposes. The other was an electro-magnetic engine, for giving motion to machinery.

'In 1838 Mr. Sturgeon noticed a highly interesting electro-calorific phenomenon, produced by a powerful battery of one hundred and sixty pairs, provided by Mr. Gassiot and Mr. Mason. On breaking the battery circuit it was observed that the disruptive discharge of electricity made the positive wire red hot, while the negative remained comparatively cool. Mr. Sturgeon applied this fact to elucidate some important points in the theory of heat.

'About this time also Mr. Sturgeon prepared a paper for the British Association for the Advancement of Science on the very important subject of *marine lightning conductors.* His researches on this subject enabled him to point out the danger likely to arise from the conductors then proposed for use in the Royal Navy by Sir W. Snow Harris, by which the lightning was sought to be conveyed through the body of the ship. He propounded at the same time a new system whereby this danger might be obviated.

'In 1843 Mr. Sturgeon published a memoir in the

Transactions of the Literary and Philosophical Society of this town, "On the direct Action of Caloric on Magnetic Poles, and the Displacement of Magnetic Action in Soft Iron by the Influence of Heat." The latter part of these researches develop some curious facts respecting the total absence of magnetic action in soft iron when made red hot, and point out by what means a bar may be converted into several magnets at one and the same time.

'We notice another memoir of even greater importance in the proceedings of the same body for 1846, entitled, "An Experimental Investigation of the Magnetic Characters of simple Metals, Metallic Alloys, and Salts." The very extraordinary fact arrived at by this research was, that *several metallic alloys become endued with magnetic properties, although the constituents separately show no such action; and that iron and nickel, two metals which, whilst pure, are susceptible of the highest magnetic powers, become almost totally inert to magnetic action when combined with some other metals.*

'The subject of atmospheric electricity was one to which Mr. Sturgeon devoted a great deal of attention, from the commencement of his scientific career to within a short period of his decease. Not satisfied with the ordinary apparatus in use at the electrical observatories, he elevated exploring kites into the atmosphere, and in all seasons and weathers, and even in some instances at considerable risk to his life, did he pursue this important branch of meteorology. The result of more than *five hundred* kite observations established the important fact, that the atmosphere is in serene weather uniformly positive with regard to the earth, and that the higher we ascend the more positive does it become; so that if the strata in which the kites are immersed are at altitudes corresponding to the series 1, 2, 3, 4, 5, their relative states of positive electricity would be conveniently represented by those numbers.

'Besides the above and a multitude of other researches which we have not room to notice, but which in a complete biography it would be impossible to pass in silence, Mr. Sturgeon was an ardent admirer and diligent observer of those grand and magnificent instances of the Creator's power which are exhibited alike in the lightning flash and the silent corruscations of the aurora borealis. Most graphic and highly interesting accounts of these natural phenomena appear interspersed among his more elaborate papers.

'The magnitude of Mr. Sturgeon's scientific labours would naturally lead one to imagine that his whole life was given up to original investigation. On the contrary, a large portion of his time was occupied in communicating his stores of knowledge to others. For several years he filled, with great credit to himself, the chair of Experimental Philosophy in the Hon. East India Company's Military Seminary, Addiscombe. In 1838 he accepted the office of superintendent of the Royal Victoria Gallery of Practical Science in this town; and subsequently to the failure of that institution, through the pressure of the times, he made strenuous, though unfortunately unsuccessful, efforts to establish another institution of a kindred character. As a lecturer, he was distinguished by the happy facility with which he conveyed the truths of science to his hearers, and the uniform success of his experimental illustrations. Nor did he confine his efforts to mere oral enunciation. The numerous elementary treatises which he published on electricity, magnetism, and chemistry, show the desire he had to extend sound knowledge as widely as possible. At the same time, he performed a real service to the cultivators of science, by establishing a new scientific journal, entitled, "The Annals of Electricity, Magnetism, and Chemistry; and Guardian of Experimental Science," which he continued with unexampled industry and perseverance through ten octavo volumes. This work became a medium of much valuable information; and its success gave rise to a similar publication on the continent, under the editorship of Professor de la Rive. Mr. Sturgeon's last work, which he completed only a few weeks before his death, was to collect into one large quarto volume the whole of his published papers. This work, which is got up in a first-rate style, and is illustrated by eighteen beautifully engraved plates, should be studied by all who wish to obtain a thorough knowledge of electrical science.

'In stature Mr. Sturgeon was above the average height, and his open brow and upright carriage conveyed the impression of integrity of character, an impression which was sure to be deepened by a personal acquaintance. As a friend he was warm-hearted and generous, and always prompt in acknowledging the merit of others, where merit was really due. To the widow and adopted daughter left is best known his sterling worth in the domestic circle. In politics he was a Conservative, though it will be readily believed he had no time to enter the arena of party strife. Conscientiously attached to the Church of England, he enjoyed the friendship of many of its distinguished ornaments.

'In Mr. Sturgeon we have lost a man of high moral worth and European reputation, and it may be doubted whether, with the single exception of Dalton, the scientific society of Manchester has ever experienced a severer calamity than by his death.'

In a somewhat fuller account of Sturgeon written by Dr. Joule and published in the Society's Memoirs, vol. xiv., 2nd ser. 1856–7, p. 78, the following specimen of his writing is given :—

'The electric fluid is so universally diffused throughout every part of nature's productions, that every particle of created matter, both animate and inanimate, which has hitherto been contemplated by the philosophers, is full of this surprising animated elemental fire.

'In regions far above the surface of the earth, where the air is much attenuated and so far thinned, near to the utmost verge of the atmosphere, as to become a conducting medium, the electric element plays its quivering streamers and sparkling corruscations in the beautiful aurora of the north. Sometimes this rare—this fascinating phenomenon—is exhibited in a steady glowing arch of light; whilst at others, it expands its dancing network in transient display over the whole concave of the visible heavens.

'At altitudes less elevated than those which form the grand theatre for the display of the aurora borealis, the electric discharges become more compact, and shoot slanting downwards on bright serene evenings these beautiful gleaming orbs of meteoric light which from ancient custom are still called falling stars.

'Still less elevated in the atmosphere the long black clouds swell with the electrical element, in all those grand magnificent and splendid forms of lightning, with their tremendous peals of thunder, so frequently displayed in most countries during the transient rage of a majestic summer's storm.

'Descending to the earth we trace its circumfluent streams polarising this vast ball of matter, on which we are destined to live and perform all our actions, and insinuating its resistless influence, in all the silent mysterious attractions of the magnet.

'Trace it to the laboratory of the chemist, and we find it the most active and vigorous agent in accomplishing all those astonishing changes which give new forms and new qualities to passive obedient matter.

'Besides all these important operations of nature, accomplished by the agency of electricity, it is capable of restoring the dormant muscular and nervous powers of man which have been prostrated by accident or disease, and of giving new life and new vigour to every other mode of medical treatment.

'In plants also as well as in animals it is said to facilitate growth, and to give health, vigour and heart to their general appearance.

'Indeed so *universally* does the electric fluid appear to be employed in *most*, if not *all* the grand processes of nature, that there is not perhaps a plant that grows or a limb that moves, but is in some measure influenced by its powers.

'Nay, it is perhaps this astonishing, this most gigantic of physical agents, which is employed by the Great Creator to spin the earth and planets on their axes, to sweep them through the heavens in their regular periods of revolutions, and to keep in uniform motion all those massy orbs of matter which compose the countless systems of the universe.

'Brief and imperfect as is the outline which I have thus portrayed of *the individual* branch of science, perhaps we may venture to ask, who is there then, who knows the advantages, beauties, nay, the pleasures of scientific knowledge, who would think his time misspent or his labours useless, in the accomplishment of so noble an acquisition ?'

Dr. Joule says, 'Mr. Sturgeon was of a tall and well built frame of body, his forehead was high and his features were strongly marked. His address was animated, and his conversation, as it generally is when the mind is stored with knowledge, pleasing and instructive. His style of writing was at once vigorous, lucid, and graceful. In friendship he was warm and steady, in domestic life affectionate and exemplary. He had a noble mind and a generous heart. . . . He was a close and sagacious reasoner, and an unsparing exposer of error. He detected quackery and false pretension, sought diligently for truth and loved it for its own sake. A diligent accumulator and observer of facts, eager in the pursuit of information of whatever kind, and in communicating his stores to others, under more fortunate circumstances he would probably have left a name unsurpassed in the scientific history of his time ; as it is, he will always be remembered as a distinguished cultivator of natural knowledge.'

To all this we agree heartily, and feel at the same time the extreme difficulty there is in this and perhaps in any country in Europe in any man obtaining a good position in any scientific establishment unless he enters in by the colleges or universities, or has made early friendships of those who have ; by their means he is put on the track of promotion, and otherwise he is often an outcast. We must feel how remarkable the influence of Sturgeon has been in developing the electrical apparatus of the present day. The results which are exciting the world are obtained by inventions begun by him, and he probably foresaw much of their value to the world.

J. F. Ekman.

In 1856 a gentleman named John Frederick Ekman was introduced to the Society, and soon began to exercise a great influence in the direction of the library. His willingness to act soon caused him to be appointed honorary librarian, and he spent most of his leisure time at the work. If we went there between one and two o'clock we were sure to find him diligent in the ordering of his books, making of lists, and writing letters to foreign societies. The idea of enlarging our correspondence with foreign scientific bodies and exchanging memoirs was certainly Mr. Binney's, and the present writer began the work when he was secretary ; but it required much time and it was done feebly, whereas Mr. Ekman put great force and enthusiasm into the work ; and it went forward with great vigour. The memoirs were not sold to any extent ; the public has given up all such purchases we may say. In early times a considerable income was made from the sale. The method of exchange was a mode of distributing our copies well and also of obtaining the works of others—an advantage it is hoped to both, although the Society cannot doubt that it has the greatest gain as a whole ; but this by no means extends to every case.

It is interesting to consider the personality of Mr. Ekman : he was tall, broad shouldered, and powerful-looking. He was from Sweden. His manners were polished and his speech was courtly, with somewhat of a tinge of the freer and more hasty habits of a commercial town. He was foreign correspondent to a commercial house, and was able to read, to speak, and to write both in the Teutonic and Latin languages, to what extent in each was not specially inquired into, but fully and completely in those of the north, whilst he had considerable classical knowledge and a great love of mathematics. He accumulated books, of which he was very careful; he saw few people, and cared not to speak of himself. Like many Swedes, he warmed strongly in speaking of France, and especially of Napoleon. He had a good deal of humour, and seemed to enjoy society when in the company of one or two friends whom he occasionally saw. This account is given because of the mystery attached to him; no one knew his parentage except one family, and it was said that his name, a common one in Sweden, was not his real one. We made no attempt to solve the problems presenting themselves, but it might now be a matter of pleasure if his friends here who took an interest in him were to receive somewhat more information. An apparently trifling illness kept him a while from our view, and when it grew into a typhoid fever it separated us most mournfully. We cannot think that it was for evil that he was banished from his country. Good men as well as wicked have had that misfortune. He loved his country however, and would gladly have gone back; he always felt here as a stranger, and although he spoke good English his pronunciation was decidedly foreign.

Mr. John Moore.

We have not learnt much concerning the life of Mr. John Moore, but we know of several of his papers, and he was president of the Society from 1851 to 1854 inclusive. He first appears in the Society's volumes as John Moore, Junior, in 1817, and in the third volume of the second series he gives an account of an excursion to Cumberland and Westmoreland. He was fond of the study of agriculture and botany, and in this excursion he remarks on the condition of crops and the habits of the farmers. One feels that, late as it was in the world's history, civilisation in many respects was only beginning on the road he took. He sees, however, the great advance the Cumberland men had made in civility over those of the Lancashire towns. We have still to learn if this is innate or caused by the employments ; it is still observable. We wonder too, when Mr. Moore speaks to the Manchester people, that the tone is adopted of one travelling in a foreign country, although the road is now traversed by many trains, and made almost into a Manchester street. So great have been the changes since the time when one of our presidents, so well remembered, was still young.

Mr. Moore was not a man of great force of character, but he was amiable and intelligent, and had a pleasure in going among scientific men, and was desirous of learning as much as possible from them concerning subjects of natural history, and especially botany. Scientific men however are not always amiable any more than other men, and Mr. Moore did not get sufficient encouragement from Liebig when that philosopher came over with all his agricultural fame in 1842. The new power was too much questioned by Mr. Moore, who was naturally anxious to learn all the new ideas. That visit of Liebig's was one of triumph, and he enjoyed his triumph much ; and why should he not ? He was an impetuous daring spirit with far-seeing Semitic eyes, but without the endurance of the Jewish portion of that race to whom his mother belonged. He might have shown his impatience even with Dalton had that gentleman been more in his company, but Dalton was then old, and the dignity of a great discoverer encompassed him, a dignity, however, which the old man in his simplicity scarcely felt when Liebig did homage to him.

Mr. Moore, having no business engagements to distract his mind, and being much respected by all who knew him, was elected president of the Society, and during his term of office one of the subjects in which he took the most prominent interest was the potato disease. A committee was formed in the Society for the examination of the subject, and a report was printed and circulated. The chief point found was the method of preventing decay from proceeding in the potato after it had been taken from the ground, and the best ideas were given by Mr. John Thom, now of Chorley. He used sulphurous acid, and found that a decided action of some kind took place by this treatment; there was moisture removed, and the temperature was lowered. It was Mr. James Young (now LL.D. and F.R.S.) who used also sulphuric acid weak for the same purpose; he was one of the committee. As the time may come when the report may be again of use, it is well to publish the whole document. As the present writer had something to do with the experiments and report, he may say that the statements made to the Mayor were not quite sufficiently representative of the committee's work. There was not enough said of the value of disinfectants in preventing decay generally, and their evident effect here; and too much was made of the value of dryness, air, and light. Dryness and air themselves are powerful disinfectants, but it is not easy to dry a great store of potatoes, whilst it is easy to send through them the vapours of sulphurous acid.

The rise of temperature shows an action of oxidation to be taking place in the potato. The lowering of the temperature by sulphurous acid shows this to be stopped, and the result is to preserve at least all that is uninjured in the potato. These experiments were repeated by the chemical committee, and the results first indicated by Mr. Thom were in every case found. Mr. Thom made his own experiments at the works where he was engaged; the committee, to satisfy themselves, made experiments at the Society's building. The report of the non-chemical part of the committee and the opinion of the chairman rather neglect the acid, and miss, as committees often do, the main truth and the originator; but the knowledge we now have of sulphurous acid and other disinfectants make us more than ever in favour of that treatment. We are at any rate happy to connect with this subject the name of Mr. John Moore.

The Potato Disease.

This report was sent to London daily papers, but was not printed, but we think it more valuable than most which were honoured.

REPORT.

The committee appointed by the Literary and Philosophical Society of Manchester, on Tuesday, November 4, 1845, 'to inquire into the nature and extent of the potato disease, and the best means to be adopted for preventing or impeding its progress,' beg leave to report—That they held their first meeting on Wednesday evening, November 5, and Friday the 7th.

John Moore, Esq., F.L.S., in the chair.

After hearing the opinions of Mr. Binney, Mr. Just, Mr. Moore, and others, as to the efficiency of drying potatoes, the committee unanimously agreed to recommend to the public :—

1. That all potatoes be kept perfectly dry.

2. That potatoes put into store in the usual way, in pits or hogs, be immediately opened, and the unsound ones picked out; the others being spread abroad, and exposed, as much as the weather will permit, to the influence of light and air, precaution being taken against frost.

3. That the least diseased potatoes be selected and dried on shelves in covered outbuildings, or kilns at a low temperature, not exceeding 80 degrees of Fahrenheit, with a constant current of air passing through them.

4. That the potatoes in the worst state of disease be immediately rasped and reduced into pulp, for the purpose of extracting their starch.

The committee also appointed a sub-committee, consisting of Mr. Ransome, Dr. Smith, Mr. Graham, Mr. Thom, and Mr. Young, to make experiments, for the purpose of ascertaining how far chemical agents could be used in averting the disease, and a sub-committee, consisting of Mr. Williamson, Mr. Campbell, Mr. Just, and Mr. Dancer, to make microscopical examinations, and report on the botanical phenomena of diseased potatoes, and the best means to be adopted for impeding or preventing their decay, and saving the tubers for planting.

The general committee met on November 12, when Mr. Young read the report of the sub-committee appointed to make experiments as to the best chemical means to be adopted for arresting the progress of the disease, as follows:

1. The committee have continued the experiments previously made by Mr. Thom, and come to the conclusion that the fumes of burning sulphur have a direct tendency to impede the progress of the potato disease.

2. That the application of sulphurous fumes is very easy: a hogshead, with two or three half-inch or one-inch holes near the bottom, may be three-fourths filled with potatoes, and a pan containing one pound of sulphur having been ignited with red-hot cinders, and placed over the potatoes, and the cask then covered with a lid, so as to confine the sulphurous fumes. Experiments as to the duration of time necessary for the process were made from fifteen minutes to twelve hours. No inconvenience ensued from their remaining the longer period, but the disease was stopped in a quarter of an hour. The committee have named a hogshead of potatoes for an experiment; but they consider that a large pit of potatoes may be easily operated upon, by removing a quantity of potatoes from both ends, and igniting some sulphur at the windward end, the top being covered with soil. A hogshead of potatoes stored three days, in which the disease was fast progressing, had risen in temperature to 62° F.; healthy potatoes being 52° in the same room; thus showing an increase in temperature of 10° F. The same cask of potatoes was then subjected to sulphurous fumes, applied in the mode above proposed, and the next day the temperature differed from the natural ones only 5° F.

3. The committee had immersed diseased potatoes in sulphuric acid, or oil of vitriol, mixed with 40 parts of water, and found that the disease in the potatoes so treated had not progressed.

4. Diseased potatoes were dipped in two gallons of

water containing a quarter of an ounce of creosote. No beneficial effect was produced.

5. Milk of lime was tried, and the disease in the potatoes was hastened.

6. The kiln-drying of potatoes, under various circumstances, has been tried with success.

7. Potatoes have been placed in dried clay or soil. The disease was stopped in all the potatoes so stored.

8. The disease increases if the potatoes be immersed in running water.

9. The temperature of potatoes in the natural state was $54\frac{1}{4}°$; those dipped in the vitriol mixture above mentioned, $53°$; those dipped in creosote, $56°$; those in milk of lime, $55°$; those fumigated with sulphur, $52\frac{1}{2}°$; those stored in dried clay or soil, $52\frac{3}{4}°$; those in natural state, becoming diseased, stored in cask three days and untouched, $64\frac{1}{4}°$. These potatoes were as nearly as possible under the same circumstances.

10. That the committee feel unable to give too much prominence to the fact, that exposure to light and air, in a dry place, with frequent turning of the potatoes, excluding those far advanced in disease, are quite sufficient to prevent the disease from doing much injury.

Mr. Moore, Mr. Clare, and Mr. Leigh, waited upon the Mayor of Manchester, on Saturday, November 15, at the Town Hall, and were very graciously received.

The Mayor, having informed the committee, that at an interview with Sir Robert Peel, at Drayton Manor, on the previous Thursday, the Premier had expressed himself much gratified that the very important question of the potato disease had been taken up by the Literary and Philosophical Society of Manchester.

Mr. Moore said:

. . . .

'There was some little difference of opinion as to the nature and origin of the disease, but none whatever as to its serious extent, in those parts of the country from which the inhabitants of Manchester and the neighbourhood are supplied with potatoes.

'On the question of preventing or impeding its progress, the committee were fully agreed that keeping the potatoes dry, and frequently bringing them into the action of light and air, was especially desirable, and we are happy in being able to assure your worship, that the recommendations issued in the short published report of the committee, have had a very beneficial effect, by inducing farmers to turn over and examine their potato stores, by which means very much good has already been done; but it will require continued care and attention to secure a sufficient supply of this necessary article of food for the consumption of the coming winter, and also, for planting in the ensuing spring.'

On Wednesday, November 26, Mr. Campbell, curator of the Botanical Gardens, reported the result of a series of interesting experiments he had made upon sound and diseased potatoes at the Botanical Gardens, which are inserted in the minutes of the committee. These experiments completely confirmed the security which sound potatoes possess when properly dried in the air against receiving the infection; and also demonstrated the check which is given to the progress of the disease in infected tubers by careful drying.

Mr. Dixon, one of the inspectors of the Manchester Agricultural Society, being present, reported that he had, since the last meeting of the committee, gone over a great extent of country in North Cheshire and Lancashire, to examine the crops of turnips, for which claims had been made for the premiums of that society. He found the crops of turnips very abundant and healthy, and that the disease in potatoes had been greatly arrested by farmers having turned them over in the pit, dried and sorted them; and his impression now is, that one-half of the crop of the present year would, by these precautionary means, be saved.

A very interesting letter was read from Mr. Rothwell, the other inspector of the Agricultural Society, in which he expresses his opinion, that one-third of the crop was rendered worse by injudicious treatment before pitting; another third had been destroyed by the farmer having pitted them too early and in too large quantities together; but that the remaining third may be considered saved by those farmers who, following the recommendations of the committee, have exerted themselves to get them properly dried and stored.

Mr. Just also informed the committee by letter, that the potatoes he had washed and afterwards carefully dried, remained perfectly sound, and that he had stopped the progress of the disease in infected tubers by cutting them in two and keeping them afterwards dry.

Your committee have had much reason to be satisfied with this result of their labours, and it will be gratifying to remember that, acting upon the cautious experiments of Mr. Binney, Mr. Just, Mr. Williamson, Mr. Thom, Mr. Moore and others, it was from this committee the public were *first* informed of the importance of getting stored potatoes *dry* as *soon as possible and keeping them so,* by frequent exposure to *air* and *light,* as the surest, as well as the simplest, means of ridding them of the superabundant moisture which was hastening their decay; and also of arresting the growth of any parasitic fungi that might have taken root, or be feeding upon them; and they have reason to believe that, by this precaution, a large amount of human food has, in this neighbourhood, been saved, which would otherwise have perished.

Your committee also consider it right to claim for the chemical sub-committee the merit of being the first to recommend, from careful experiments, the efficacy and safety of very dilute sulphuric acid, in arresting the progress of decay upon such tubers as are partially affected with disease; and, from the experiments of Mr. Campbell, there appears reason to conclude that, as keeping potatoes dry and frequently exposed to light and air is the safest way of preventing them from decay, so it will also afford the best security for a healthy and vigorous growth in the ensuing spring.

It is well known that, in ordinary seasons, when potatoes are pitted and stored in the common way, a great proportion begin to sprout before the time of planting the later kinds, and these sprouts have, from time to time, to be rubbed off, to the manifest weakening of the plant.

Under the comparatively imperfect growth of the tubers of the present year, although Mr. Campbell has proved they will vegetate freely, it is certain they would not stand this waste of vitality; and hence it becomes the more necessary to adopt the course he has pointed out, viz. keeping them dry, to prevent them from sprouting until they are required for planting.

Your committee cannot conclude without acknowledging the kindness and attention they have received from all persons to whom application has been made for information during this important inquiry; and they regret that the limited nature of this report prevents them doing more justice to communications of great value.

These documents will, however, be placed in the hands of the Society, and will furnish an encouraging illustration, and valuable record, of the essential aid which science is now affording to investigations of the highest importance to the agriculture and domestic economy of the country.

(Signed), JOHN MOORE,
Chairman of the Committee.

Mr. Joseph Chessborough Dyer.

A very prominent man in the Society for many years was J. C. Dyer. He was a tall and very powerfully built man. As he died in 1871 at the age of ninety-two years, he was not known at his best to the present members; but one could see how strong he must have appeared in his prime. Making this remark reminds us of the frequency with which the words *tall* and *powerful*, or some equivalent, has been used in speaking of the men who have adorned the Society, and at the same time contributed to the power of Manchester. They have been men of both physical and mental force: men who did their daily work for maintenance, and when it was over had time enough to continue thinking and planning both for a farther continuance of advantage to themselves, and for an improvement in the condition of the neighbourhood or of the kingdom. Men who have no overtime cannot make progress. But there are more ways than one of giving it to humanity; public works require both a strong body and an active mind: when this exists, the day is lengthened or made equal to an addition of assistants who require no wages.

Mr. Dyer was not strong in the period remembered by us, but he was active in mind; he was bent down considerably, but he changed little during an interval of twenty-five years, and took an interest in all that was going on; contributing in 1861 and 1866 four papers relating to inventions the history of which he had become intimately acquainted with. He had a considerable hesitation in speech, and his hands, playing nervously and tremblingly with his eye-glasses, gave one an idea of uncertainty in his intention; but on watching carefully his slow utterance, it was found that it was unnecessary to change any word when reducing his observations to writing. He was remarkably sound in his judgments, moderate, and kindly.

As an intimate friend of Fulton of steamboat fame, and agent for him in this country in the early part of this century, he becomes a person of interest to us, even if his own inventions did not mark him as important to all interested in the advance of machinery and trade, whilst his position in the Society gave him an additional importance for this history.

The short account of Mr. Dyer will be made of most interest if we give first one of his papers read at the Society in the session 1861–1862, 'On the Introduction of Steam Navigation.' It has a peculiar value from being the work of a man who had seen the earliest struggles in America.

Notes on the Introduction of Steam Navigation. By J. C. Dyer, Esq. Read Oct. 16, 1863.[1]

'Whatever saves labour, rewards labour.'—GOVERNOR MORRIS.

'The application of steam power to propel boats and ships being a subject of great public interest, has from time

[1] Mem. of the Soc. vol. ii. 3rd series, p. 284.

to time been treated by many able writers advocating the claims of the different parties alleged to have been the first inventors of the means of using this power to supersede that of the wind for propelling ships. Some of these writers have given a national importance to the questions of originality among the experimenters who claimed priority in the different parts of Europe and America, where trials had been made of their several schemes with various results. On these results, and their subsequent influence on steam navigation, many sharp controversies formerly appeared ; but of late years these seem to have subsided into the quiet assumption, on behalf of each nation, that its claimants were fairly entitled to the honour of having been the first discoverers of steam navigation. According with this impression two letters have appeared in the "Times" respecting the first introduction of steamers into the English waters: the first of which was copied from the "Dumbarton Herald," and the second, in reply thereto, is signed "Investigator," whose statements of the facts of the case are given in the "Engineer" of December 12, 1862, thus :—"Seeing that there has been a discussion and that there still remains an uncertainty as to who has the right to claim the honour of placing the first steamship in English waters, I beg to submit the following statement of authentic facts for settling the matters in dispute. The 'Margery' was built at Dumbarton by the late Mr. William Denny, for Mr. W. Anderson, merchant, Glasgow, and when launched was christened the 'Margery' after his eldest daughter, who named her, who is still alive, and a resident in London. At the close of the year 1814, Captain Curtis was sent by a London company to Glasgow, to negotiate with Mr. Anderson for the purchase of the

'Margery,' which was effected, the only stipulation made by Mr. Anderson being that the name of the steamer should at no future period be changed; this Captain Curtis agreed to, and the promise was faithfully kept. Captain Curtis took the 'Margery' through the Forth and Clyde Canal, and invited a large party of Mr. Anderson's friends to accompany him while passing through the canal. There remain but two of this party now alive, viz. the lady after whom the steamer was named, and a clergyman, a friend of Mr. Anderson's. The writer of the article in the 'Dumbarton Herald' is quite correct in his statement of the fear and wonder which the appearance of the 'Margery' excited on the coast while on her passage to England, as well as among the English fleet; in most cases she was supposed to be a vessel on fire. The 'Margery' was the first steamship that ever sailed in English waters, and made her first trip to Milton, below Gravesend, on January 23, 1815.[1] She was ultimately taken to Paris, where not many years ago her timbers were still lying on the banks of the Seine. Mr. Anderson was therefore owner of the first steamer that was ever seen in London, and also the first in Paris. He also owned the first that ever crossed from Scotland to Ireland (namely the 'Greenock,' built soon after the 'Margery'), which he took to Belfast."

'Considering that fifty-five years have passed since the first successful application of steam power to navigation was clearly established, and witnessed by myriads of people at New York and on the Hudson River, we may reason-

[1] Mr. Dyer seems to have forgotten Henry Bell, and his steamer 'Comet,' which plied on the Clyde, as is well known, in 1811, and went at the rate of six miles an hour.

ably invoke a calm review of the steps taken by the author of that success, as well as of those who had been engaged in the pursuits of employing steamers in Europe and America.

'The first steamboat established as a packet for passengers between New York and Albany was the "Claremont," built in 1806, and launched in the spring of 1807, and continued to run during the remainder of that year. As it was not until 1815 that the first steamer was seen in English waters, the successful application of steam to navigation was therefore *eight years* sooner in the American waters; and the honour of that success can hardly be denied to Robert Fulton, who achieved it, and whose preceding labours had gradually led him to its accomplishment. I propose to notice a few of Mr. Fulton's previous experiments and speculations upon the subject, without at all calling in question the merits of other ingenious men engaged in the same inquiries, though none of them had succeeded in practical steam navigation, so that either by the turn of fortune, or by the exercise of superior judgment and skill, Robert Fulton is justly entitled to rank as the author of steam navigation; and when the above facts are fairly considered, I doubt not that the English people will willingly accord the meed of praise due to him for the genius that conceived, and the persevering labour that led to his triumphant command of the elements, that enable us now "to walk over the oceans in the midst of their stormy terrors."

'In the year 1793 Mr. Fulton communicated his scheme for navigating by steam to Lord Stanhope, and received his lordship's thanks for the same, in September of that year. In 1811 I communicated with his lordship on the subject of bringing into use in England Mr. Fulton's inventions for steam navigation. Lord Stanhope then confirmed to me the fact of his having received Mr. Fulton's plans so early as 1793, and of his having conferred with him upon their practical application. In 1803 Mr. Fulton constructed a steamboat on the Seine, which satisfied him of the correctness of the principle he had adopted; and in conjunction with the American Minister, Mr. Livingstone, it was determined to transfer their joint exertions for establishing steam navigation to the American waters, for which purpose a steam-engine was ordered from Messrs. Boulton and Watt. From various causes of delay, Mr. Fulton did not arrive in New York until 1806. During that year he devoted his attention to superintend the building of the "Claremont" in the shipyard of Mr. Charles Brown. This vessel was 133 feet long, 18 feet beam, and 160 tons burden, and was employed, as aforesaid, in the summer of 1807.

'I have sailed in this vessel in company with Mr. Fulton, and retain a vivid recollection of the general interest which this great enterprise excited, and of the admiration bestowed upon its author, even by the many persons who had shortly before ridiculed his projects as chimerical.

'It is not my present purpose to join issue in any of the discussions concerning the original application of steam power to navigation, the subject having been exhausted by the respective advocates claiming it on behalf of England, France, Switzerland, and America. I content myself with stating the simple fact, that all of the experiments in each country, which preceded those of Mr. Fulton, had already proved, without any exception, utter failures, and no benefit whatever had arisen from the application of any one of the trials to navigate by steam prior to the complete success of the "Claremont" packet in the summer of 1807 on the Hudson River.

'It is worthy of remark, that the sensations of astonishment and alarm, among the spectators on shore and the crews of the vessels, created by the "Claremont" in 1807, were exactly the same as those created by the "Margery" among the vessels on the Thames in 1815, or eight years afterwards; this will be seen by Mr. Colden's description of the "Claremont's" first voyage, and Mr. Anderson's account of the first voyage of the "Margery," as before given.

'Steam could not be successfully employed to give rotatory motion to machinery by any of "the inventors of steam-engines," before the great improvements brought into use by James Watt. Considering that steam power had not been made to supersede water-wheels and horses, for giving rotatory motion to fixed machines on land, it was certain to fail as applied to such motion for propelling ships. It is needless, then, to notice any of the several schemes that had been proposed, or tried, for steam navigation, except those based on the use of Watt's steam-engine; and all inquiry concerning these are of interest only as they unfold the approaches to success attained by the several claimants, before the actual success of Robert Fulton in 1807. It will suffice, then, shortly to mention the several methods employed by the persons claiming to have been the "inventors of steam navigation."

'In France, the Marquis de Jouffroy claims to have constructed a steamboat with paddle-wheels at Lyons in 1783, which, however, was not heard of until 1816 (thirty-four years afterwards), when the first boat on Fulton's plan was started on the Seine; and *then* the Marquis complained loudly of Fulton's boat as being a piracy of his invention. On this occasion, Monsieur Royou (in the "Journal des Débats," March 19, 1816), in reply to the Marquis, says, "It is not concerning an invention, but the means of applying a power already known. Fulton never pretended to be an inventor, in regard to steamboats, in any other sense. The application of steam to navigation had been thought of by all artists; but the means of executing it were wanting, and Fulton furnished them."

'Dr. Franklin, in 1785, writes to Monsieur Alphonse Leroy thus:—"Several projectors have at different times proposed to give motion to boats, and even to ships, by paddles placed on the circumference of wheels on each side of the vessel; but this method has been found so ineffectual, as to discourage a continuance of the practice."[1]

'The plan proposed by Daniel Bernouilli, in 1738,[2] was by driving a column of water out at the stern of the vessel; which plan has been many times suggested, and several times tried by other ingenious men, but without success. It seems strange that, to so eminent a mathematician as Bernouilli, the radical defects of this plan should not have occurred. As the water issues from the mouth of the tube, it escapes in the radial lines of a semisphere. The resisting forces will be directly as the distance of each of the radii from the surface, and their propelling power will be equal to the force with which the water is driven from the orifice, *only* in the direct line of the tube's centre, and it will diminish with the angular deviation of the radii from that line, until it becomes *nil* at right angles; wherefore

[1] Life of Dr. Franklin, vol. iii. p. 528. London, 1818.

[2] In the Society's vol. this is put 1783 by inversion. D. Bernouilli died in 1782.

this mode of pressing water against water (though simple and plausible at first sight) is the most wasteful expenditure of propelling force of any that has been proposed.

'It appears that "endless chain-floats" have been many times proposed and patented; but this plan, too, is defective in principle, and has always failed in practice. The chain-floats are driven horizontally, and successively acting upon the same column of water, generate a current in the direction of their motion, and much of their propelling power is lost by moving and agitating the water. In an experiment I witnessed in 1813 (in a boat on the Bridgewater Canal), the floats were placed about four feet apart, and when first started, the boat moved with considerable speed; but as the speed of the floats increased, that of the boat decreased. Then every other float was removed, and at a new start better speed was obtained, but could not be kept above three miles the hour. Then all the floats were removed, and the chain only dragged through the water; this carried the boat a trifle faster than the floats had done.

'In 1795 Lord Stanhope made experiments with a steamboat with the "duck's-foot paddles," which did not succeed. The defects of this form of propelling arise from the loss of time in withdrawing the paddle between each propulsion, and in the waste of power in this retrograde motion.

'In 1795, James Rumsay, of Virginia, constructed a steamboat, which was tried on the Potomac in 1787, and which sailed by means of steam four miles an hour, as stated in Dr. Rush's letter to Dr. Letsome; but the boat was not continued on the Potomac, and Rumsay afterwards tried his plan in London without success. About the same time, Mr. Fitch of Philadelphia made experiments on the Delaware River for propelling boats by paddle-wheels; but owing to his miscalculation of the propelling wheels and of the steam-power as applied to the resistances to be overcome, his boats did not succeed, and were given up as failures, but were revived as his invention after the success of the "Claremont."

'J. C. Stephens, of New York, in 1804, made experiments with a steamboat 25 feet long and 5 feet wide; engine cylinder $4\frac{1}{2}$ inches diameter, with 6-inch stroke. At first she broke her steam-pipe; but after repairs she ran for a fortnight on the Hudson River, making two or three miles an hour, crossing from Hoboken to New York: therefore it is said by a distinguished writer, "Mr. Stephens has the merit of being the first person who took a steamboat to sea." (Qy.—Did he take this boat to sea on board of another vessel?)

'In 1788 and 1789, William Symington, in conjunction with Patrick Miller and James Taylor, made several experiments on patents they had obtained relating to steam navigation, and in 1802 started a boat on the canal at Glasgow, which ran at the rate of three miles an hour, and it was concluded that his plan would supersede horses in canal navigation. The wheel was placed at the stern of the boat; but he states that the wheel, or wheels, may be at the sides if preferred. The boat, however, was discontinued, and no more was heard of Symington's boats until long after those of Fulton had become widely extended on the American waters.

'The first ocean steamer was the "Fulton," of 327 tons, built in 1813 by A. and N. Brown at New York. The first steamer constructed for harbour defence, under the personal superintendence of Mr. Fulton, was built in 1814, of 2,470 tons burden. This boat has been the type from which all the ironclad batteries and rams have since been constructed, with various modifications, by later inventors.

'Thus it appears that the continuous rotative motion of the paddle-wheel and the screw propeller are the only means yet discovered for navigating by steam-power with safety and effect.

'In the specifications of Mr. Fulton's inventions, he gives drawings and descriptions—(1) of the chain-float; (2) of the duck's-foot paddle; (3) of the screw, fan, or smoke-jack propeller; and (4) of his paddle-wheels; with which several plans he had made experiments in France, which led him to throw aside the three first, and to adopt the paddle-wheel as the best in practice according to the then powers of construction; for it is well known that it was many years after the first screw steamer was constructed (the "James Watt," running from London to Havre) before a safe screw propeller could be made, for large ships, equal to the paddle-wheels.

'Having witnessed the triumphant success of Fulton's steamboats on the Hudson River, and their rapid increase for navigating the other American rivers, I undertook, in 1811, the task of inducing some of the leading engineers and capitalists of London to engage in the introduction of steamboats, on Fulton's plan, to run on the Thames and other waters in this country. Believing that they must soon be adopted and become of great importance to England, as they were so rapidly becoming in the United States, I had obtained from Mr. Fulton (through a mutual friend) a full description and the drawings of his inventions and discoveries relating to steam navigation, with the result of his labours in America. But I found it impossible to convince any of them that steamboats could be made to run with safety and profit in the English waters. The general reply was, "We don't doubt the success of steamboats in the large American rivers and inlets from the sea, but they will never answer in our (comparatively) small rivers and crowded harbours."

'Many of my personal friends urged me strongly not to waste my time and money on so hopeless a task as that of introducing steam navigation into England. Even the great and scientific engineer, John Rennie (father of the present eminent Sir John Rennie), urged me, with parental kindness, to drop all thoughts of bringing these boats into use—and this after having Fulton's plans before him, and fully admitting their success in America. Thus we see how difficult it is to make even great men move in any path before the destined time. Our late distinguished townsman, Peter Ewart, Vice-President of this Society, dissuaded me, as a personal friend, from trying to introduce steamboats into England, saying that "he knew of the trials made here without success, as also of those in America which were successful; but it did not appear likely that they could ever come into general use in the waters of England." This opinion of Mr. Ewart was expressed in the spring of 1814, just a year before the "Margery" was passed through the canal from the Clyde to the Forth, to make her first voyage in the English waters, as before stated. Mr. Ewart was fully informed of the nature and the results of the trials of the small boat constructed by John Bell, and run a short time, in the autumn of 1813 and the spring of 1814, on the Clyde and Forth before she was finally discontinued as a failure, which experiment had no tendency to convince him, any more than other

English engineers, of the practical utility of steam navigation in English waters. In that year (1814) I lent Mr. Ewart Fulton's specifications and drawings, which were sent by him to Boulton and Watt, and returned to me about six months after. I have reason to believe that that eminent house was led thereby to make further and more exact inquiries concerning the progress of steam navigation in America; for they, as well as several other engineers, commenced building steamboats in 1815 and 1816, since which time the progress of steam navigation has been marvellous for the perfection and the extension of British-built steamers both for inland navigation and, finally, for traversing alike the narrow seas and "the broad oceans that belt the globe."

'The engineering talent, the mechanical skill, and the active enterprise that abounded in England had created a self-reliance which seemed to forbid the direction of either into other channels than those marked out at home. Her most gifted men were satisfied with the progress of knowledge *within* the realm. National intercourse was then both irregular and sluggish; so that peoples were to each other real strangers, and much given to mutual jealousies. These recollections serve to explain the fact that eight years had passed away from the time when the waters of the Hudson were first agitated by the paddles of the "Claremont," and when over 5,000 tons had been launched upon her bosom, before those of the Thames welcomed those of the "Margery" steamer. The desire for instruction ever lags far behind the means of imparting it; hence the slow pace of nations in gaining knowledge through reports of its spread in other lands. This dislike to the "search for teachers" is alike found among men individually and in their national aggregates—all presenting the type of "the whining schoolboy, with his satchel and shining morning face, creeping like snail unwillingly to school."

'At length, however, successful teachers have raised the spirit of lofty enterprise; and, by reason of extended and personal intercourse, relations of mutual benefit have been so widely extended that peoples of different nations begin to approach the condition of a vast co-operative society, giving to each member the utmost value of their joint labours.' (*See* p. 323).

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It is fortunate that we have it in our power to give some account of a remarkable life from the pen of Mr. J. C. Dyer's son, Mr. F. N. Dyer, now in Macclesfield.

Notice of the Life and Labours of J. C. Dyer, V.P. of the Literary and Philosophical Society of Manchester. By F. N. Dyer.

'Joseph Chessborough Dyer was born in the small town Stonnington Point, in the province of Connecticut, on November 15, 1780. He was thus by birth an English subject, the independence of the United States not being recognised by the British Government till the peace of 1783. He was the son of Captain Nathaniel Dyer, Rhode Island Navy, who had been sent to Stonnington to put the little port in a posture of defence. The family soon returned to Noosenec Manor, Rhode Island, an estate held under a grant of Charles II. to Edward Dyer, or Dyre, as the name was then spelled. At an early age, Mr. Dyer had the misfortune to lose his mother. She was in New London during its bombardment and burning by the fleet under command of Benedict Arnold,[1] and never recovered from the hardships and agitation of her escape from the town, and journey on foot through the woods to the nearest settlement.

'For his education, J. C. Dyer was sent to the common school of Opdike's Newtown, now called Wickford, on Narragansett Bay. He boarded with Mr. Sands, a watch-maker; and there his natural turn for mechanical contrivance received its first direction and training. When he was about fourteen his father sold Noosenec Manor to his brother George Dyer (the Revolution having of course broken up all the settlements under royal grants), and went to Wickford, to be near his son and to enjoy fishing and boating on the bay. This circumstance led to the first practical effort of J. C. Dyer's mechanical ingenuity, in the construction of an unsinkable, or life-boat. The problem to be solved was to combine handiness and security, so as to build a boat small enough to be easily managed by his father and himself alone, and strong and buoyant enough to enable them to extend their excursions to Block Island, Nantuckett, or even Cape Cod. The boat was 18 feet long and 6 feet broad, with a half-deck forward and two masts, with thole-pins for oars or sweeps. The buoyancy was attained by small water-tight casks, securely lashed round the inside of the boat, below the level of the seats. When loaded and filled with water, with her crew of an old man and a boy, she floated well above the surface. I have no plans of this boat, and only describe it from verbal descrip-

[1] Arnold was in command of the troops, but the fleet was under his orders. The English officers protested to a man against the burning of a defenceless town, but, of course, they had to obey.

tion. It answered its purpose, and Captain Dyer used it till increasing age forced him to be quiet.

'At the age of sixteen J. C. Dyer entered the counting-house of Monsieur de Nancrède, a French refugee, who had established a large business as importer of European, chiefly English goods. M. de Nancrède returned to France on the repeal of the laws against the *émigrés*, selling the goodwill, &c., of his business to Mr. Dyer and Mr. Eddie, under whose names the business was carried on very successfully; till it was abruptly ended by the "Non-intercourse Act of Congress" of Jefferson in 1811, forbidding absolutely the importation of English goods. Mr. Dyer had made several voyages to England in the interim, and treating directly with the manufacturers in this country added largely to the profits of the business. In 1811 he left the United States, and in the same year married Eliza Jones, daughter of Somerset Jones, of Gower Street, London, whose acquaintance he had made on his first visit to England in 1802.[1] Mr. Dyer had taken steps on his first arrival in this country to establish his English nationality. Between 1802 and 1811, when he finally left America, he resided chiefly in London, only occasionally returning to Boston to make business arrangements with his partner Mr. Eddie. Though engaged in extensive mercantile transactions, his early bent for mechanics had in no wise lessened, and on his marriage he resolved to confine himself to that line of business exclusively. In his various papers, read before the Literary and Philosophical Society of Manchester, he gives so clear an account of

[1] It may be of interest to say, that on his first visit to Manchester (in 1802), the coach left Liverpool at 7 A.M., stopped for breakfast at Prescott, for dinner at Warrington, for tea at Eccles, and reached the Bridgewater Arms at 11 P.M.

his inventions and improvements, that it would merely lengthen this notice uselessly to describe them. It will therefore suffice to give the dates of the principal ones. In 1809 Mr. Perkins sent him his plans for steel engraving, and a patent was taken out in their joint names. The fur-shearing and nail-making machines were patented in 1810; the carding engine in 1811; and in that year Mr. Fulton sent him the drawings and specification of his steamboat, then in successful operation on the Hudson. In his paper on steam navigation Mr. Dyer relates the difficulties and discouragements he encountered in trying to introduce the system into England. In 1825 he took out his first patent for the roving frame for himself and Mr. Danforth, from whom he purchased the exclusive patent right for 1,500*l.* It is very characteristic of Mr. Dyer, that having improved this machine and brought it into successful operation, he sent out to Mr. Danforth, who had returned to America, an additional 3,000*l.*, on the grounds that the *principle* of the machine was sounder than he had thought it to be. It is nevertheless true, that the practical working out of that principle was due alone to the inventive talents of Mr. Dyer. The same may be said of the nail-making and carding engines, the successful working of which was wholly due to their simplification by Mr. Dyer, and it seems to the present writer that the real inventor of any machine is the man who brings it into practical working form and renders it commercially successful.[1] Thus James Watt is justly famed as the inventor of the steam-engine, the previous labours of Savory, Newcomen, and others enhancing rather than detracting from his merits.

[1] Mr. F. N. Dyer is solely responsible for this opinion.

'On his marriage Mr. Dyer took a house in the then almost rural village of Camden Town, where he resided until 1816, when he finally settled in Manchester. During his residence in London, which practically began in 1804, he enjoyed the friendship of many eminent men, among whom may be mentioned Earl Stanhope, who had earned in political circles the singular distinction of being in the House of Lords "His Majesty's opposition of one," Sir Joseph Banks, Dr. Rees (of the Cyclopædia), Dr. Wollaston, and others. With Dr. Wollaston, who on several occasions spent some weeks at his houses in Manchester and Burnage, his intimacy continued till the death of that great man.

'Soon after his settlement in Manchester, Mr. Dyer was elected an ordinary member of the Literary and Philosophical Society. Thus far he had taken no active part in politics, but the miserable event called the "Peterloo massacre" roused him to a full sense of the abuses of the times, and from that time he took a determined course in support of reform ; not, however, neglecting his scientific and literary avocations. Some years before this (when residing at Birmingham) he was engaged with Mr. Henry Tudor in founding "The North American Review," the first four numbers of which were written by Mr. Tudor and himself at the house of the latter. There is no record of the articles written by Mr. Dyer. Mr. Tudor went to America with the MSS. of the four numbers, and the periodical soon obtained a commanding position in American literature. After the first year or two Mr. Dyer ceased to be a contributor. Mr. Tudor filled the editorial chair till he was appointed United States Ambassador to Peru, where he resided till his death many years afterwards, the pernicious system of changing the functionaries at every presidential election being then unknown to the republic. It is to be hoped that the atrocious crime perpetrated on General Garfield will rouse the people of that great country to the establishment of some less corrupt system of appointment to diplomatic and civil offices than that now in use.

'In 1830 Mr. Dyer was delegated, with Messrs. Mark, Philips, and Alexander Kay, to take the contributions of the town of Manchester to Paris, for the relief of the wounded of the Revolution of July of that year, and to congratulate Louis Philippe on his election to the throne. As chairman of the Reform League, Mr. Dyer was enabled to set on foot public meetings in the other large towns, and so call forth an outburst of public opinion in favour of the immediate recognition of Louis Philippe by the British Government, which influenced the Cabinet to reject the overtures of Russia and Prussia for a joint war to restore Charles X., for which purpose the former Power had given orders for the mobilisation of its troops. This was justly considered by the Government of July as a most important service rendered to France,[1] and the Manchester deputation (which had been joined in Paris by Dr. [afterwards Sir John] Bowring and Mr. John Silk Buckingham) was received by King, Government, and people with the highest distinction.

'For the next two years Mr. Dyer was chiefly occupied with the struggle for Parliamentary reform, and in connection with the Liverpool and Manchester railway. It was

[1] In after years I have often heard Frenchmen of distinction maintain that the preservation of peace at that time was chiefly due to J. C. Dyer's prompt action in England.—F. N. D.

proposed to the committee of management, by Mr. Dyer, to lay down a short railway in a convenient spot, somewhere near Rainhill, I believe, for experimental purposes, and mainly with a view to ascertain the most advantageous gauge. The suggestion was not acted on, the committee being satisfied with the gauge of the Stockton and Darlington line; a gauge having no other *raison d'être* than the accidental width between the rails of the old tramway on which Stephenson experimented with his original engine. The selection of rails and sleepers was also under consideration of this committee, and Mr. Dyer urged the adoption of the heavy double-headed rail, very similar to that now in general use, and of wooden sleepers. He was outvoted in both instances; light fish-bellied rails and stone sleepers were adopted. They had to be taken up in a few years. The stone sleepers were especially faulty, giving a harsh jarring movement to the carriages, and requiring constant watchfulness and labour, to keep them in their places and maintain the correct width between the rails.

'In 1832 Mr. Dyer established the machine-making works at Gamaches, Somme, France, under the management of Mr. Henry Farey, brother of John Farey, author of "A Treatise on the Steam Engine," that attained some vogue.

'The works at Gamaches were placed nominally in charge of Mr. Dyer's eldest son, to whom Mr. Farey was to act as dry-nurse, a duty that gentleman seems to have very carefully neglected. The business never recovered the injury he inflicted on it, though under the better management of George H. Dyer it was able to keep afloat, until the Revolution of 1848 finally swamped it; entailing great loss on Mr. Dyer, senior, the total amounting to 120,000*l.*, speaking in round numbers.

'After establishing these works, Mr. Dyer returned to England, and only visited France at rare intervals afterwards. In conjunction with Messrs Edwin Baxter, John Shuttleworth, J. B. Smith, M.P., and others, Mr. Dyer took the first steps for founding a newspaper in Manchester, to support the cause of enlightened Liberalism. The "Manchester Guardian" was the result; the management, literary and commercial, being entrusted to Messrs John Edward Taylor and Jeremiah Garnett. The prosperity of the new paper was such as to enable those gentlemen to pay out the original subscribers in a very few years. About this time, or somewhat earlier, he was concerned in the establishment of the Bank of Manchester, of which he continued to be a director till 1838, when severe and dangerous illness forced him to retire from the board. This was a great misfortune, alike to Mr. Dyer and many others; for on his retirement from the board, a reckless and speculative system of business was commenced that in a few years resulted in disaster. Mr. Dyer about this time was engaged with others, whose names are too well known to need mention here, in the formation of the Anti-Corn-Law League, and gave his best energies to the protracted agitation for Free Trade. Before this he was on the board of several railway companies, and was especially active on that of the Manchester and Birmingham line. He had been engaged in the foundation of the Royal and the Mechanics' Institutions, and other useful establishments and societies, and he was always an earnest supporter of the Infirmary and Henshall's Blind Asylum, &c. He was also active in founding the Liverpool and District Bank, which falling into better hands had a very different fortune from the Bank of Manchester. Of the disasters of the latter bank little need be said. It is enough to state briefly Mr. Dyer's loss :—he had 40,000*l.* in shares, upon which calls in all amounting to 12,000*l.* were made, making 52,000*l.* But to meet these calls, Mr. Dyer had to sell real estate in and near Manchester for what it would fetch, and this during the severest commercial crisis that had occurred since 1825. The loss upon these sales amounted to more than 40,000*l.*, Mr. Dyer estimating his total loss by the Bank of Manchester at the enormous sum of 96,000*l.*

'In 1839 Mr. Dyer removed to the mansion he had built about a mile from his old house in Burnage, on a field called Moldeth.[1] Since its sale by Mr. Dyer—to meet calls on his bank shares—it had been improperly called Moldeth Hall, though the estate has no manorial privileges to justify the designation. This house may be fairly classed among Mr. Dyer's scientific successes. Intending to make it fireproof, he obtained from his old friend Lieut.-General Wilson, of the Russian Civil Service, the plans of the fireproof imperial factories at Colpino, then just built. General Wilson, having business in England, brought them over himself, but warned Mr. Dyer of the insecurity of long cast-iron beams, as exemplified by an accident that had happened at Colpino. A quantity of bricks being required in the top storey of the building they were brought up by hodmen, in batches commanded by a sergeant, in thorough drill fashion, "shouldering hods," "discharging hods," &c., at word of command, as they manage such matters in Russia. When the heap of bricks has attained a certain magnitude, to complete the job at once, some twenty or more men were ordered up, and at the word of

[1] Also called Mauldeth. 'Probably "Mold," or mole, heath; mold, or moldy warp, being an Old English form of the animal's name.'

command discharged their hods simultaneously. The shock, added to the weight already accumulated, broke down the arch, and the *débris,* falling with heightened force on the arch below, carried it away, and so a hole was cut from top to bottom of the high building—seven storeys—in the course of a few seconds.

'To obviate danger from the use of cast-iron beams of the length required by the spacious rooms of the house, Mr. Dyer conceived the plan of narrow flattened arches (about 5 feet span) supported by their *thrust* upon the beams, which were in like manner supported by the *thrust* of the next arch, and so on from end to end of the house; the ends of the beams being of course built into the walls. The outside walls were constructed especially to meet the accumulated strain. First the stone casing, nine or ten inches thick, then a space filled with carefully wrought rubble and inside brickwork, a brick and a half thick, of which thickness were also the inner walls of the house.[1] The top floor was, however, rendered fireproof on a different plan, wooden beams being used and the spaces between them filled with *grout,* completely excluding the air from the beams, and when set hard, imbedding them so to speak in stone casings. On a similar plan Mr. Dyer built his factory in Store Street, the latter being finished several years before the former, which took about seven years to build.

[1] 'The east and west ends of the house that bore the chief strain were strengthened, the former by a row of strong semi-circular pilasters bearing a pediment, the latter by a large bow window, with side abutments or projections. The beams lay north and south, save in the large saloon, where they lay east and west, the southern wall being strengthened to meet their trust in that direction, and to the north it was met by the ends of the arches of the drawing-room and boudoir.'

'Mr. Dyer resided at Moldeth till the death of Mrs. Dyer in 1842, who *thus* escaped the calamities that fell upon the family by the collapse of the Bank of Manchester. Mr. Dyer continued to reside there, with his younger sons, till compelled to sell the mansion as above explained, when it was purchased by Mr. Edmond Wright, from whose executors the Ecclesiastical Commission purchased it, for the seat of the first Bishop of Manchester. It is now converted into a hospital for incurables.

'On the sale of Moldeth, Mr. Dyer returned to his old house in Burnage, where he lived with his two younger sons, Frederick and Wilson, a literary man and an artist. There he occupied himself solely with science, literature, and politics, having ceded the machine works to Messrs. Parr, Curtis and Madeley. His contributions to various journals were very numerous, and, with the pamphlets he occasionally published, covered a great number of subjects. In all movements for promoting the welfare of the working classes, for the reformation of abuses, and especially in support of Free Trade, he took an active part, his mental energies by no means affected by his advancing age. This was no doubt due to his extremely temperate and regular habits. He was not, however, what is called a teetotaller, taking one or two glasses of light wine with his dinner, and a tumbler of warm sherry and water before going to bed. As he finally attained the great age of ninety-two, this slight mention of his habits will not be out of place. There is no complete list of his writings, nor, as yet, a classified *résumé* of his works, which would be of some interest to the public, and especially so the notes and sketches of the men and events of his own times. One of his MSS. was sent for publication to a firm of London publishers, a few months before his death, and when inquired for afterwards was missing and has not since been found. This MS. treated of the means of reaching old age, and was entitled "Longevity, by a Nonogenarian."

'After the marriages of his sons Wilson and Frederick, he lived at their houses alternately, dividing his time pretty equally between them. In 1867 he experienced a severe affliction in the death of Wilson, his youngest son, when he fixed his abode with Frederick for his remaining years. His sorrow found relief in a still closer devotion to intellectual pursuits, and in the society of a few friends. He soon recovered his wonted cheerfulness, and never once suffered an unmanly regret for the loss of his vast fortune to disturb it.

'He died painlessly on May 3, 1871, after a lingering illness. In accordance with his strict injunctions, his funeral was quite private.'

. . . .

Mr. Dyer was desirous of keeping up with the progress of science, and his inclination to be fair led him to use the remark quoted, 'Thus we see how difficult it is to make even great men move in any path before the destined time.' It is remarkable how strongly in his late years this was illustrated by his own case. He could never agree to the new ideas regarding the relations of Heat and Force, and he read several papers discussing the subject, and opposing, in the most respectful way of course, the opinions of Dr. Joule, who did his best also most respectfully to make the new opinions and discussions clear, but without effect. This defect occurring in men depends sometimes on the new meaning given to words; and this was the case at the time of earlier discussions, when phrases were used to which men fresher in science attached a somewhat different meaning.

Perhaps it would be unfair to let Mr. Dyer's remarks (p. 307) pass without a quotation from 'Carlyle's Reminiscences' (1881), (to which the name of James Anthony Froude has been attached). The passage is in vol. i., at p. 128. 'At Greenock I first saw *steamers* on the water; queer dumpy things with a red sail to each, and legible name "Defiance," and such like, bobbing about there, and making continual passages to Glasgow as their business. Not till about two years later (1819, if I mistake not) did Forth see a steamer; Forth's first was bigger than the Greenock ones, and called itself "The Tug," being intended for towing ships in these narrow waters, as I have often seen it doing; *it* still had no rival or conqueror till (in 1825) Leith, spurred on by one Bain, a kind of half-pay Master R.N., got up a large finely appointed steamer, or pair of steamers for London; which, so successful were they, all ports then set to imitating. London alone still held back for a good few years; London was notably shy of the steamship, great as are its doings now in that line. An old friend of mine, the late Mr. Strachey, has told me that in his schooldays he at one time—early in the nineties I should guess, say 1793—used to see, in crossing Westminster Bridge, a little model steamship paddling to and fro between him and Blackfriars Bridge, with steam funnel, paddlewheels, and the other outfits, exhibiting and recommending itself to London and whatever scientific or other spirit of marine adventure London might have—London entirely dead to the phenomenon, which had to duck under and dive across the Atlantic before London saw it again, when a new generation had risen. The real inventor of steamships, I have learned creditably elsewhere, the maker and proprietor of that fruitless model on the Thames, was Mr. Miller, Laird of Dalswinton, in Dumfriesshire (Poet Burns' landlord), who spent his life and his estate in that adventure, and is not now to be heard of in these parts, having had to sell Dalswinton and die quasi-bankrupt (and I should think broken-hearted) after the completing of his painful invention and finding London and mankind dead to it. Miller's assistant and work-hand for many years was John Bell, a joiner in the neighbouring village of Thornhill. Miller being ruined, Bell was out of work and connection, emigrated to New York, and there speaking much of his old master and glorious unheeded invention well known to Bell in all its outlines or details, at length found one Fulton to listen to him; and by Fulton and Bell (about 1809) an actual packet steamer was got launched, and, lucratively plying on the Hudson River, became the miracle of Yankeedom and gradually of all lands. These I believe are essentially the facts. Old Robert McQueen, of Thornhill, Strachey of the India House, and many other bits of good testimony and indication, once far apart, curiously coalescing and corresponding for me. And as, possibly enough, the story is not now known in whole to anybody but myself, it may go in here as a digression, *à propos* of those brisk little Greenock steamers which I first saw and still so vividly remember; little "Defiance," &c., saucily bounding about with their red sails in the sun on this my tour with Irving.'

It might be also said that it is unfair to mention these men without also mentioning that remarkable inventor Denis Papin, whose little vessel with paddles, not steam however, went up the stream as well as down, and whose whole life, like Miller's, was wrecked because some miserable creatures at Münden seized it for some money without which it could not pass. Poor Papin says to Leibnitz that he had abandoned thinking of some theories, the reason being 'on account of the number of inventions and machines that have multiplied in my head for some time; and I passionately wish to see all the surprising and useful effects that they would produce if they could be put in motion; I am getting old and the war prevents me from keeping an artisan near me; I do all for myself, and my many distractions make the work slow. I see also that notwithstanding my diligence I shall die without doing half my work, and so I have decided to confine my efforts to serve the public by the talent which God has given me, and to leave to great and vast geniuses such as yours, to penetrate into eternal truths and open to posterity short and easy methods of continually making great progress.' Here we have the idea of progress well shown; and in the strange character of Papin much more is seen: his study of steam for example, as illustrated in the 'Correspondence of Leibnitz and Papin,' by Dr. Ernst Gerland, of Cassel, 1881; 'Leibnitzen's und Huygens' Briefwechsel mit Papin nebst der Biographie Papin's,' &c., von Dr. Ernst Gerland, Berlin, 1881.

Richard Roberts.

The life of Richard Roberts the mechanician is, we understand, to have more attention paid to it than hitherto. Mr. W. H. Bailey has given a preliminary sketch in vol. v. of the publications of the Manchester Literary Club. From this we shall take such information as may seem most characteristic. Mr. Roberts was well known in the great firm of Sharpe, Roberts and Co., makers of engines in Manchester. He was the inventor there ; he was a regular attendant for a long time at the council meetings of our Society, and displayed his remarkable instincts in matters relating to mechanics. He is best known as the inventor of the self-acting mule, but he informed the writer that he had made three hundred distinct mechanical inventions. It would be a long study to find out these, and only a mechanician could describe them, so we shall leave them to Mr. Bailey, who is well able to give an account of them. He was another example of a tall and powerful man being an engineer ; he had not, however, the natural or acquired refinement spoken of in connection with others.

Roberts was born at Carreghova, in the parish of Llanywynech, North Wales, about six miles from Oswestry, in 1789; still he had not the usual build of a Welshman, who is seldom as tall as Mr. Roberts was, although of good weight. It is marvellous from how low a social stratum of society, as we are accustomed to express it, the first of our Manchester men sprang in generations not long gone by, as if the flowers had faded and new roots were required on which to grow good fruit. There was a very interesting attempt to prove the contrary, but it was a failure, as we think, and only went to show that men of talent were born of parents not below the average in talent. Richard Roberts as a youth worked in the mines and stone quarries, and dragged canal boats. Accident gave him an opportunity of working with a pole-lathe, and he made his mother a spinning-wheel, a feat so remarkable in a boy who never was at school that a subscription was got up to give him a tool-chest. With these tools he made another spinning-wheel, inlaid with many woods and said to be a great work of art, in the possession still of some one in that neighbourhood. He went to Bilston, and worked at the works of Mr. John Wilkinson, a man of great skill, we are told, and who made the first iron boat; Roberts made patterns at these works. He went from place to place, trying to escape being drawn for the Militia, and came to the White Lion Inn, then in Deansgate, seeking for work. There the mechanicians met. Here he got an engagement to turn a lathe, being a strong fellow; but the turner for whom he was to labour did not come as it was *blue* Monday, and Roberts offered himself for and obtained the higher work. Again in fear of the Militia he went to London, and worked at Maudslay's engineering works, but soon returned to Manchester, and started in a small way in Water Street, where his wife turned the lathe. His skill brought favour, and we can do little more now than put down the names of some of the numerous inventions mentioned by Mr. Bailey. The town commissioners requested him to invent a measure for gas, and he did so. Mr. Clegg is generally said to have done this first.

The slide lathe was invented by Roberts about this time; then the slotting machine with automatic motion, the bed being adjusted to move in any direction. Then came the planing machine, invented simultaneously by Fox of Derby. He took patents in 1822 for weaving machinery, and in the year after he invented for Mr. Wm. Sharp a reed-making machine, which gave such satisfaction that he was made a partner, and the machine-making firm of Sharp, Roberts and Co., of Atlas Works, took its name.

Mr. Roberts also made turret clocks. One is at the works in Bridgewater Street, and one at St. Ann's Church. Methods of cutting off the steam, and working it in an engine expansively, received attention. Self-regulators and locomotives all came under his improving hand, with spinning and doubling of thread, and machines for grinding corn. He invented apparatus for punching the plates of the Menai Bridge so regularly, that if they were stacked, a bar of iron could be passed through the holes from top to bottom without interruption. This regularity has been the cause of much greater strength.

His greatest invention has been considered to be the self-acting mule, causing that of Crompton's to change its own motion, spontaneously going backwards and forwards.

The centrifugal railway was constructed by him to illustrate centrifugal force; also a clock which was to regulate other clocks connected by hollow tubes containing air which was passed through at regular intervals.

He constructed the blockade runner 'Flora' and other vessels, which by means of screws could turn in their own length. He was consulted by Napoleon III. about turret ships; also by the Russian Government. The Emperor Nicholas invited him to take up his residence at St. Petersburg. Mr. Bailey says, 'I have endeavoured to give some account of a man who has had an immense influence on our prosperity and comfort; a man who will be classed in future records as one of the most remarkable men of this century, crowded as its history is with the names of great benefactors. His genius and the supremacy of his intellect caused all those contemporaries who knew him to lean to him as a great master. His old workmen always spoke of his ability with great reverence, for to them ever he was a continual and fascinating surprise,' &c. We shall look with interest to the volume promised by Mr. Bailey, and hope to see full illustrations of the work of a man whom he so much admires and has so carefully studied.

Roberts died poor in London in 1864, and was buried in Kensal Green. He exhausted his funds in constant experiments, like so many enthusiastic inventors.

John Blackwall, F.L.S.

The magnificent volumes written by one of our members, John Blackwall, F.L.S., and issued by the Ray Society, entitle the author to more than a slight mention. The title of the work is 'A History of the Spiders of Great Britain and Ireland.' We have no account of him personally, farther than that he was a medical man in Manchester, where he became a member of the Society, continuing from January 1821 until the summer of this year, 1881, when he died at his house near Llanrwst. He has written for the Society papers already mentioned on the habits of birds, and was fortunate enough to retire many years ago to a pleasant district, where he pursued his work as long as possible, and lived to a good old age.

J. A. Ransome.

This volume must not go out without the name of Joseph Atkinson Ransome, the son of a well-known physician in Manchester, and father of a still better known one, Arthur Ransome. Mr. J. A. Ransome and his father were intimate friends of Dr. Dalton. The former was also a prominent member of the Society and regular in his attendance, well informed on scientific subjects.

He was one of those men whose force of character was seen in conversation, and who made little if any attempt to write his thoughts.

(Thomas Jarrold, M.D., elected a member in 1807, continued a member long after Dalton's death, and was a physician of considerable renown in his day, following a speculative system of his own. He is remembered at the Society chiefly for his hand-writing, which was almost illegible, and the difficulty of reading his prescriptions. The writer of this short notice remembers an incident which occurred in the library of the Society, then occupied by Dalton, who, in addition to his chemical work, was at that time a sort of managing director of the Society's scientific proceedings. Dr. Jarrold came to complain that a paper of his had not been read, when Dalton told him flatly that it was illegible, adding sharply that the Doctor could not read it himself, which, on trial, proved to be true. Dr. Jarrold was fond of physiological and metaphysical investigations, and wrote with much acumen on 'Instinct and Reason,' pointing out the essential distinction between the former as a perfect and complete faculty and the latter as an imperfect unreliable quality, capable, however, of improvement and unlimited growth.)

CHAPTER XII.

Dr. Joule.

ALMOST concurrent with later chemical search on the constituents of matter we see an inquiry in physics, where also atoms have done full duty, and without which the existence of gases, for example, has been found to be difficult to conceive. The condition may be shortly described in a summary serving as an introduction to the works of the late Thomas Graham, Master of the Mint.[1]

'When we arrive at this point we pass to the next important stage, namely, the motion of gaseous molecules, if not of atoms, and the beginning of the attempt to define it precisely. The first definite ideas are by D. Bernouilli.[2] They are explained in his 'Hydrodynamics,' which, although published in Strasburg in 1738, were previously worked at when he was Professor in St. Petersburg.

'D. Bernouilli says: "The chief peculiarities of fluids are these: first, they are heavy; second, they expand in all directions unless they are confined; and third, they allow

[1] *Chemical and Physical Researches*, by Thomas Graham, with introduction and analytical contents or abridgment by R. Angus Smith, edition distributed by Dr. Young, F.R.S.

[2] Danielis Bernouilli, Joh. Fil., Med. Prof. Basil., *Hydrodynamica sive de viribus et motibus fluidorum Commentarii* (Argentorati, 1738), p. 200. Sectio decima. 'Fluida nunc elastica consideraturis licebit nobis talem iis affingere constitutionem, quæ cum omnibus adhuc cognitis conveniat affectionibus, ut sic ad reliquas etiam nondum satis exploratas detur aditus.'

themselves to be compressed more and more, according to the increased force applied."[1] Speaking of a vessel of air with a weighted cover, and which he illustrates with a diagram, he says, "So the minute bodies, whilst they impinge on the cover E F, keep it up by their continually repeated strokes, and form an elastic fluid which expands itself when the weight is removed or diminished.[2] We shall consider the corpuscles enclosed in the hollow of the cylinder as infinite in number, and when they occupy the space E C D F we shall say that they constitute the natural air."[3]

'Davy and Count Rumford entered the field when this theory of gaseous motion was forgotten, and inaugurated a new theory of heat founded on molecular activity. That heat is immaterial was no rare opinion last century, or since Lord Bacon spoke of it as "motus et nihil aliud." However, atomic motion ceased from the time of Rumford to be a vague idea. Davy[4] spoke definitely when, without calling in the aid of repulsions, he supposed that in solids the particles are in a vibratory motion, the particles of the hottest bodies moving with greatest velocity and through the greatest space; that in fluids and elastic fluids, besides the vibratory motion which must be considered greatest in

[1] 'Fluidorum autem elasticorum præcipuæ affectiones in eo positæ sunt: 1°, ut sint gravia; 2°, ut se in omnes plagas explicent, nisi contineantur, et 3°, ut se continue magis magisque comprimi patiantur crescentibus potentiis compressionis: ita comparatus est aër, ad quem potissimum presentes nostræ pertinent cogitationes.'

[2] '. . . Sic corpuscula dum impingunt in operculum EF idemque suis sustinent impetibus continue repetitis fluidum componunt elasticum quod remoto aut diminuto pondere P sese expandit—— '

[3] 'Corpuscula cavitati cylindri inclusa considerabimus tanquam numero infinita, et cum spatium ECDF occupant, tunc aërem illa dicemus formare naturalem.'

[4] Collected Works, vol. iv. p. 67.

the last, the particles have a motion round their own axes with different velocities, the particles of elastic fluids moving with the greatest quickness; and that in ethereal substances the particles move round their own axes and separate from each other, penetrating in right lines through space. Temperature may be conceived to depend on the velocity of the vibrations, increase of capacity on the motion being performed in greater space, etc.'

This is evidently the work of Rumford and Bernouilli, with additions after passing later through an original and powerful mind.

We may take the next step and go to Herapath.[1] At p. 14, vol. i., he says:—

'*Theory of gases.*—From these considerations it follows that if a number of small bodies be enclosed in any hollow body, and be continually impinging on one another and on the sides of the inclosing body, and if the motions of the bodies be conserved by an equivalent action in the sides of the containing body, then will these small bodies compose a medium, whose elastic force will be like that of air and other gaseous bodies; for if the bodies be exceedingly small, the medium might, like any æriform body, be compressed into a very small space; and yet if it had no other tendency than what would arise from the internal collision of its atoms, it would, if left to itself, extend to the occupation of a space of almost indefinite greatness. And its temperature remaining the same, its elasticity would also be greater when occupying a less, and less when occupying a greater space; for in a compressed state the number of atoms striking against a given portion of the containing vessel must be augmented, and the space in

[1] *Mathematical Physics*, &c., by John Herapath, two vols. 8vo. 1847.

which the atoms have to move being less, their motions or periods must be shorter, and the number of them in a given time consequently greater; on both of which accounts the elasticity is greater the greater the compression. Besides, when other things are the same, the elastic force augments with an augmentation of temperature and diminishes with a diminution; for an increase of temperature, according to our theory, must necessarily be attended with an increase of velocity, and therefore with an increase in the number of collisions.'

'Dr. Joule continued the subject, and introduced it into the region of experiment and observation, or, in other words, to the science of modern times.[1] Joule might have added that the view he adopted is not only in accordance with the known laws of the elasticity of gases, but conforms to the ratio of the specific heats of gases. The mathematical development continued to make progress in the hands of Clausius, Clerk Maxwell, Holtzmann, and others, taking us to new fields, &c.'

In 'Some remarks on Heat, and the Constitution of Elastic Fluids,' by J. P. Joule, F.R.S. &c. Mem. Lit. and Phil. Soc., vol. ix. 2nd series, p. 111, read Oct. 3, 1848, we find:—

'I have myself endeavoured to prove that a rotary motion such as that described by Sir H. Davy, will account for the law of Boyle and Mariotte, and other phenomena presented by elastic fluids; nevertheless, since the hypothesis of Herapath, in which it is assumed that the particles of a gas are constantly flying about in every direction with great velocity, the pressure of the gas being owing to the impact of the particles against any surface presented to

[1] See *Math. Physics*, vol. i. p. 264.

them, is somewhat simpler, I shall employ it in the following remarks on the constitution of elastic fluids; premising, however, that the hypothesis of a rotary motion accords equally well with the phenomena.

'Let us suppose an envelope of the size and shape of a cubic foot to be filled with hydrogen gas, which, at 60° temperature and 30 inches barometrical pressure, will weigh 36·927 grains. Further, let us suppose the above quantity to be divided into three equal and indefinitely small elastic particles, each weighing 12·309 grains; and further, that each of these particles vibrates between opposite sides of the cube, and maintains a uniform velocity except at the instant of impact; it is required to find the velocity at which each particle must move so as to produce the atmospherical pressure of 14,831,712 grains on each of the square sides of the cube. In the first place it is known that if a body moving with the velocity of $32\frac{1}{6}$ feet per second be opposed during one second by a pressure equal to its weight, its motion will be stopped, and that, if the pressure be continued one second longer, the particles will acquire the velocity of $32\frac{1}{6}$ feet per second in the contrary direction. At this velocity there will be $32\frac{1}{6}$ collisions of a particle of 12·309 grains against each side of the cubical vessel in every two seconds of time; and the pressure occasioned thereby will be $12{\cdot}309 \times 32\frac{1}{6} = 395{\cdot}938$ grains. Therefore, since it is manifest that the pressure will be proportional to the square of the velocity of the particles, we shall have for the velocity of the particles requisite to produce the pressure of 14,831,712 grains on each side of the cubical vessel,

$$v = v\left(\frac{14{,}831{,}712}{395{\cdot}938}\right)32\tfrac{1}{6} = 6{,}225 \text{ feet per second.}$$

'The above velocity will be found equal to produce the atmospheric pressure, whether the particles strike each other before they arrive at the sides of the cubical vessel, whether they strike the sides obliquely, and, thirdly, into whatever number of particles the 36·927 grains of hydrogen are divided.

'If only one-half the weight of hydrogen, or 18·4635 grs., be enclosed in the cubical vessel, and the velocity of the particles be as before, 6,225 feet per second, the pressure will manifestly be only one-half of what it was previously; which shows that the law of Boyle and Mariotte flows naturally from the hypothesis.

'The velocity above-named is that of hydrogen at the temperature of 60°; but we know that the pressure of an elastic fluid at 60° is to that at 32° as 519 is to 491. Therefore the velocity of the particles at 60° will be to that at 32° as $\sqrt{519}$, $\sqrt{491}$; which shows that the velocity at the freezing temperature of water is 6,055 feet per second.

'In the above calculations it is supposed that the particles of hydrogen have no sensible magnitude, otherwise the velocity corresponding to the same pressure would be lessened.

'Since the pressure of a gas increases with its temperature in arithmetical progression, and since the pressure is proportional to the square of the velocity of the particles, in other words, to their *vis viva*, it follows that the absolute temperature, pressure, and *vis viva* are proportional to one another, and that the zero of temperature is 491° below the freezing point of water. Further, the absolute heat of the gas, or, in other words, its capacity, will be represented by the whole amount of *vis viva* at a given temperature.

The specific heat may therefore be determined in the following simple manner:—

'The velocity of the particles of hydrogen, at the temperature of 60°, has been stated to be 6,225 feet per second, a velocity equivalent to a fall from the perpendicular height of 602,342 feet. The velocity at 61° will be 6,225 $\sqrt{\frac{520}{519}}$ = 6,230·93 feet per second, which is equivalent to a fall of 603,502 feet. The difference between the above falls is 1,160 feet, which is therefore the space through which 1 lb. of pressure must operate upon each pound of hydrogen in order to elevate its temperature one degree. But our mechanical equivalent of heat shows that 770 feet is the altitude representing the force required to raise the temperature of water one degree; consequently the specific heat of hydrogen will be $\frac{1160}{770}$ = 1·506, calling that of water unity.

'The specific heats of other gases will be easily deduced from that of hydrogen; for the whole *vis viva* and capacity of equal bulks of the various gases will be equal to one another, and the velocity of the particles will be inversely as the square root of the specific gravity. Hence the specific heat will be inversely proportional to the specific gravity, a law which has been arrived at experimentally by De la Rive and Marcet.

'In the following table I have placed the specific heats of various gases, determined in the above manner, in juxtaposition with the experimental results of Delaroche and Berard reduced to constant volume:—

	Experimental specific heat.	Theoretical specific heat.
Hydrogen	2·352	1·506
Oxygen	0·168	0·094
Nitrogen	0·195	0·107
Carbonic oxide	0·158	0·068

'The experimental results of Delaroche and Berard are invariably higher than those demanded by the hypothesis. But it must be observed that the experiments of Delaroche and Berard, though considered the best that have hitherto been made, differ considerably from those of other philosophers. I believe, however, that the investigation undertaken by M. V. Regnault, for the French Government, will embrace the important subject of the capacity of bodies for heat, and that we may shortly expect a new series of determinations of the specific heat of gases, characterised by all the accuracy for which that distinguished philosopher is so justly famous. Till then, perhaps, it will be better to delay any further modifications of the dynamical theory, by which its deductions may be made to correspond more closely with the results of experiment.' [1]

We have thus got to the motion of atoms, but the result of this motion was also taken up by Joule, and we give him without difficulty the honour of showing its relations first in one very important direction, namely

[1] If we assume that the particles of a gas are resisted uniformly until their motion is stopped, and that then their motion is renewed in the opposite direction, by the continued operation of the same cause, as in the projection upwards and subsequent fall of a heavy body, the maximum velocity of the particles will be to the uniform velocity required by the theory assumed in the text as the square root of 2 is to 1, and the comparison of the theoretical with the experimental specific heat will be as follows :—

	Experimental specific heat.	Theoretical specific heat.
Hydrogen	2·352	3·012
Oxygen	0·168	0·188
Nitrogen	0·195	0·214
Carbonic oxide	0·158	0·136

I have just learned that the experiments of Regnault on the specific heat of elastic fluids are on the eve of publication, and doubt not that their accuracy will enable us to arrive at a decisive conclusion as to the correctness of the above hypothesis.—June 1851, J. P. J.

heat. We have the pleasure of knowing that he went still further, and showed that whilst the heat itself resulted in force, that force had a definite limit, and could be estimated by the amount of chemical action or by the combinations taking place between the elements. In other words, he showed the connection between chemical action, electricity, heat, and mechanical force. The long train of papers on this subject written by Dr. Joule would astonish many who receive his results in a few lines and are satisfied with their simplicity; but it would also be a very simple thing if after living to maturity in a pit, with artificial light only, we were to come up and see the sun. How simply we should then get light—no candle used, no wax, no oil, no paraffin; the sun laughs at all our methods of illumination, and we, too, may laugh at ourselves when we think how short was our view in the direction indicated before Dr. Joule discovered the mechanical equivalent of heat. To show the fullest early form in which the author approached the subject we quote farther on. (See Mem. of the Lit. and Phil. Soc. of Manchester, Vol. VII., Second Series, pp. 103, 104, and 110.) We shall further quote a paper read January 24, 1843, his 20th paper on heat, electricity, and magnetism, though still a youth.

When speaking of Dr. Joule we must not forget to put before ourselves clearly the position taken up by Faraday in the development of measurable quantity, a position which is gained by the vantage ground of the atomic theory, and stands between that of Dalton's and Joule's, to whose wider generalisations it tended. In his 'Experimental Researches in Electricity,' § 704 (ed. 1839), we find one of his papers read in January 1834: 'I have already said, when engaged in reducing common and voltaic electricity to one standard of measurement, and again, when introducing my theory of electro-chemical decomposition, that the chemical decomposing action of a current is constant for a constant quantity of electricity, notwithstanding the greatest variation in its sources, in its intensity, in the size of the electrodes used, in the nature of the conductors (or non-conductors, 307) through which it passes, or in other circumstances.'

'§ 705. I endeavoured upon this law to construct an instrument which should measure out the electricity passing through it, and which, being interposed in the course of the current used, should serve at pleasure either as a *comparative standard* of effect or as a *positive measure* of the subtle agent.'

§ 706. . . . 'Water therefore, acidulated by sulphuric acid, is the substance I shall generally refer to, although it may become expedient in peculiar cases or forms of experiment to use other bodies.' In § 843 it is said, 'I expect to find in some salts, as the acetate of mercury and zinc, solutions favourable for this use.'

In § 866, speaking of the decomposition of water, he says, 'For an equivalent of zinc oxidised an equivalent of water must be decomposed.'

'§ 918. All the facts show us that that power commonly called chemical affinity can be communicated to a distance through the metals and certain forms of carbon; that the electric current is only another form of the forces of chemical affinity; that its power is in proportion to the chemical affinities producing it; that when it is deficient in force it may be helped by calling in chemical aid, the want in the former being made up by an equivalent of the latter; that, in other words, "*the forces termed chemical affinity and electricity are one and the same.*"'

That equivalents exist is no proof of oneness, but we see here great progress made by Faraday in the consideration of the unity of power and the relation of important forms of power.

We shall quote here some of Joule's early papers.

On the Heat Evolved during the Electrolysis of Water. January 26, 1843. *By James Prescott Joule. Vol. VII., Second Series, Memoirs of the Literary and Philosophical Society of Manchester, pp.* 101, 103, 104, 110.

'1st. In an electrolytic cell, there are three distinct obstacles to the voltaic current. The first is resistance to conduction; the second is resistance to electrolysis without chemical change, arising simply from the presence of chemical repulsion; and the third is resistance to electrolysis accompanied by chemical changes.

'2nd. By the first of these (the resistance to conduction) heat is evolved exactly as it is by a wire, according to the resistance and the square of the current; and it is thus that a part of the heat belonging to the chemical actions of the battery is evolved. By the second, a reaction on the intensity of the battery occurs, and wherever it exists heat is evolved exactly equivalent to the loss of heating power in the battery arising from its diminished intensity. But the third resistance differs from the second, inasmuch as the heat due to its reaction is rendered latent and is thus lost by the circuit.

'3rd. Hence it is that, however we arrange the voltaic apparatus, and whatever cells of electrolysis we include in the circuit, the whole caloric of the circuit is exactly accounted for by the whole of the chemical changes.

'4th. As was discovered by Faraday, the quantity of current electricity depends upon the number of atoms which suffer electrolysis in each cell: and the intensity depends upon the sum of chemical affinities. Now both the mechanical and heating powers of a current are (*per* equivalent of electrolysis in any one of the battery cells) proportional to its intensity. Therefore the mechanical and heating powers of a current are proportional to each other.

'5th. The magnetic electrical machine enables us to convert power into heat, by means of the electric currents which are induced by it. And I have little doubt that by interposing an electro-magnetic engine in the circuit of a battery, a diminution of the heat evolved *per* equivalent of chemical change would be the consequence, and this in proportion to the mechanical power obtained.[1]

'I have shown also that the *modus operandi* is resistance to conduction.

'There are many phenomena which cannot be accounted for by the theory which recognises heat as a substance; and there are several, which though sometimes adduced as triumphant objections to the other theory, tend, when rightly considered, only to confirm it. The heat of fluidity may very naturally be regarded as the momentum, or mechanical force necessary to overcome the aggregation of particles in the solid state. The heat of vaporisation may be regarded, partly as the mechanical force requisite to overcome the aggregated condition of atoms in the fluid state, and partly as the force requisite to overcome atmospheric pressure. Again, the heat of combination is only

[1] I am preparing for experiments to test the accuracy of this proposition.—February 18, J. P. J.

the manifestation, in another form, of the mechanical force with which atoms combine; on the other hand, the phenomena of electrolysis by the voltaic battery give us positive proof that the mechanical force of the current requisite to procure the decomposition of an electrolyte is the equivalent of the heat due to the recombination of the elements. *Thus it appears that electricity is a grand agent for converting heat and the ordinary forms of mechanical power into one another.*'

On a New Method of Ascertaining the Specific Heat of Bodies. Read December 2, 1845. *Memoirs of Philosophical Society of Manchester, Vol. VII. Second Series, p.* 562.

'When any body, capable of conducting the voltaic electricity, is placed in the circuit of a battery, the quantity of heat evolved by it in a given time is proportional to its resistance to conduction and the square of the quantity of transmitted electricity. Consequently, if a wire traversed by a voltaic current be made to communicate to any body the heat which it evolves, the capacity for heat of that body and the wire taken together will be directly proportional to the square of the quantity of electricity transmitted in a given time to the resistance of the wire and to the time, and inversely proportional to the increase of temperature of the body. Hence we derive the general equation,

$$y = \frac{Cc^2rt}{h} \quad . \quad . \quad . \quad . \quad 1$$

where y is put for the capacity, c for the voltaic current, r for the resistance of the wire, t for the time, and h for the increase of temperature.

'If we make the time and the resistance of the wire constant, the above equation becomes simplified to

$$y = \frac{Co^2}{h} \quad . \quad . \quad . \quad . \quad . \quad 2$$

'If the current and time are constant, we have

$$y = \frac{Cr}{h} \quad . \quad . \quad . \quad . \quad 3$$

'I have made several series of experiments, using the same conducting wire as a source of heat, a constant interval of time, and a variable current of electricity. The method adopted in these experiments was, to try the effect of a wire traversed by a current of electricity,—first, when it was immersed in water, and afterwards when it was immersed in another liquid. Hence I obtained two determinations of y in equation 2, one of them for water, the other for the liquid. The relation between these two quantities gave, of course, the capacity of the liquid compared with that of the water.'

Without pretending to say that it was impossible to arrive at Joule's conclusions without the atomic theory of Dalton, we may say distinctly that it was not attained without its aid. The idea of full portions, *units of measure* in Dalton's mind, developed itself gradually into *units of force* in the mind of Joule, and it is in this form that we received it from the hand of one illustrious member still active amongst us. To say that the two are the most successful descendants of the great thinkers who have grappled with the subject of atoms for three thousand years is but to express a simple fact; and to assert that Dalton and he have made the great leading discoveries on the subject is simply to follow history. From one we learn the order in which the ultimate particles of bodies move, from the other we learn the force and relation of their movements in those great phenomena, heat, electricity, and mechanical force.

It is of course impossible to deny great honour to many men who have laboured on heat. We have great admiration for the work of Dulong and Petit, great illustrators of atomic action. We may delight in the speculative ideas of Clausius, Helmholtz, Clerk Maxwell, and Sir William Thomson, but we must remember that these men represent another department of atomic study.

They take the Daltonian atom as granted. They take it also as Joule, Dalton's pupil, made it—a measure of power, and they seek to go farther in studying its physical properties.[1] We have here a follower worthy of the prophet. Dalton's pupil has become the master of many learners.

[1] In speaking of Joule we do not attach weight to the able but merely speculative papers of Meyer. The comparative value of these is fully discussed in the Thermodynamics of P. G. Tait.

CHAPTER XIII.

THE PRESENT TIME.

IT is not safe to speak of the present members, and, much as the author longs to tell how he has admired personal friends, he leaves this subject and proceeds only to give a few remarks on the present state of the Society. It would have been impossible, however, to leave out all reference to Dr. Joule, but even regarding him too little, as has been said, one might have enlarged with propriety on his scientific works, now being collected by the Physical Society, as well as on the many virtues which have endeared him to his friends, and which make his private life as pleasing as his scientific career is brilliant. We do not even describe Dr. Edward Schunck, whose laboratory at Kersal is probably the finest private one in the country, and whose long personal relations with the writer make the subject tempting. Whilst writing this volume the President (Mr. Binney) died, and the writer had the melancholy duty of revising his work. It was Mr. Binney mainly who caused this volume to be written. It would also have been pleasant to remember more fully Mr. Baxendell, our Secretary, and to describe him in his Observatory at Southport ; but all these things seem forbidden by the circumstances of the case, and it might be asked, Why is not every member who writes a paper described, and every professor who visits the Society?

This would have been too daring an inroad on contemporary life. These ideas have, indeed, prevented the author from mentioning names to such an extent as he thinks he might fairly have done without hurting any man's feelings. However, he has avoided the danger by silence.

It has been remarked that members of the Society are not content to read their papers here, but prefer to send them to the Royal Society. This remark has, so far as the writer knows, been made without attaching blame to any one. It is useless to complain of this: it is a phase of national life, and it will grow stronger probably for a time, until this subcentre becomes sufficiently brilliant to make men feel that it is an object of great ambition to become distinguished here. This might be the case even now if there was a combined determination to send work to the Society; but such an event can never take place suddenly, and it cannot be expected to take place here rapidly whilst the Society has none of the funds which have of late so materially strengthened the position of the Royal Society. It would be a great advantage to the community if this Society had at its disposal a sum to be spent on scientific or literary investigations, and it is much to be desired that this subject be brought before men who have wealth to dispose of.

With an honest and sufficient pride of position, and respect for the city which has increased so much in importance, the Society may continue to be the centre of all that is most original in the department of Science in the district. It is extremely important for the sake of humanity itself to diminish to the utmost the centralisation of mental activity, unless when necessary to raise a series of batteries to attack some very strong position where ignorance reigns. It is remarkable how many towns in France have valuable societies, notwithstanding many evils connected with centralisation there, and in this respect she has given a good example. This may appear in contradiction to another opinion given, but this is not the place to reconcile the two, even if success were certain.

The number of literary and scientific men is increasing here, and they are beginning to publish their results in separate Societies.[1] Probably we have lost by want of sympathy, and allowed the forces to be too much scattered ; but good is doing, and our aim is to receive only the more original portion of scientific work and such literary memoirs as may be considered in the character of investigations. This has not been defined by the rules, but it follows from

[1] James Young, LL.D., F.R.S., who was a member of the Society when he lived in Manchester about thirty years ago, wished to have a chemical society, and brought together about thirty young men connected with works ; they, or at least some of them, met in summer in country places, had tea at an inn generally, and held their meetings at the tea-table. Some of the meetings were very pleasant. It was afterwards connected with the Lit. and Phil. Society itself, forming the first section ; the addition of several sections took place afterwards. The writer of this was secretary, but he found it difficult in those days to gain attendance, and papers were too few. He at last gave up calling the meetings. The most of the members were chemists in works. Mr. Young began another movement in Manchester. He wished to have a Liberal paper, not considering the *Guardian* sufficiently so. Talking with the present writer both agreed that the editor should be Thomas Ballantyne, and that it should be called the *Examiner*. Mr. Ballantyne obtained other men, who do not seem to have been told of Mr. Young's idea. Mr. Ballantyne left the paper soon, and never succeeded. He was a remarkable man, capable of speaking many leading articles in an evening—articles too of great power —but he had apparently little power of writing them out in such a way as to attract the public. At any rate he did not please his friends, and circumstances were against him in after life.

the character and habits of the Society. As an example, a poem, however beautiful and original, would not suit our memoirs. Essays are of various kinds, and we have some; their suitability depends entirely on the mode of treating the subject and the result obtained, and of these qualities the Council must judge.

At present we are doing our best to make a good collection of the labours of scientific societies over all the world, so that our members are able to see for themselves the work of their contemporaries.

The Society has never accumulated money, having spent all its income for the benefit of those who subscribe, keeping at the same time carefully out of all engagements which it could not fulfil.

The time, however, has come when it must make an effort to enlarge the buildings which were erected for its accommodation in 1804, or remove to new ones. The library is making the rooms inconveniently small, and it has been proposed to sell the building and site, take cheaper premises, and look to using the interest of the money obtained by the sale for purposes of the Society. It has also been proposed that the books should be added to the Free Library under certain conditions, whilst members only of the Society should have permission to read them at home; but the feelings of the members seem decidedly opposed to this; and it is remarkable how strong and how beautiful the sentiment is of attachment to the spot where the Society has gained its fame. The members are unwilling to leave the rooms where Dalton studied, rooms that were given him for his laboratory, and which were his home from morning till evening for the greater part of his life, a building which has been consecrated to science in the memory of all who are in Manchester, and to which many have looked with wonder and awe from childhood. This would not be strange in those who had seen the old philosopher moving to and from his lodgings with his lantern in hand in the early winter mornings or the dark evenings, but it is pleasant to find it true of those whose age prevents all such memories; to them the old reasons for attachment remain by inheritance, whilst new ones have arisen with every year of their visits, and around many or all of its active members or its frequent attendants: this must be allowed to speak well for the later as well as earlier condition of the Society. For these reasons many consider that it would be well if we could remain, enlarging our premises and building as the early fathers of the Society built, or at any rate that if we move we ought to have an establishment to ourselves. We have the land bought for us: they had theirs to buy. As to the means, it is not for the writer to say more than this: that Manchester is rich, and without science it will not remain so.

It has, however, been said that the Society has done nothing to teach Manchester. It has given no lectures, no soirées, no displays; it has not in any way, except by its publications, shown itself; its members are scarcely seen, and it is looked on as stagnant. We certainly are not wanting in members who speak well and appear prominent as visible agents in the scientific world although not as representing our Society; but it has been the habit of the Society to make no display. It has even given up the few lectures which at one time were allowed in its rooms. This subject has been frequently discussed at the council, and it has been decided that the Society shall leave rather to the Royal Institution here to rival that of London, and such an institution must be held to be of marvellous value to a city. The intention was at one time carried out more than at present, and public attention to lectures has fallen wherever it has existed. On the other hand the roads to places of amusement—concert-halls and theatres—are choked with vehicles, and the world shouts out for more play and less work. The world is fitful in its progress, and whilst far from satisfactory this light singing of society has some good mixed with it; men are not so violent, and knowledge as well as comfort are increased. On the other side, whilst earnestness exists it is too much spent in seeking wealth, which when obtained is dissipated in pleasure. We cannot suppose that the loss of earnestness will be lasting; we shall believe that it will be made up by such a gain of knowledge and comfort as will give power and peace to a coming generation; and let us hope that Dr. Beddoe has made a mistake if he estimates that our mental power is diminishing with a lessening girth of the base of the head; for if that is true a removal backwards is for certain before our country.

Whatever the future may be, it is the part of this Society to keep within its walls a sound stock of scientific food, and to bring to it as many members as possible, giving them every encouragement to feed.

We begin a new century, it would be well to begin with hope, and it would probably be good if we enlarged our plans and endeavoured to attach to ourselves some of the younger societies of the city and do something to guide the progress of investigation. An attempt has been made more than once to do this by means of a medal, and one was presented in early times, whilst another was made for the purpose in late years, but the plan has never been carried out. It may be of little interest to the world that we as a society should exist, but that an organisation for the direction and encouragement of original research should exist in Manchester has been shown by results to be of the greatest importance, and as this Society has proved its fitness it is most proper that it should be preserved as a centre. For this reason it seems essential that some changes should be made in conformity with the changing habits of recent times as well as the change of relative position caused by the growth of the city, one of the causes of change of manners. For example, more is done by reading than was formerly done; opportunities of meeting are fewer. This has caused an increase of books. Distances are greater, and central positions are more expensive. Shall we seek to overcome this difficulty and endeavour to pay for larger premises on a spot equally central with our own? This would entail a hopeless expense. Shall we seek to enlarge our own buildings, close to great warehouses and in constant danger of being burnt down, keeping nevertheless the prestige of position with all its sentiment? Thirdly, shall we seek a new settlement in a new position, even if circumstances have determined that it shall not be central?

Of all these plans the writer is inclined to the third. The premises are small, and must be enlarged some day; they are also old. That a new place would be less convenient for some sites of the town is a misfortune to which the character of space compels us to yield.

However, it would change the minds of some of the members if a fine central position were given to the Society by the city or otherwise, and in such a manner as to leave the institution quite independent as now in all future time, as the Government has given an independent position to the Royal and other societies.

This is an important problem for the Society to solve, viz. what is to be its residence when beginning this second century of its life? It is also important for it to show to the scientific men around that it is for their benefit to have a centre of their own, and that it greatly trammels the intellectual power of a nation to have few centres of thought; the individual and the nation suffer together. Two examples are seen, in Germany and France: in the former the many centres have made a highly educated nation, a nation of thinkers; in the latter the thought-power has been deeply depressed, by the central guiding power having too much influence. In England the North has suffered much because of the universities being only in the south and very exclusive; indeed, to a large amount of the population England has been a country without a university, whilst the two in the south sent out for generations untaught men to teach the people. The energy of the nation has made them look elsewhere, but we have suffered for want of scientific training.

The new university, the Victorian, contains much of our hopes. We want variety in our education, and no greater misfortune can exist in the national education than to have one staff of examiners, one university, one mode of thinkers, only one mode of drilling mind. This is the true way to crush out originality, although in a talented race nature causes it to break out in spite of our little formalities. Unless the Victoria University develops a valuable variation of study, the reason for its existence ceases. To some extent it has done, and we watch its progress.

In Scotland, where there have been five universities to a population the seventh part of England, there has been, without deep learning, an effect of education on the people such as has not been found in England in wealthy counties, and a scattered and poor population (at least poor till lately) has done more than its share of the world's work. Much of this is to be attributed to the emulation caused by numerous and endowed universities; a difference amongst the youth in Manchester has been observed by the writer since Owens College was founded. The full-grown generation is also affected.

This Society acted as the only centre of scientific thought for many years in the district, and much of the influence of a university must be attributed to it. Still we must remember that it is not our province to teach youth, it is for us to receive amongst us those who have already learned; we must judge of their labours, and give these labours in a fitting form to the world that it may benefit by them. This has been the aim as well as the habit of the Society, and this must continue. It would be well if we could give also aid to those who show themselves fit to discover: not stimulating research by reward, merely to help to make it a trade as seems to be often the sole wish, but assisting those whose minds naturally lead them to research in directions valuable to the world, although not immediately if at all profitable.

The inclination to seek the greatest centre arises in most cases from an excusable love of fame, but chiefly from a haste to be famous. True fame always finds the centre at last; whilst false fame, or fame forced too soon, is thrust from it. One advantage in having many centres is that more men are satisfied, or fewer men are left with a feeling of neglect. The greater centre is better fed by the lesser, and certainly to be at a provincial centre is much the safest for all men, and the surest way to gain confidence. On the other hand, to the man who loves science and thinks nothing of fame—and of this class there really are a few—a provincial society is by far the pleasantest place in which to publish and discuss his ideas; there is less of jealousy and envy, and less of selfish opposition; as at football so in many scientific societies, he who kicks and elbows most violently is the most prominent, although he may kick the shins instead of the ball.

It is much to be desired, for these reasons, that calm and eager societies should increase. They may be satisfied to feed those of the metropolis, but not to be controlled in any way by them, and the larger cities such as Manchester may be serviceable in giving encouragement. We must finish with a cheerful hope that the work of the past will successfully encourage the future, and that the success which we have received in our isolation will be still greater when we have entered into union with our fellows, and that the speed of our work will be increased in accordance with the speed that seems to be gained of late by exertions in every department of knowledge, and even in every department of the thinking power itself.

It may be here mentioned that the constitution of the Society has been so far altered that there are now sections for different departments of science, and more may be formed at any time according to the demand. The physical and mathematical section and the natural history and microscopical section are at present in active existence. The chemical section has long ceased to meet, and at present there is scarcely room for it. The new society of students in Owens College seems to be found more convenient for such of the members as are likely to attend.

The publications of the Society consist of Memoirs and Proceedings. The latter are printed after every meeting and distributed with the circular calling the next. In this way the abstracts of work done are published rapidly, being sent not only to the members but to newspapers and scientific journals. The Memoirs are published in octavo at irregular intervals.

The Society was very active till 1803, having in eight years printed six volumes. The earlier volumes sold well, and helped to build the present house, which cost 600*l.*; during 45 years afterwards it published only seven volumes; during the next twenty years it published ten volumes, so that about 1840 it began a period of activity after a rather slumbering state. The period of early activity produced above all Dalton, with Henry and the founders who have been mentioned. The second period of less activity produced certain men of mark of which the Society may be proud, but no society was very active during that period of war and struggle with its consequences.

The third period has produced Joule's work, and we may claim some of Sturgeon's, and brought to the Society a greater variety of men and study. It is not easy to judge our intimate friends, but it is certain that there are in this third period more men in the Society who are members of other societies—the Royal, for example—than in any former period. The Society may partly be judged of in this way, and not solely by the papers read at its meetings.

If the members find that it is a convenient, useful, or agreeable thing to speak on subjects of common interest, they form a centre of intellectual life which may send forth its vigour in any direction ; that vigour is not solely to be measured by anything they may say or do at a meeting, but by the force generated, by the face of man strengthening his friend. The great struggles for political changes are made in Parliament, but these are merely the result of hundreds of smaller struggles elsewhere. It is therefore of great importance that Manchester should keep with earnestness its centre of scientific life, even if the results should not all be published there, but should frequently be sent to other societies whose position is supposed by the authors to give the papers more dignity or cause them to be more widely spread.

Are we talking without consideration, are we merely wishing to exalt a favourite institution, boasting as so many patriotic men do of their own country, their town, or their village, and turning even their weaknesses into subjects for applause ? We think not. The commerce of Manchester and its manufactories have benefited the world, but the formation of a science is the creation of a power which enables the world to benefit itself at all times and in all quarters. If this is an exaggerated view, let us take out of the world of books the atomic theory as begun by Dalton, and the mechanical equivalent of heat as developed by Joule, both of these great thoughts having emanated from this Society, and it will be more difficult to conceive the magnitude of the loss to mankind than if the whole of Manchester and its dependents, and many cities and counties besides, were obliterated from the earth.

Supplementary.

Some of the results which more directly flow from Dalton's work belong to the later period of the Society's life not entered on.

The great peculiarity of the atomic discovery of Dalton was that it supplied a measure for all combinations—a measure of bulk in an intellectual sense, and a measure of weight in an absolute sense. This has been extended so far that not only does the atom become a measure of comparative gravity, but it also supplies the same measure for other forces, viz. heat and mechanical force. Matter therefore has become a measure of force, and in the minds of some a force in a wider sense than ever had been foreseen.

The following are two attempts made of late in the Society to extend the atomic theory, and as such they have their own interest. They are still in a state not to be exactly understood, because their relationships are not sufficiently known; but they are young, and may grow, and it may be well to place them beside those which have already done much of their work. The world takes up some of the themes, and leaves others, one wonders why. When the true theory is found the relationships of the elements will be numerous and astonish us daily. So with the atomic weights of bodies, even those we have, and still more those which exist below them and make up our atoms; and first will be given an account of Mr. Wilde's theories.

It has been objected to this paper of Mr. Wilde's that the numbers can have only some accidental similarity. What can atoms have to do with the great movements of celestial bodies? The objections have been considered, and the reply is that analogous numbers or forms in different departments of nature are most interesting, and he who has followed the growth of thought on the mode of making worlds must be thankful to see that some numbers in one correspond to the other. It may be the beginning of vast thought in cosmogony, and of a mathematical era for thinking on the wild vortices of creation that have been described by theorists of all ages. Atoms seem to have begun worlds, and it is for us to watch the smallest openings that give a "blink" into the great region where matter took its shape. Who knows if our chemical compounds do not form by motions analogous to celestial? This is a region where we can have no regard to mere opinion, and where reason has been unable to see clearly. Such is our conclusion after hearing all voices without prejudice, and so an abstract of the memoir remains here.

'*On the Origin of Elementary Substances, and on Some New Relations of their Atomic Weights,' by Henry Wilde, Esq.* ('Proceedings,' April 30, 1878.)

'The hypothesis, that the solar system, as at present constituted, was formed by the successive condensations of a gaseous substance rotating under the influence of a central force, has so much evidence in its favour, that it may be affirmed to equal the best of that obtained from the geological record of the changes which in past times have taken place on the surface of the terrestrial globe. That this gaseous or primordial substance consisted of a chaotic mixture of the sixty-five elements known to chemists is a notion too absurd to be entertained by any one possessing the faculty of philosophic thinking, as the regular gradation of properties observable in certain groups of elements clearly shows that elementary species are not eternal, but have a history which it is the proper object of physical science to unfold.

'One of the principal facts which to my mind establishes the nebular theory of the formation of planetary systems on a firm basis, is Bode's empirical law of the distances of the members of the solar system from each other and from the central body, as in this law is comprehended the idea of nebular condensation in definite proportions. Now, if elementary species were created from a homogeneous substance possessing a capacity for change in definite proportions, it is probable that the greater number of elements would be formed during, or after, the transition of the nebular matter from the annular to the spheroidal form. Moreover, as great cosmic transitions are not made *per saltum*, it might be expected that some modification of the law of nebular condensation into planetary systems as exhibited in Bode's law, would be found on the further condensation of the primitive matter into elementary species.

'That relations such as I have indicated exist between the nebular and elementary condensations, represented by the planetary distances on the one hand, with the atomic weights of well-defined groups of elementary substances on the other, will be evident on comparing the numbers in the following table :—

I.

$0 \cdot 0 \cdot 4 = 4$	Mercury.	$8 \times 3 + 4 = 28$	Ceres, Pallas, &c.
$1 \times 3 + 4 = 7$	Venus.	$16 \times 3 + 4 = 52$	Jupiter.
$2 \times 3 + 4 = 10$	Earth.	$32 \times 3 + 4 = 100$	Saturn.
$4 \times 3 + 4 = 16$	Mars.	$64 \times 3 + 4 = 196$	Uranus.

'In the above table the numbers expressing the relative distances of the planetary bodies from the sun, and from each other, are obtained by multiplying successively the difference (3) between the distance of the first and second members of the system by a geometric series, and adding to the products the constant distance (4) of the first member from the sun.

'If the atomic weight of the second member of the alkaline and silver group of metals (Na = 23) be multiplied successively by an arithmetical series, then will the products, minus the atomic weight of the first member (Li = 7), be the atomic weights of all the elements belonging to that group.

II.

0· 0· 7 = Li = 7	5 × 23 − 7 = Ag = 108
1 × 23 ·0 = Na = 23	6 × 23 − 7 = Cs = 131
2 × 23 − 7 = Ka = 39	7 × 23 − 7 = = 154
3 × 23 − 7 = Cu = 62	8 × 23 − 7 = = 177
4 × 23 − 7 = Rb = 85	9 × 23 − 7 = Hg = 200

'Again, by multiplying in like manner the atomic weight of the second member of the alkaline earth and cadmium group of metals, the products, minus the atomic weight of the first member (Gl = 8), are the atomic weights of all the elements of this group.

III.

0· 0· 8 = Gl = 8	5 × 24 − 8 = Cd = 112
1 × 24 ·0 = Mg = 24	6 × 24 − 8 = Ba = 136
2 × 24 − 8 = Ca = 40	7 × 24 − 8 = = 160
3 × 24 − 8 = Zu = 64	8 × 24 − 8 = = 184
4 × 24 − 8 = Sr = 88	9 × 24 − 8 = Pb = 208

'The further relations observable between interplanetary voids and atomic condensations of the natural groups of elements in Tables II., III., are as follows:—

'1. The regular geometric series of the planetary distances commences at the second member of the system, and the regular arithmetical series of atomic weights commences at the second and corresponding member of each group.

'2. As the atomic weight of the second element in each group is half the sum of the atomic weights of the first and third elements, so is the distance of the second member of the solar system an arithmetical mean, or half the sum of the distances of the first and third members.

'3. The atomic weight of the fourth member in each group of elements is equal to the sum of the atomic weights of the second and the third; and the distance of the fourth member of the solar system is also equal, within a unit, to the sum of the distances of the second and third members.

'4. As the smallest planetary distance is a constant function of the distances of the outer planetary bodies, so is the smallest atomic weight in each group a similar function of all the higher members of the series to which it belongs. It will also be observed that the plus and minus signs of these constants are correlated respectively with the interplanetary spaces and the elementary condensations.

'5. Each of the atomic weights after the third in the groups is an arithmetical mean of any pair of atomic weights at the same distance above and below it; and the distance of each member of the solar system (minus the constant 4) is a mean proportional of the distances of any two members, externally and internally to it, from the central body.

'6. The geometric ratio of the planetary distances from each other terminates at the two members nearest the central body, and approaches to an arithmetical one; and a similar departure is also noticeable from the regular arithmetical series of the atomic weights of the first two members of the groups, which renders the third less than an arithmetical mean of the atomic weights of the second and fourth members.'

If any man will say that Mr. Wilde compares a law of weight with a law of distance, then we may reply, 'Does the weight not determine the distance? Is not the atom that which determines the motion of worlds, and the power of suns?'

It may certainly look like presumption in the writer to bring forward any of his own work when leaving out that of his friends; but these two papers are all that have been published by the Society on the atomic numbers since Dalton and Joule. The author does not pretend to see their bearing, but they have a bearing of a certainty. He sends them to be explained, if he fails to explain them himself. Only the beginning can be shown, but the results were obtained with care, and seem to indicate a new departure for the atomic theory. The writer had been collecting papers on the subject, a favourite one, when this result was found by him. It led to a new direction of thought, but more practical work has driven him from it for too long a time. It arose from no crotchet, but from a series of most unexpected facts. The first idea was given in 1868 at the Norwich meeting of the British Association, and then published by this Society. Afterwards every experiment was several times repeated with similar results after an interval of ten years, and the following abridgment was published by the Royal Society.

Absorption of Gases by Charcoal. Part II. On a new Series of Equivalents or Molecules. By R. Angus Smith, Ph.D., F.R.S. Received January 30, 1879.

(Abstract.)

'In the "Transactions of the British Association," 1868, Norwich, on page 64 of the "Abstracts," there is a preliminary notice of an investigation into the amount of certain gases absorbed by charcoal. . . . The results given were :—

Hydrogen	1
Oxygen	7·99
Carbonic oxide	6·03
Carbonic acid	22·05
Marsh-gas	10·01
Nitrous oxide	12·90
Sulphurous acid	36·95
Nitrogen	4·27

'It was remarked that the number for nitrogen was probably too low; I had some belief that the charcoal retained a certain amount which I had not been able to estimate.

'For common air, the number 40·065 crept into the paper or abstract instead of the quotient 7·06.

'The cause of this was clear, as I believed, namely, the irregular character of the charcoal with which I had to deal. The experiments which I had published were forgotten, I suppose, by most men, but the late Professor Graham told me that he had repeated them with the same results which I had given. I might have considered this sufficient, but waited for time to make a still more elaborate investigation of the subject, and to take special care with oxygen, in the belief that, the rule being found, the rest of the inquiry would be easy; this was extended to nitrogen, but not by so many experiments as with oxygen. I am now assured of a sound foundation for inquiries, which must take their beginning from the results here given.

'It is found that charcoal absorbs gases in definite volumes, the physical action resembling the chemical.

'Calling the volume of hydrogen absorbed 1, the volume of oxygen absorbed is 8. That is, whilst hydrogen unites with eight times its weight of oxygen to constitute water, charcoal absorbs eight times more oxygen by volume than it absorbs hydrogen. No relation by volume has been hitherto found the same as the relation by weight.

'The specific gravity of oxygen being 16 times greater than hydrogen, charcoal absorbs 8 times 16, or 128 times more oxygen by weight than it does hydrogen. This is equal to the specific gravity of oxygen squared and divided by two, $\frac{16^2}{2}$, or it is the atomic weight and specific gravity multiplied into each other, 16×16, and divided by two, $\frac{256}{2} = 128$.

'Nitrogen was expected to act in a similar way, but it refused. The average number of the latest inquiry is 4·52, but the difficulty of removing all the nitrogen from charcoal is great, and I suppose the correct number to be 4·66. Taking this one as the weight absorbed, $14 \times 4{\cdot}66 = 65{\cdot}24$, or it is $\frac{14^2}{3}$. Oxygen is a dyad; nitrogen a triad.

'We have then carbonic acid not divided, but simply 22 squared = 484.

'Time is required for full speculation, but the chemist must be surprised at the following :—

Carbonic oxide	6	volumes.		
Carbonic acid, CO_2 . . .	6+16	,,		=22
Marsh-gas, CH_4	6+4	,,		=10
Protoxide of nitrogen, NO . .	8+4·66 (N)		(4·9)	12·66

'These four results belong to the early group not corroborated lately, but so remarkably carrying out the principle of volume in this union, giving numbers the same as those of weight in chemical union, that they scarcely require to be delayed.

'I am not willing to theorise much on the results; it is here sufficient to make a good beginning. We appear to have the formation of a new series of molecules made by squaring our present chemical atoms, and by certain other divisions peculiar to the gases themselves. Or it may be that the larger molecule exists in the free gas, and chemical combination breaks it up. These new and larger molecules may lead us to the understanding of chemical combinations in organic chemistry, and whenever there is union not very firm, and may also modify some of our opinions on atomic weights and the motion of gases.

'Of course, I cannot pretend to give the result of these results; but as we have here the building up of a molecule by volumes, so as to form an equivalent of physical combination analogous to the chemical equivalent, it is impossible to avoid seeing that it indicates the possibility of our present equivalents being made up in a similar manner.

'I did not expect these numbers; but I certainly, as my previous paper showed, had in full view a necessity for some connection between physical and chemical phenomena more decided than we possessed.'

CHAPTER XIV.

Memorandum of Association of the Manchester Literary and Philosophical Society.

1. The name of this Society is the Manchester Literary and Philosophical Society.

2. The registered office of the Society will be situated in England.

3. The objects for which the Society is established are:—

(*a*) The advancement of literature and science.

(*b*) The reading and discussion, at the meetings of the Society, and sections of the Society, of original papers, essays, or treatises on literary or scientific subjects, written by members of the Society, or communicated to the Society by members on behalf of the authors.

(*c*) The printing and publishing, at the expense of the Society, of such of the said papers, essays, or treatises, as shall, in the opinion of the Society, or its governing body, be of sufficient merit or interest to be worthy of publication.

(*d*) The doing all such other lawful things as are incidental or conducive to the attainment of the above-mentioned objects, or any of them.

4. No subject relating to or involving any question of party politics, or controversial divinity, shall be brought before, or entertained by the Society, or any section thereof, nor shall any discussion of any such subject as last aforesaid be permitted at any meeting of the Society, or any section thereof, and no member or other person shall be allowed, directly or indirectly, to introduce or submit to the Society, or any section thereof, any subject, with a view to pecuniary gain either to himself or any other person.

5. The income and property of the Society, whencesoever derived, shall be applied solely towards the promotion of the objects of the Society, as set forth in this Memorandum of Association, and no portion thereof shall be paid or transferred directly or indirectly, by way of dividend or bonus, or otherwise howsoever, by way of profit, to the persons who at any time are or have been members of the Society, or to any of them, or to any person claiming through any of them, provided that nothing herein contained shall prevent the payment, in good faith, of remuneration to any officers or servants of the Society, or to any member of the Society, or other person, in return for any services actually rendered to the Society.

6. The 5th paragraph of this Memorandum is a condition on which a licence is granted by the Board of Trade to the Society, in pursuance of section 23 of the 'Companies Act, 1867.' For the purpose of preventing any evasion of the terms of the said 5th paragraph, the Board of Trade may from time to time, on the application of any member of the Society, impose further conditions, which shall be duly observed by the Society.

7. If the Society act in contravention of the 5th para-

graph of this Memorandum, or of any such further conditions, the liability of every ordinary member of the Society shall be unlimited, and the liability of every member who has received any such dividend, bonus, or other profit, as aforesaid, shall likewise be unlimited.

8. Every ordinary member of the Society undertakes to contribute to the assets of the Society, in the event of the same being wound up during the time that he is an ordinary member, or within one year afterwards, for payment of the debts and liabilities of the Society, contracted before the time at which he ceases to be an ordinary member, and of the costs, charges, and expenses of winding up the same, and for the adjustment of the rights of the contributories amongst themselves, such amount as may be required, not exceeding 10*l.*; or in case of his liability becoming unlimited, such other amount as may be required in pursuance of the last preceding paragraph of this Memorandum.

We, the several persons whose names and addresses are subscribed, are desirous of being formed into a Society in pursuance of this Memorandum of Association.

Names, Addresses, and Description of Subscribers.

EDWARD SCHUNCK, Vine Street, Higher Broughton, Chemist.
EDWARD WILLIAM BINNEY, 55 Peter Street, Manchester, Solicitor.
ROBERT ANGUS SMITH, 22 Devonshire Street, All Saints', Manchester, Inspector of Alkali Works.
WILLIAM GASKELL, Minister, 84 Plymouth Grove, Manchester.
SAMUEL BROUGHTON, Collector, Heaton Mersey, Manchester.
JOSEPH BAXENDELL, 32 Crescent Road, Cheetham Hill, Agent.

OSBORNE REYNOLDS, 23 Lady Barn Road, Fallowfield, Manchester, Professor of Engineering.

Dated this ninth day of March, 1875.
Witness to the above Signatures,

HENRY MERE ORMEROD,
5 Clarence Street, Manchester, Solicitor.

Articles of Association of the Manchester Literary and Philosophical Society.

It is hereby agreed as follows :—

1. The regulations contained in the table marked A in the first schedule to the 'Companies Act, 1862,' shall not apply to this Society, but instead thereof, the following shall be the regulations of the Society, subject nevertheless to repeal and alterations thereof, and additions thereto, as is provided by these presents.

INTERPRETATION.

2. In the interpretation of these presents the following words and expressions shall have the following meanings, unless such meanings be excluded by the subject or context, viz. :—

'The Society' means the Manchester Literary and Philosophical Society.

'The Statutes' means and includes the 'Companies Act, 1862,' the 'Companies Act, 1867,' and every other Act from time to time in force concerning Joint Stock Companies with limited liability, and necessarily affecting the Society.

'These Presents' means and includes the 'Memorandum of Association,' and the regulations and

Articles of Association of the Society from time to time in force.

'Special Resolution' means a special resolution of the Society, in accordance with section 51 of the 'Companies Act, 1862.'

'The Property' means the lands, buildings, funds, books, instruments, furniture, and other real and personal property from time to time of the Society.

'Ordinary Member' means an ordinary member of the Society, as defined by these presents. 'Corresponding Member' and 'Honorary Member' respectively mean persons occupying the positions or relations with reference to the Society, which are by these presents attributed to or prescribed for corresponding and honorary members of the Society respectively.

'Secretary' means any one of the Secretaries from time to time of the Society, and any temporary substitute for such Secretary.

'Ordinary Meeting' means an ordinary meeting or assembly of members, whether ordinary, corresponding, or honorary, for literary, scientific, or philosophical purposes.

'General Meeting' means a general meeting of ordinary members of the Society duly called and constituted for the purpose of electing members or officers, or for financial or constitutional purposes, or for purposes not within the power of ordinary meetings, and any adjourned holding of such general meeting

'Council' means a meeting of the members of the council, duly called and constituted, or (as the context may require) such of the members of the council as are present at a meeting thereof, or (as to the decision of any question, or the exercise of any power, which the council are by these presents or the statutes enabled to exercise), the majority of those members of the council who shall be present at a meeting thereof, such majority being a majority in number of votes according to the provisions of these presents, with respect to the votes of the chairman and members of council present at a meeting thereof.

'Office' means the registered office from time to time of the Society.

'Month' means calendar month.

Words importing the singular number only shall include the plural number, except where such meaning shall be repugnant to the context.

'Words importing the plural number only shall include the singular number, except where such meaning shall be repugnant to the context.

Words importing the masculine gender only shall include the feminine gender.

3. For the purposes of registration, the number of the ordinary members of the Society is declared not to exceed two hundred.

4. The Society is established for the purposes expressed in its 'Memorandum of Association,' and its business and affairs and property shall be carried on, conducted, and managed by or under the direction of the council, subject only to such control as is by these presents reserved to or vested in general meetings of the Society.

CONSTITUTION.

5. Such of the present members of the Society heretofore called the Literary and Philosophical Society of Manchester as shall be desirous of becoming members of the Company constituted by the foregoing Memorandum of Association, and shall respectively subscribe these Articles of Association, or shall, within twelve calendar months next after the incorporation of the Company, either pay the hereinafter-mentioned composition for subscriptions of 25 guineas, or annual subscription of 2*l.* 2*s.*, or signify in writing to the Secretary for the time being of the said Company their desire to become members of the said Company, shall be the first and present members of the said Company.

6. The Society, so far as its constitutional and financial powers, rights, and obligations are concerned, shall consist of ordinary members only; but it may elect and admit to the ordinary meetings and to such of the privileges and benefits of the Society as are not by these presents confined to ordinary members, other persons who, according to circumstances, shall be styled either corresponding members or honorary members.

7. Persons who have attained the age of twenty-one years, and have given proof by their writings, researches, or attainments of being duly qualified in those respects, may be elected ordinary members

8. The ordinary members shall be liable for all the expenses of the Society, subject nevertheless to such limitation of liability as is prescribed by the 'Memorandum of Association,' and the ordinary members shall alone be entitled to the property of the Society, and they

only shall have the right of voting at general meetings of the Society.

9. Persons who are duly qualified as aforesaid to be ordinary members, and who have shown an active interest in the proceedings of the Society, may be elected corresponding members if recommended by the Council.

10. Persons who have by their genius and labours contributed in an eminent degree to the advancement of literature or science may be elected honorary members if recommended by the Council.

11. Both corresponding members and honorary members may be present at and take part in the business of any ordinary meetings, but only ordinary members shall be present at or take part in the business of any general meeting of the Society.

ELECTION OF MEMBERS.

12. Every candidate for admission to any of the privileges of the Society, whether as an ordinary member, or corresponding member, or an honorary member, shall be proposed by not less than three ordinary members.

13. The proposers shall sign and deliver to the Secretary a certificate, giving the name of the candidate in full, together with his profession or business, and usual place of residence, as well as specifying any work or works which he may have published, and declaring likewise, that they, either from personal knowledge, or acquaintance with his writings, researches, or attainments, believe him to be qualified to become a member of the Society, and stating whether the candidate is proposed as an ordinary member, or a corresponding member, or an honorary member.

14. As soon as this certificate has been properly filled up and signed, a copy of it shall be suspended in the meeting hall or office of the Society, and shall not be removed until after the day of election.

15. The certificate shall be audibly read by the Secretary at not fewer than two successive ordinary meetings, previous to the general meeting, at which the election is to take place.

16. Notice of the name, profession, and usual place of residence, of each candidate shall be inserted in the circular convening the general meeting at which the election of such candidate is to be proceeded with.

17. The election of members shall be by ballot, and three-fourths at least of the votes given shall be in favour of the candidate, in order to render his election valid.

18. The ballot shall be conducted under the direction and supervision of the Chairman of the meeting at which it shall take place, and the result of the ballot shall be ascertained by the Secretary, under the direction and supervision of such Chairman, and shall be announced to the meeting by such Chairman.

SUBSCRIPTIONS.

19. The financial year of the Society shall commence on the 1st day of April, and end on the following 31st day of March.

20. Every ordinary member whose name is on the register of the Society on the first day of the financial year shall pay a subscription of *2l. 2s.* for that year, and such subscription shall be due on the 24th day of June in the same year.

21. Every ordinary member shall immediately upon his election, and before being admitted to any meeting of the Society, pay an admission fee of two guineas; if elected in any month from April to December, both inclusive, he shall also pay the full amount of his annual subscription for the then current year, in addition to his said admission fee, but if elected in January, February, or March, he shall pay only one-half his subscription for the then current year, in addition to his said admission fee.

22. Every ordinary member whose annual subscription shall, on the 31st day of March, in any year, be in arrear for two years or upwards, shall cease to be a member of the Society, and the council shall cause the fact of his having so ceased to be a member to be announced at the next following general meeting, and shall erase his name from the register of the ordinary members of the Society.

23. If any person, who, by virtue of the Article last hereinbefore contained, shall cease to be a member of the Society, shall within one year from the date of the general meeting at which such an announcement as last aforesaid shall have been made, apply for re-admission to the Society, the council may, on reasonable cause being shown by the applicant, recommend the Society to re-admit him as an ordinary member, on condition of his paying the amount of his arrears and such further subscription as would have become due from him if he had during the interval continued to be an ordinary member, and upon such recommendation being made, and on the performance by him of the aforesaid conditions, the Society may, at its then next or any subsequent general meeting, re-elect him as an ordinary member of the Society.

24. A copy of the last two preceding Articles shall be

printed on all receipts given to ordinary members for the payment of their subscriptions.

25. Any ordinary member may at any time compound for all his future subscriptions by a payment to the Society of twenty-five guineas.

ORDINARY MEETINGS.

26. The Society shall hold a session annually, beginning with the month of October, and ending with the month of April in the year following, and may hold such intermediate ordinary meetings as the Society or the Council may from time to time determine on.

27. The first ordinary meeting of the session shall be held on the first Tuesday in October, and the subsequent ordinary meetings on every alternate Tuesday up to the end of April, at seven o'clock in the evening.

28. If Christmas Day or any national holiday fall on any of those days on which an ordinary meeting of the Society ought to take place, such meeting shall be held on the day next preceding or the day next following, as the council may determine.

29. Persons who are not members of the Society may assist at its ordinary meetings when introduced by members of any class.

30. At every ordinary meeting each member in entering the hall of the Society shall write his name, as well as the name and address of any visitor introduced by him, in a book accessible for this purpose.

31. Members and visitors in making remarks, or taking part in the discussion at the ordinary meetings, shall address themselves to the Chairman of the meeting, and private desultory conversation shall not be permitted.

32. Not more than forty minutes shall be allowed for reading a paper, essay, or treatise, and if it is not concluded within that time, the remainder shall be deferred till the next or some other ordinary meeting.

33. In other respects the proceedings of ordinary meetings shall be conducted according to the standing orders of the council, so far as such standing orders apply, and where these presents and such standing orders do not apply, then as the Chairman of the meeting in question shall determine.

PUBLICATION OF MEMOIRS AND PROCEEDINGS.

34. The Memoirs of the Society for each session shall be published as soon as practicable after the close of each session.

35. Every honorary member shall be presented with a copy of the volume of Memoirs which may be in course of publication at the time of his election, and of all volumes subsequently published during the continuance of his honorary membership.

36. The proceedings of the ordinary meetings of the Society may be published at the discretion of the council, and shall be sent free of charge to every member of each class, ordinary, corresponding, and honorary, residing in the United Kingdom.

37. The council may depute one or more ordinary members to superintend the printing of the Memoirs and proceedings, and may award to the member or members so deputed such remuneration for his or their services as the council may deem fit.

GENERAL MEETINGS.

38. A general meeting shall be held annually, in the month of April, at such place, on such day, and at such hour as the council shall, from time to time, determine. The first annual general meeting shall be held in the month of April, 1875.

39. An extraordinary general meeting may, at any time, be called by the council, or the president of the council, or one-third of the members of the council, of their own accord.

40. An extraordinary general meeting shall be called by the council whenever a requisition, signed by five or more ordinary members, and stating fully the object of the meeting, shall have been delivered to the Secretary, or left at the office, addressed to the council or the president of the council.

41. Whenever the council shall neglect for fourteen days after such delivery, or leaving of any such requisition, to call a meeting in accordance therewith, the requisitionists, or any three of them, may call the meeting by notice to the ordinary members.

42. Every extraordinary meeting shall be held at such hour, at the rooms of the Society, in Manchester, as the council, or the president, or the members of council, or requisitionists calling the meeting (as the case may be), shall in the notice of the meeting appoint.

43. Five ordinary members shall be the quorum of every general meeting.

44. If within half an hour after the time appointed for the holding of a general meeting the quorum be not present, the meeting, if convened on the requisition of ordinary

members, shall be dissolved, and in any other case shall stand adjourned to the next working day, at the same place, and to meet at the same hour of the day as was appointed for the holding of the original meeting.

45. If at any adjourned general meeting the quorum be not present within half an hour after the time appointed for holding the meeting, the meeting shall be finally dissolved.

46. The Chairman of the meeting may adjourn any general meeting from time to time, but to be held at the same place.

47. An adjourned general meeting shall be deemed to be part of the original meeting from which the adjournment took place.

48. No business shall be transacted at any adjourned general meeting other than the business left unfinished at the meeting from which the adjournment took place.

49. The council, or president, or members of council calling any general meeting, and the ordinary members calling any extraordinary general meeting, shall respectively give at least seven days' notice of the meeting.

50. When any general meeting shall be adjourned for more than seven days, the council shall give at least four days' notice of the holding of the adjourned meeting.

51. The several days' notice above-mentioned shall be reckoned exclusively of the day of giving the notice, but inclusively of the day of the meeting.

52. Notices calling general meetings shall be given by circulars to the ordinary members having registered places of address in the United Kingdom, expressing the time and place of the meeting.

53. In every case in which by virtue of these presents

notice of any business to be transacted at a general meeting is to be given, the circular shall, so far as may be practicable, particularise the business.

54. Any general meeting, when notice in that behalf has been given in the notice convening the meeting, or otherwise, in the manner required by these presents, may remove any member of council, or officer, or servant of the Society for misconduct, negligence, incapacity, or other cause deemed by the meeting sufficient, and (subject to the provisions of these presents) may from time to time determine how and to what purposes any property or revenue of the Society shall be expended or applied, and may from time to time vary the number of members of council, and (subject to the provisions of these presents) may generally decide on any affairs or questions of, or relating to the Society, of which due notice has been given.

55. Any general meeting, without any notice in that behalf, may receive and either wholly or partially reject or adopt and confirm the accounts, balance-sheets, and reports of the council, Treasurer, and Librarian respectively, and may discuss, transact, and decide on any business or matter brought under its consideration by any report thereto of the council and (subject to the provisions of these presents) may generally discuss any affairs of or relating to the Society.

56. Except when otherwise provided by these presents, every question to be decided by any general meeting, unless resolved on without a dissentient, shall be decided by a simple majority by show of hands of the ordinary members personally present thereat.

57. No corresponding member or honarary member shall take part in or be present at the proceedings of any

general meeting, and only ordinary members shall vote at or take part in the proceedings of general meetings.

58. Every ordinary member present in person at any general meeting shall have one and only one vote upon each question arising at such meeting. But no ordinary member shall vote or exercise any privilege of an ordinary member at any general meeting while any admission fee or subscription or any part thereof due from him shall be unpaid.

59. Except with reference to the election of members, the person in the chair at a general meeting in every case in which on any question arising at such meeting there shall be for and against such question an equality of votes, shall have an additional or casting vote.

60. No objection shall be made to the validity of any vote, except at the meeting at which such vote shall be tendered, and every vote not disallowed at such meeting shall be deemed valid for all purposes whatsoever.

61. The Chairman of any general meeting shall be the sole and absolute judge of the validity of every vote tendered at such meeting, and may allow or disallow the votes tendered accordingly as he shall be of opinion that the same are or are not valid.

62. A statutory declaration by the Secretary, to the effect that notice of any general meeting has been given in the manner specified by these presents to each of the ordinary members having registered places of address in the United Kingdom, shall in the absence of proof to the contrary be conclusive evidence of notice of such meeting having been given to each such ordinary member, and the proceedings of any general meeting shall not be invalidated by reason of no such notice thereof having been given to one-tenth or less in

number of the ordinary members having such registered places of address, unless it shall appear that the failure or neglect to give them such notice was intentional on the part of the person or persons by or by whose direction the notices of such meeting were or ought to have been given.

COUNCIL AND OFFICERS.

63. Subject only to such control as is by these presents reserved to or vested in the general meetings of the Society, and to such resolutions as may be passed by general meetings, the affairs of the Society shall be managed by a council chosen from the ordinary members.

64. The number and constitution of such council may be from time to time determined by a general meeting, but until otherwise determined by a general meeting such council shall consist of a President, four Vice-Presidents, two Secretaries, a Treasurer, a Librarian, and six other ordinary members.

65. The first and present members of the council and their respective offices shall be as follows:—Edward Schunck, President; James Prescott Joule, LL. D., Edward William Binney, Robert Angus Smith, Ph.D., William Gaskell, Vice-Presidents; Joseph Baxendell, Osborne Reynolds, Secretaries; Samuel Broughton, Treasurer; Francis Nicholson, Librarian; Robert Dukinfield Darbishire, William Boyd Dawkins, Balfour Stewart, Alfred Brothers, Brooke Herford, Charles Bailey, ordinary members of council.

66. At the annual general meeting, to be held in the month of April, 1875, and at each annual general meeting

in every subsequent year, all the members of the council for the time then being shall retire from office, and the general meeting shall or may elect to fill their respective places an equal number of qualified ordinary members.

67. Every retiring member of the council, if otherwise qualified, shall be eligible for re-election, but no person shall be eligible to the office of President for more than two consecutive years at any one time.

68. Every election of an officer of the Society or a member of the council shall be by ballot and in no other mode.

69. Every member of the council shall vacate his office upon his ceasing to be an ordinary member, or being found lunatic, or if he shall absent himself from the council for six months without the sanction of the council, but until an entry of his disqualification is made in the minutes of the council his acts in his official capacity shall be as effectual as if he had not been disqualified.

70. Any occasional vacancy in the office of any member of the council may be filled up by an extraordinary general meeting by the election of a duly qualified ordinary member to the vacant office.

71. Whenever the annual general meeting in any year shall fail to elect members of council in the place of any of the retiring members of council whose places ought, according to the fixed number of members of council for the time then being, to be filled up at such meeting, then the retiring members of council, or those of them whose places ought to have been, but have not been, filled up, shall (if willing and able to act) continue in their respective offices until some subsequent extraordinary or annual general meeting shall have filled up their places.

PROCEDURE, POWERS, AND DUTIES OF THE COUNCIL AND OFFICERS.

72. Ordinary meetings of the council shall be held when and where the council shall think fit, but one ordinary meeting of the council shall be held in each month during the session of the Society. Special meetings of the council may be convened by the President or the Secretary when deemed necessary by them or either of them, and shall be convened when called for by a requisition to the President or Secretary, signed by at least three members of the council.

73. The quorum of every council shall be three members of the council at the least, and every question arising at a council, except where required by these presents, or by any member of the council to be decided by ballot, shall be decided by a simple majority of the members of council present thereat, and in case of an equality of votes at a council, whether by ballot or by show of hands, the acting chairman thereat shall have a second or casting vote.

74. In the exercise of the functions entrusted to them, the council shall be guided by such instructions as shall be given them by general meetings of the Society, and subject thereto, their procedure shall be regulated so far as the standing orders of the council extend by such standing orders, and in other respects as the members of council present thereat shall think fit.

75. The council shall take into consideration, and propose to the Society, such measures as they deem conducive to its interests and the furtherance of its objects.

76. The council shall decide by ballot if not unanimous

whether papers, essays, or treatises read or communicated to or at ordinary meetings of the Society shall be printed or not in its Memoirs. Every paper, essay, and treatise so read or communicated shall be laid before the council at their next following meeting, or at a meeting as soon as conveniently can be held to consider the same, and if they do not then unanimously agree either to print or reject it, they shall refer it to one or more members of the Society to report upon its merits. It shall, however, be left to the discussion of the council in exceptional cases to refer papers, essays, or treatises to persons who are not members of the Society to report thereon. After having received the report upon a paper, essay, or treatise, the council shall without delay decide by ballot whether or not the same is to be printed.

77. Four days, at least, before each annual general meeting the council shall deliver, or send by post, or otherwise, to each ordinary member the annual report of the council, including the Treasurer's annual account and the Librarian's annual report, and such reports and accounts shall be read by the Secretary at the commencement of such annual general meeting.

78. The council shall, in addition to the powers and duties by these presents expressly conferred or imposed on them, exercise and perform all such other powers and duties as by the statutes or these presents respectively are directly or by implication conferred or imposed on the governing body of the Society.

79. The duties of the President and Vice-Presidents respectively shall be to preside when required at the general and ordinary meetings of the Society and the ordinary and special meetings of the council, to call for

reports and accounts from committees and officers, to check irregularities, to preserve order during discussions, to see that the regulations, standing orders, and rules of the Society are observed, and to decide questions of practice which may arise on the proceedings.

80. At every meeting of the Society, whether general or ordinary, the President, or, during his absence, a Vice-President then present, elected by the ordinary members then present, and if there shall be neither President nor Vice-President present, a member of the council, elected by the ordinary members present, or during the absence of all the members of the council an ordinary member, elected by the ordinary members present, shall take the chair.

81. The duties of the Secretary shall be to attend all meetings of the Society and the council, to take minutes of the proceedings at meetings of the Society and the council, to conduct the correspondence of the Society, to take charge of the diplomas and seal, to receive papers and communications and lay them before the Society or the council, to keep the register of members of the Society, and to enter in such register the name of each member in order as elected, and to issue the circulars convening the meetings of the Society and the council.

82. If either of the Secretaries be prevented from attending any meeting of the Society or the council, he may appoint a member of the council to officiate for him, who shall for all purposes be deemed to represent the Secretary.

83. The duties of the Treasurer shall be to receive and give effectual discharges for all sums of money which may be due or payable to the Society; to disburse all sums of

money which may be due from or payable by the Society; to keep proper accounts of all such receipts and payments; to submit to the council all bills for their approval; to report to the council the state of the funds of the Society; to submit to the council, at their first meeting in April in every year, a list of members whose subscriptions may be in arrear, together with the amount in each case, and to make up his annual account immediately after the conclusion of each financial year, so that such account, with the vouchers thereto, may be ready for audit ten days before the annual general meeting then instant.

84. The Treasurer may draw cheques on the Society's bankers, and shall have charge of the trust-deeds and all other documents relating to the property of the Society; certified copies of such deeds and such other documents shall be deposited by him in the archives of the Society.

85. Any Collector whom the council may appoint shall be under the control of the Treasurer, as regards the time and mode of collecting and of accounting for the sums collected.

86. The Librarian shall have charge of the library, the stock of the printed Memoirs of the Society, and the archives; and his duties shall be to keep the catalogue of the library constantly entered up; to keep a proper register of all papers and documents in the archives; to keep an account of the copies of the printed Memoirs; to purchase all books ordered by the Society; to see that no book be taken out of the library without having been previously entered in a register; and to report to the council at their first meeting in April, every year, the names of members who may not have returned books obtained from the library.

87. All books obtained by members from the library shall be returned in the last week of March in every year, and defaulters shall be liable and shall be required to make good to the Society, without delay, any book not so returned.

88. At the first ordinary meeting of the Society, in February in each year, the Chairman of such meeting shall appoint two ordinary members, who shall audit the Treasurer's account for the then current financial year, and previous to the day on which the next annual general meeting is to be held, they shall report to the council the result of the audit.

SECTIONS AND THEIR REGULATIONS.

89. Upon the request of not less than seven members of any class the council may establish for any special object a section consisting of members of the Society interested in such object, provided the proposed object of such section is included in the objects aimed at by the Society.

90. Each section shall pay 2*l.* 2*s.* per annum to the Treasurer, to be paid by him to the Curator of the Society's rooms for his trouble in preparing the rooms for meetings of such section, and in attendance on such meetings and otherwise in reference to such sections.

91. All cabinets, instruments, specimens, books, and other articles which shall have been purchased by or presented to any section, shall be the property of the Society, but shall be held by the Society for the use of the members of such section.

92. The internal government and management of each section shall be regulated by its own members, subject however to the regulations and standing orders of the Society

from time to time in force, and such bye-laws as may be prescribed by the council for the regulation of such section, and each section shall from time to time appoint a secretary for the purpose of transacting such business with the council or Society at large as may be needed, and such secretary (whose appointment shall be notified to the council) shall be considered as the official representative of the section in its intercourse with the council and the Society respectively.

93. All rules made by any section shall only be provisional until they have been approved by the council.

94. The Sectional Secretary, or other person appointed by the section for this purpose, shall, after each meeting of the section, furnish to the Secretaries of the Society an abstract of the paper or papers read at the sectional meeting, and of any other valuable or interesting communications made to the sections at such meeting, for the purpose of the same being inserted in the next number of the Society's proceedings, subject to any directions which may be given in that behalf by the council.

95. All papers which any section (or the governing body of such section) shall deem worthy of printing *in extenso* shall be communicated to the Society at the first ordinary meeting which the Secretary of the Society may think convenient for the purpose, and shall then come before, and be considered and dealt with by, the council in the manner prescribed for papers read at, or communicated to, ordinary meetings of the Society.

DISPOSAL OF DOCUMENTS AND PAPERS.

96. After the annual report of the council for any year has been passed at any general meeting, the Treasurer's

account for the same year, and the vouchers thereto, shall be deposited in the archives of the Society.

97. All papers, letters, and documents received by the Society, the council, or the Secretary, which the council shall think proper to be preserved, shall be deposited in the archives as soon as practicable.

98. The original copies of papers, essays, or treatises read at any ordinary meeting of the Society, or any such section as aforesaid, shall be the property of the Society, unless an agreement has been previously made to the contrary. The authors, however, shall be at liberty to take copies of their papers, essays, or treatises.

99. The author of any paper, essay, or treatise read at any meeting of the Society, or any such section as aforesaid, shall have a right to withdraw it from publication by giving timely notice to the council.

ALTERATION OF REGULATIONS.

100. The Society may, from time to time, in general meetings, by special resolution, alter and make new provisions and regulations in lieu of, or in addition to, any regulations of the Society from time to time in force.

101. No resolution for an alteration of, or addition to, the regulations from time to time of the Society, shall be submitted to any general meeting, unless the member who intends to propose it shall, at least one month before the general meeting at which it is to be proposed, have given written notice to the council of his intention, and also of the exact tenor of the alteration or addition which he contemplates.

102. Notice of every such proposed alteration or addi-

tion shall be given, or sent by post, or otherwise, to the ordinary members, with the circular convening the general meeting at which the resolution is to be proposed.

NOTICES.

103. Every member shall, from time to time, in writing, name to the Secretary a place of address in the United Kingdom, and the place so named shall be entered in the books of the Society as the address of such member, and shall, for the purposes of these presents and the statutes, be deemed to be his place of residence and address.

104. Every notice and circular required by these presents to be given or sent to any person shall be sufficient if it shall bear the name or signature of the Secretary, or (as the case may be) of the person or persons giving such notice, and every notice, circular, and documents by these presents required to be delivered, sent, or given to any person shall, if put into the post-office in a letter or envelope, addressed to him (if a registered member) at his registered place of address, and (if not) at his usual or last known place of abode, shall be deemed to have been delivered to him on the day on which, in the regular course of the post-office, it would be delivered at his place of address or abode.

105. It shall not be necessary for any of the purposes of these presents, or for the validity of any proceeding, meeting, or act of the Society, or the council, or any other person under these presents, to give or send any notice or circular or document to any member not having at the time a registered place of address in the United Kingdom.

Names, Addresses, and Description of Subscribers.

Edward Schunck, Vine Street, Higher Broughton, Chemist.

Edward William Binney, 55 Peter Street, Manchester, Solicitor.

Robert Angus Smith, 22 Devonshire Street, All Saints', Manchester, Inspector of Alkali Works.

William Gaskell, Minister, 84 Plymouth Grove, Manchester.

Samuel Broughton, Collector, Heaton Mersey, Manchester.

Joseph Baxendell, 32 Crescent Road, Cheetham Hill, Agent.

Osborne Reynolds, 23 Lady Barn Road, Fallowfield, Manchester, Professor of Engineering.

Dated this ninth day of March, 1875.

Witness to the above signatures,

Henry Mere Ormerod,
5 Clarence Street, Manchester, Solicitor.

Licence by the Board of Trade pursuant to Section 23 *of the Companies Act,* 1867. *R* 1963.

Whereas it has been proved to the Board of Trade that the Manchester Literary and Philosophical Society, which is about to be registered under the Companies Act 1862, and the Companies Act 1867, as an Association Limited by Guarantee, is formed for the purpose of promoting objects of the nature contemplated by the 23rd section of the last-mentioned Act, and that it is the intention of the said Society that the income and property of the Association, whencesoever derived, shall be applied solely towards the promotion of the objects of the Association as set forth in the Memorandum of Association of the said Society, and that no proportion thereof shall be paid or transferred directly or indirectly by way of dividend or bonus, or otherwise howsoever by way of profit to the persons who at any time are or have been members of the said Society, or to any of them or to any person claiming through any of them:

Now therefore, the Board of Trade, in pursuance of the powers in them vested, and in consideration of the provisions, and subject to the conditions contained in the Memorandum of Association of the said Society, as subscribed by seven members thereof, on the 9th day of March, 1875, do, by this their Licence, direct the Manchester Literary and Philosophical Society to be registered with 'Limited Liability' without the addition of the word 'Limited' to its name.

Signed by order of the Board of Trade, this 13th day of March, 1875.

HENRY G. CALCRAFT,

An Assistant Secretary to the Board of Trade.

No. 9330 *c.* *N. L.* 9017.

Certificate of Incorporation of the Manchester Literary and Philosophical Society.

I hereby certify that the Manchester Literary and Philosophical Society (the word 'Limited' being omitted by licence of the Board of Trade) is this day incorporated under the Companies Act 1862, and that this Company is Limited.

Given under my hand, at London, this twenty-second day of March, one thousand eight hundred and seventy-five.

E. C. CURZON,
Registrar of Joint Stock Companies.

Fee, 5*l.* 10*s.* 0*d.*
S 18.

CHAPTER XV.

It was considered to be an interesting thing to have a list of all persons that have been members of the Society or are still members: this list includes the earliest in 1781, and the latest up to the annual meeting in April, 1881.

Those with an asterisk form the list of members at the latter date.

PRESENT OFFICERS OF THE SOCIETY, APRIL, 1881.

PRESIDENT.

Edward William Binney, F.R.S., F.G.S.

VICE-PRESIDENTS.

James Prescott Joule, LL.D., F.R.S., F.C.S.
Edward Schunck, Ph.D., F.R.S., F.C.S.
Robert Angus Smith, Ph.D., LL.D., F.R.S., F.C.S.
Henry Enfield Roscoe, B.A., Ph.D., F.R.S., F.C.S.

SECRETARIES.

Joseph Baxendell, F.R.A.S.
Osborne Reynolds, M.A., F.R.S.

TREASURER.

Charles Bailey, F.L.S.

LIBRARIAN.

Francis Nicholson, F.Z.S.

OF THE COUNCIL.

Rev. William Gaskell, M.A.
Robert Dukinfield Darbishire, B.A., F.G.S.
Balfour Stewart, LL.D., F.R.S.
Carl Schorlemmer, F.R.S.
James Bottomley, B.A., D.Sc., F.C.S.
William Henry Johnson, B.Sc.

OFFICERS OF THE SOCIETY FOR EVERY YEAR SINCE ITS COMMENCEMENT.

PRESIDENTS ELECTED.

Feb. 28, 1781	Peter Mainwaring, M.D., James Massey, Esq.
April 24, 1782	James Massey, Esq., Thomas Percival, M.D.
„ 30, 1783	Thomas Percival, M.D., James Massey, Esq.
„ 28, 1784	James Massey, Esq., Thomas Percival, M.D.
„ 25, 1785	James Massey, Esq., Thomas Percival, M.D.
„ 26, 1786	James Massey, Esq., Thomas Percival, M.D.
„ 25, 1787	James Massey, Esq.
„ 25, 1788	„
„ 24, 1789	„
„ 30, 1790	Dr. Percival.
„ 29, 1791	Thomas Percival, M.D.
May 4, 1792	„
April 26, 1793	„
„ 25, 1794	„
„ 24, 1795	„
„ 29, 1796	Dr. Percival.
„ 28, 1797	„
„ 20, 1798	„
„ 26, 1799	„
May 2, 1800	„
„ 1, 1801	„
April 30, 1802	„
„ 9, 1803	„
„ 27, 1804	„
„ 26, 1805	Rev. G. Walker, F.R.S.
„ 25, 1806	„

May 9, 1807 .	. Thomas Henry, F.R.S.
April 29, 1808 .	. Thomas Henry, F.R.S.
„ 28, 1809 .	. J. Hull, M.D.
„ 27, 1810 .	. Thomas Henry, F.R.S.
„ 26, 1811 .	. „
„ 24, 1812 .	. „
„ 30, 1813 .	. „
„ 29, 1814 .	. „
„ 28, 1815 .	. „
„ 26, 1816 .	. „
„ 25, 1817 .	. Mr. John Dalton.
„ 24, 1818 .	. „
„ 30, 1819 .	. „
„ 28, 1820 .	. „
„ 19, 1821 .	. „
„ 26, 1822 .	. „
„ 18, 1823 .	. „
„ 30, 1824 .	. „
„ 29, 1825 .	. Mr. J. Dalton, F.R.S.
„ 21, 1826 .	. „
„ 20, 1827 .	. „
„ 18, 1828 .	. „
„ 16, 1829 .	. „
„ 30, 1830 .	. „
„ 29, 1831 .	. „
„ 27, 1832 .	. „
„ 26, 1833 .	. „
„ 18, 1834 .	. „
„ 24, 1835 .	. „
„ 29, 1836 .	. „
Aug. 11, 1837 .	. „
April 17, 1838 .	. „
„ 30, 1839 .	. „
„ 28, 1840 .	. „
„ 20, 1841 .	. „
„ 19, 1842 .	. „
„ 18, 1843 .	. „

April 30, 1844 .	. Mr. J. Dalton, F.R.S.
Oct. 29, 1844 .	. Dr. Holme.
April 29, 1845 .	. ,,
,, 21, 1846 .	. ,,
,, 20, 1847 .	. ,,
,, 18, 1848 .	. Eaton Hodgkinson.
,, 17, 1849 .	. ,,
,, 30, 1850 .	. ,,
,, 29, 1851 .	. John Moore
,, 20, 1852 .	. ,,
,, 19, 1853 .	. ,,
,, 18, 1854 .	. ,,
,, 17, 1855 .	. W. Fairbairn, C.E., F.R.S.
,, 29, 1856 .	,,
,, 21, 1857 .	. ,,
,, 20, 1858 .	. ,,
,, 19, 1859 .	. ,,
,, 17, 1860 .	. J. Prescott Joule, F.R.S.
,, 30, 1861 .	. ,,
,, 29, 1862 .	. E. W. Binney, F.R.S.
,, 21, 1863 .	. ,,
,, 19, 1864 .	. R. Angus Smith, F.R.S.
,, 25, 1865 .	. ,,
,, 17, 1866 .	. Edward Schunck, F.R.S.
,, 30, 1867 .	. ,,
,, 28, 1868 .	. J. P. Joule.
,, 20, 1869 .	. ,,
,, 19, 1870 .	. E. W. Binney.
,, 18, 1871 .	. ,,
,, 30, 1872 .	. J. P. Joule.
,, 29, 1873 .	. ,,
,, 21, 1874 .	. Edward Shunck.
,, 20, 1875 .	. ,,
,, 18, 1876 .	. E. W. Binney.
,, 17, 1877 .	. ,,
,, 30, 1878 .	. J. P. Joule.
,, 29, 1879 .	. ,,
,, 20, 1880 .	. E. W. Binney.

VICE-PRESIDENTS ELECTED.

May 2, 1781	Dr. Percival, The Rev. Mr. Barnes, Thomas Butterworth Bayley, Esq., and Dr. Eason were elected Vice-presidents.
April 24, 1782	Rev. Samuel Hall, Dr. Cowling, The Rev. Thomas Barnes, and Alexander Eason, M.D., were elected Vice-presidents.
„ 30, 1783	Rev. Thomas Barnes, Alexander Eason, M.D., Rev. Samuel Hall, and Charles White, Esq.
„ 28, 1784	The Rev. Thomas Barnes, D.D., Alexander Eason, M.D., Charles White, Esq., and Rev. Samuel Hall.
„ 25, 1785	The Rev. Mr. Hall, Charles White, Esq., George Lloyd, Esq., and Mr. George Bew.
„ 26, 1786	Rev. Mr. Hall, Thomas Cooper, Esq., Charles White, Esq., and George Lloyd, Esq.
„ 25, 1787	Charles White, Esq., Thomas Cooper, Esq., Rev. Mr. Hall, and George Lloyd, Esq.
„ 25, 1788	Rev. Mr. Hall, Charles White, Esq., Thomas Cooper, Esq., and Mr. Thomas Henry.
„ 24, 1789	Thomas Cooper, Esq., Rev. Mr. Hall, Mr. Thomas Henry, and Charles White, Esq.
„ 30, 1790	Mr. Cooper, Mr. Henry, Mr. White, and Mr. George Philips.
„ 29, 1791	Thomas Cooper, Esq., Mr. Thomas Henry, Mr. George Philips, and Charles White, Esq.
May 4, 1792	Charles White, Esq., Thomas Henry, Esq., John Ferriar, and George Philips.
April 26, 1793	Charles White, Esq., Thomas Henry, Esq., John Ferriar, and Rev. John Radcliffe.
„ 25, 1794	Charles White, Esq., Thomas Henry, Esq., John Ferriar, and Rev. John Radcliffe.
„ 24, 1795	Mr. White, Mr. Henry, Mr. Radcliffe, and Dr. Ferriar.
„ 29, 1796	Dr. Ferriar, Mr. Henry, the Rev. J. Radcliffe, and Charles White, Esq.

April 28, 1797	Mr. White, Dr. Bardsley, Mr. Henry, and Dr. Ferriar.
„ 20, 1798	Mr. White, Mr. Henry, Dr. Bardsley, Dr. Holme.
„ 26, 1799	Charles White, Mr. Henry, Dr. Bardsley, and Dr. Holme.
May 2, 1800	Mr. White, Mr. Henry, Dr. Bardsley, Dr. Holme.
„ 1, 1801	Mr. White, Dr. Bardsley, Mr. Henry, Dr. Holme.
April 30, 1802	Dr. Bardsley, Mr. Henry, Mr. White, Dr. Holme.
„ 29, 1803	Mr. White, Mr. Henry, Dr. Bardsley, and Dr. Holme.
„ 27, 1804	Dr. Bardsley, Mr. White, Dr. Holme, and Mr. Henry.
„ 26, 1805	Charles White, Esq., F.R.S., S. A. Bardsley, T. Henry, F.R.S., and Edward Holme, M.D.
„ 25, 1806	T. Henry, F.R.S., Charles White, F.R.S., Dr. Bardsley, and Dr. Holme.
May 9, 1807	Dr. Holme, Dr. Bardsley, Dr. Roget, and Mr. William Henry.
April 29, 1808	Dr. Holme, Dr. Bardsley, Dr. Henry, and Dr. Roget.
„ 28, 1809	E. Holme, M.D., Mr. Gibson, Mr. Dalton, and W. Henry, M.D.
„ 27, 1810	Dr. Holme, Mr. Dalton, W. Henry, M.D., and Mr. B. Gibson.
„ 26, 1811	Dr. Henry, Dr. Holme, Mr. Dalton, and Mr. Gibson.
„ 24, 1812	Dr. Holme, Dr. Henry, Mr. Dalton, and Mr. Ewart.
„ 30, 1813	Dr. Holme, Mr. Ewart, Dr. Henry, Mr. Dalton.
„ 29, 1814	Dr. Henry, Mr. Ewart, Dr. Holme, Mr. Dalton.
„ 28, 1815	Dr. Holme, Dr. Henry, Mr. Dalton, and Mr. Ewart.
„ 26, 1816	Dr. Holme, Dr. Henry, Mr. Dalton, and Mr. Ewart.
„ 25, 1817	Edward Holme, M.D., William Henry, M.D., Mr. Ewart, and Mr. Johns.

April 24, 1818	Dr. Holme, Dr. Henry, Mr. Ewart, and Mr. Johns.
„ 30, 1819	Dr. Henry, Dr. Holme, Mr. Ewart, and Mr. Johns.
28, 1820	Dr. Holme, Dr. Henry, Mr. Ewart, and Mr. Johns.
„ 19, 1821	Dr. Holme, Dr. Henry, Mr. Ewart, and Mr. Johns.
„ 26, 1822	Dr. Holme, Dr. Henry, Peter Ewart, and G. W. Wood.
„ 18, 1823	Mr. Edward Holme, M.D., William Henry, M.D., Peter Ewart, and George William Wood.
„ 30, 1824	Edward Holme, F.L.S., William Henry, Peter Ewart, and George William Wood.
„ 29, 1825	Dr. Holme, Dr. Henry, Mr. P. Ewart, and Mr. G. W. Wood.
„ 21, 1826	Edward Holme, William Henry, Peter Ewart, and G. W. Wood.
„ 20, 1827	Edward Holme, William Henry, Peter Clare, and G. W. Wood.
„ 18, 1828	Edward Holme, William Henry, Mr. Peter Ewart, and G. W. Wood.
„ 16, 1829	Edward Holme, William Henry, Mr. Peter Ewart, and G. W. Wood.
„ 30, 1830	E. Holme, William Henry, Mr. P. Ewart, and G. W. Wood.
„ 29, 1831	Edward Holme, William Henry, P. Ewart, and G. W. Wood.
„ 27, 1832	Edward Holme, William Henry, P. Ewart, and G. W. Wood.
„ 26, 1833	Dr. Henry, Dr. Holme, Mr. Ewart, and Mr. G. W. Wood.
„ 18, 1834	Edward Holme, William Henry, Peter Ewart, and G. W. Wood.
„ 24, 1835	Edward Holme, William Henry, Peter Ewart, and G. W. Wood.
„ 29, 1836	Edward Holme, Wm. Henry, Geo. W. Wood, and Charles Phillips.

Aug. 11, 1837	Edward Holme, G. W. Wood, Charles Phillips, M.D., and William C. Henry.
April 17, 1838	Edward Holme, G. W. Wood, Rev. John James Tayler, B.A., and John Moore, F.L.S.
" 30, 1839	Edward Holme, G. W. Wood, Rev. John James Tayler, B.A., and John Moore, F.L.S.
" 28, 1840	Edward Holme, G. W. Wood, Rev. John James Tayler, B.A., and John Moore, F.L.S.
" 20, 1841	Edward Holme, G. W. Wood, Rev. John James Tayler, B.A., and John Moore, F.L.S.
" 19, 1842	Edward Holme, G. W. Wood, Rev. John James Tayler, B.A., and John Moore, F.L.S.
" 18, 1843	Edward Holme, G. W. Wood, John Moore, and Peter Clare.
" 30, 1844	Edward Holme, John Moore, Peter Clare, and J. A. Ransome.
Oct. 29, 1844	Mr. Hodgkinson, in place of Dr. Holme.
April 29, 1845	John Moore, Peter Clare, J. Atkinson Ransome, and E. Hodgkinson.
" 21, 1846	John Moore, Peter Clare, J. Atkinson Ransome, and E. Hodgkinson.
" 20, 1847	John Moore, Peter Clare, J. Atkinson Ransome, and E. Hodgkinson.
" 18, 1848	J. Moore, P. Clare, J. A. Ransome, and John Davies.
" 17, 1849	J. Moore, P. Clare, J. A. Ransome, and William Fairbairn.
" 30, 1850	J. Moore, P. Clare, J. A. Ransome, and William Fairbairn.
" 29, 1851	William Fairbairn, J. P. Joule, Laurence Buchan, and Joseph C. Dyer.
" 20, 1852	W. Fairbairn, J. C. Dyer, Eaton Hodgkinson, and J. P. Joule.
" 19, 1853	W. Fairbairn, J. P. Joule, Eaton Hodgkinson, and J. C. Dyer.
" 18, 1854	J. P. Joule, William Fairbairn, J. C. Dyer, and E. Hodgkinson.
" 17, 1855	J. P. Joule, J. C. Dyer, Eaton Hodgkinson and Thomas Hopkins.

April 29, 1856	J. P. Joule, J. C. Dyer, Thomas Hopkins, and E. W. Binney.
" 21, 1857	J. P. Joule, J. C. Dyer, Thomas Hopkins, and A. J. Scott.
" 20, 1858	J. P. Joule, J. C. Dyer, Thomas Hopkins, and James Crossley.
" 19, 1859	J. P. Joule, Thomas Hopkins, J. C. Dyer, and R. Angus Smith.
" 17, 1860	William Fairbairn, R. Angus Smith, J. C. Dyer, and E. W. Binney.
" 30, 1861	Robert Angus Smith, E. W. Binney, William Fairbairn, and J. C. Dyer.
" 29, 1862	J. P. Joule, Robert Angus Smith, J. C. Dyer, and Edward Schunck.
" 21, 1863	J. P. Joule, Robert Angus Smith, J. C. Dyer, and Edward Schunck.
" 19, 1864	J. P. Joule, E. W. Binney, J. C. Dyer, and Edward Schunck.
" 25, 1865	J. P. Joule, E. W. Binney, J. C. Dyer, and Edward Schunck.
" 17, 1866	Robert Angus Smith, J. P. Joule, E. W. Binney, and J. C. Dyer.
" 30, 1867	Robert Angus Smith, J. P. Joule, E. W. Binney, and J. C. Dyer.
" 28, 1868	E. Schunck, R. Angus Smith, E. W. Binney, and J. C. Dyer.
" 20, 1869	E. Schunck, R. Angus Smith, E. W. Binney, and Rev. W. Gaskell.
" 19, 1870	J. P. Joule, E. Schunck, R. Angus Smith, and Rev. W. Gaskell.
" 18, 1871	J. P. Joule, E. Schunck, R. Angus Smith, and Rev. W. Gaskell.
" 30, 1872	E. W. Binney, E. Schunck, R. Angus Smith, and Rev. W. Gaskell.
" 29, 1873	E. W. Binney, E. Schunck, R. Angus Smith, and Rev. W. Gaskell.
" 21, 1874	J. P. Joule, E. W. Binney, R. Angus Smith, and Rev. W. Gaskell.

April 20, 1875	J. P. Joule, E. W. Binney, R. Angus Smith, and Rev. W. Gaskell.
" 18, 1876	E. Schunck, J. P. Joule, R. Angus Smith, and H. E. Roscoe.
" 17, 1877	E. Schunck, J. P. Joule, R. Angus Smith, and H. E. Roscoe.
" 30, 1878	E. W. Binney, E. Schunck, R. Angus Smith, and H. E. Roscoe.
" 29, 1879	E. Schunck, E. W. Binney, H. E. Roscoe, and R. Angus Smith.
" 20, 1880	J. P. Joule, E. Schunck, R. Angus Smith, and H. E. Roscoe.

SECRETARIES ELECTED.

Feb. 28, 1781	Mr. Thomas Henry, F.R.S., Mr. George Bew.
April 24, 1782	Mr. Thomas Henry, F.R.S., Mr. George Bew.
" 30, 1783	Mr. Thomas Henry, Mr. George Bew.
" 28, 1784	Mr. Thomas Henry, Mr. George Bew.
" 25, 1785	The Rev. Dr. Barnes, Mr. Thomas Henry, F.R.S.
" 26, 1786	Dr. Barnes and Mr. Henry.
" 25, 1787	Thomas Henry and John Ferriar.
" 25, 1788	Mr. John Wynne and John Ferriar.
" 24, 1789	John Ferriar, M.D., and Mr. James Watt.
" 30, 1790	Dr. Ferriar and Mr. Watt.
" 29, 1791	John Ferriar and Mr. William Simmons.
May 4, 1792	Mr. W. Simmons and Thomas Henry, junior.
April 26, 1793	Mr. Harvey and S. A. Bardsley, Esq.
" 25, 1794	S. A. Bardsley and Edward Holme,
" 24, 1795	Dr. Bardsley and Dr. Holme.
" 29, 1796	Dr. Bardsley and Dr. Holme.
" 28, 1797	Dr. Holme and Mr. William Henry.
" 20, 1798	Dr. Hull and Mr. Henry.
" 26, 1799	Dr. Hull and Mr. William Henry.
May 2, 1800	Dr. Hull and Mr. Dalton.
" 1, 1801	Dr. Hull and Mr. Dalton.
April 30, 1802	Dr. Hull and Mr. Dalton.
" 29, 1803	Dr. Hull and Mr. Dalton.

April 27, 1804 . .	Dr. Hull and Mr. Dalton.
" 26, 1805 . .	Dr. Hull and Mr. Dalton.
" 25, 1806 . .	Dr. Hull and Mr. Dalton.
May 9, 1807 . .	Mr. J. Dalton and Rev. William Johns.
April 29, 1808 . .	Mr. Dalton and Mr. Johns.
" 28, 1809 . .	Mr. Johns and W. Winstanley.
" 27, 1810 . .	Mr. Johns and J. A. Ransome.
" 26, 1811 . .	Mr. Ransome and Mr. Johns.
" 24, 1812 . .	Mr. Ransome and Mr. Johns.
" 30, 1813 . .	Mr. Ransome and Mr. Johns.
" 29, 1814 . .	Mr. Ransome and Mr. Johns.
" 28, 1815 . .	Mr. Ransome and Mr. Johns.
" 26, 1816 . .	Mr. Ransome and Mr. Johns.
" 25, 1817 . .	Mr. Ransome and T. H. Robinson.
" 24, 1818 . .	Mr. Ransome and T. H. Robinson.
" 30, 1819 . .	Mr. Ransome and Mr. Robinson.
" 28, 1820 . .	Mr. Ransome and T. H. Robinson.
" 19, 1821 . .	Mr. T. H. Robinson and Mr. P. Clare.
" 26, 1822 . .	Peter Clare and Rev. J. J. Tayler.
" 18, 1823 . .	Peter Clare and Rev. J. J. Tayler.
" 30, 1824 . .	Peter Clare and J. J. Tayler.
" 29, 1825 . .	Peter Clare and J. J. Tayler.
" 21, 1826 . .	Peter Clare and J. J. Tayler.
" 20, 1827 . .	Peter Clare and J. J. Tayler.
" 18, 1828 . .	Peter Clare and J. J. Tayler.
" 16, 1829 . .	Peter Clare and J. J. Tayler.
" 30, 1830 . .	Peter Clare and J. J. Tayler.
" 29, 1831 . .	Peter Clare and J. J. Tayler.
" 27, 1832 . .	Peter Clare and J. J. Tayler.
" 26, 1833 . .	Peter Clare and J. J. Tayler.
" 18, 1834 . .	Peter Clare and J. J. Tayler.
" 24, 1835 . .	Peter Clare and J. J. Tayler.
" 29, 1836 . .	Peter Clare and J. J. Tayler.
Aug. 11, 1837 . .	Peter Clare and J. J. Tayler.
April 17, 1838 . .	Peter Clare and J. A. Ransome.
" 30, 1839 . .	Peter Clare and J. A. Ransome.
" 28, 1840 . .	Peter Clare and J. A. Ransome.
" 20, 1841 . .	Peter Clare and J. A. Ransome.

April 19, 1842	Peter Clare and J. A. Ransome.
„ 18, 1843	J. A. Ransome and John Davies.
„ 30, 1844	John Davies and J. Holt Stanway.
„ 29, 1845	John Davies and J. Holt Stanway.
„ 21, 1846	John Davies and J. P. Joule.
„ 20, 1847	John Davies and J. P. Joule.
„ 18, 1848	J. P. Joule and E. W. Binney.
„ 17, 1849	J. P. Joule and E. W. Binney.
„ 30, 1850	J. P. Joule and E. W. Binney.
„ 29, 1851	E. W. Binney and Rev. H. H. Jones.
„ 20, 1852	Rev. H. H. Jones and Robert Angus
„ 19, 1853	Smith.
„ 18, 1854	Rev. H. H. Jones and Robert Angus Smith.
„ 17, 1855	Dr. R. A. Smith and Rev. H. H. Jones.
„ 29, 1856	Dr. R. A. Smith and Edward Schunck.
„ 21, 1857	E. Schunck and R. C. Christie, M.A.
„ 20, 1858	E. Schunck and R. C. Christie, M.A.
„ 19, 1859	E. Schunck and R. C. Christie, M.A.
„ 17, 1860	E. Schunck and Henry E. Roscoe.
„ 30, 1861	H. E. Roscoe and J. Baxendell.
„ 29, 1862	H. E. Roscoe and J. Baxendell.
„ 21, 1863	H. E. Roscoe and J. Baxendall.
„ 19, 1864	H. E. Roscoe and J. Baxendell.
„ 25, 1865	H. E. Roscoe and J. Baxendell.
„ 17, 1866	H. E. Roscoe and J. Baxendell.
„ 30, 1867	H. E. Roscoe and J. Baxendell.
„ 28. 1868	H. E. Roscoe and J. Baxendell.
„ 20, 1869	H. E. Roscoe and J. Baxendell.
„ 19, 1870	H. E. Roscoe and J. Baxendell.
„ 18, 1871	H. E. Roscoe and J. Baxendell.
„ 30, 1872	H. E. Roscoe and J. Baxendell.
„ 29, 1873	H. E. Roscoe and J. Baxendell.
„ 21, 1874	J. Baxendell and O. Reynolds.
„ 20, 1875	J. Baxendell and O. Reynolds.
„ 18, 1876	J. Baxendell and O. Reynolds.
„ 17, 1877	J. Baxendell and O. Reynolds.
„ 30, 1878	J. Baxendell and O. Reynolds.

April 29, 1879 . .	J. Baxendell and O. Reynolds.
„ 20, 1880 . .	J. Baxendell and O. Reynolds.

TREASURERS ELECTED.

April 30, 1783 . .	Mr. Isaac Mosse.
„ 28, 1784 . .	„
„ 27, 1785 . .	„
„ 26, 1786 . .	„
„ 25, 1787 . .	„
„ 25, 1788 . .	„
„ 24, 1789 . .	„
„ 30, 1790 . .	Mr. Maxwell.
„ 29, 1791 . .	B. A. Heywood, Esq.
May 4, 1792 . .	„
April 26, 1793 . .	„
„ 25, 1794 . .	„
„ 24, 1795 . .	„
„ 29, 1796 . .	Nathaniel Heywood.
„ 28, 1797 . .	„
„ 20, 1798 . .	„
„ 26, 1799 . .	„
May 2, 1800 . .	„
„ 1, 1801 . .	„
April 30, 1802 . .	„
„ 29, 1803 . .	„
„ 27, 1804 . .	„
„ 26, 1805 . .	„
„ 25, 1806 . .	„
May 9, 1807 . .	„
April 29, 1808 . .	„
„ 28, 1809 . .	„
„ 27, 1810 . .	„
„ 26, 1811 . .	„
„ 24, 1812 . .	„
„ 30, 1813 . .	„
„ 29, 1814 . .	„

April 28, 1815 . .	Benjamin Heywood, jun.
,, 26, 1816 . .	,,
,, 25, 1817 . .	,,
,, 24, 1818 . .	,,
,, 30, 1819 . .	,,
,, 28, 1820 . .	,,
,, 19, 1821 . .	,,
,, 26, 1822 . .	,,
,, 18, 1823 . .	,,
,, 30, 1824 . .	,,
,, 29, 1825 . .	,,
,, 21, 1826 . .	,,
,, 20, 1827 . .	,,
,, 18, 1828 . .	,,
,, 16, 1829 . .	,,
,, 30, 1830 . .	,,
,, 29, 1831 . .	,,
,, 27, 1832 . .	,,
,, 26, 1833 . .	,,
,, 18, 1834 . .	,,
,, 24, 1835 . .	,,
,, 29, 1836 . .	,,
Aug. 11, 1837 . .	,,
April 17, 1838 . .	,,
,, 30, 1839 . .	Sir Benjamin Heywood, Bart.
,, 28, 1840 . .	,,
,, 20, 1841 . .	,,
,, 19, 1842 . .	,,
,, 18, 1843 . .	,,
,, 30, 1844 . .	,,
,, 29, 1845 . .	,,
,, 21, 1846 . .	,,
,, 20, 1847 . .	,,
,, 18, 1848 . .	,,
,, 17, 1849 . .	,,
,, 30, 1850 . .	,,
,, 29, 1851 . .	George Wareing Ormerod, M.A.

April 20, 1852	. .	George Wareing Ormerod, M.A.
„ 19, 1853	. .	„
„ 18, 1854	. .	„
„ 17, 1855	. .	Henry Mere Ormerod.
„ 29, 1856	. .	„
„ 21, 1857	. .	„
„ 20, 1858	. .	„
„ 19, 1859	. .	„
„ 17, 1860	. .	„
„ 30, 1861	. .	„
„ 29, 1862	. .	„
„ 21, 1863	. .	Robert Worthington.
„ 19, 1864	. .	„
„ 25, 1865	. .	„
„ 17, 1866	. .	„
„ 30, 1867	. .	„
„ 28, 1868	. .	„
„ 20, 1869	. .	Thomas Carrick.
„ 19, 1870	. .	„
„ 18, 1871	. .	„
„ 30, 1872	. .	„
„ 29, 1873	. .	„
„ 21, 1874	. .	Samuel Broughton
„ 20, 1875	. .	„
„ 18, 1876	. .	„
„ 17, 1877	. .	Charles Bailey.
„ 30, 1878	. .	„
„ 29, 1879	. .	„
„ 20, 1880	. .	„

LIBRARIANS ELECTED.

April 28, 1784	. .	Mr. Thomas Robinson.
„ 25, 1785	. .	„
„ 26, 1786	. .	„
„ 25, 1787	. .	John Mitchell.
„ 25, 1788	. .	John Mitchell, M.D.

April 24, 1789 . .	John Mitchell, M.D.
" 30, 1790 . .	"
" 29, 1791 . .	"
May 4, 1792 . .	"
April 26, 1793 . .	Mr. Simmons.
" 25, 1794 . .	Mr. Henry.
" 24, 1795 . .	Rev. Joshua Brookes.
" 29, 1796 . .	Mr. William Henry.
" 28, 1797 . .	Mr. Joseph Collier.
" 20, 1798 . .	"
" 26, 1799 . .	"
May 2, 1800 . .	"
" 1, 1801 . .	"
April 30, 1802 . .	Mr. R. Robinson.
" 29, 1803 . .	"
" 27, 1804 . .	Mr. Hutchinson.
" 26, 1805 . .	"
" 25, 1806 . .	"
May 9, 1807 . .	"
April 29, 1808 . .	Dr. Winstanley.
" 28, 1809 . .	Mr. Ransome.
" 27, 1810 . .	William Cririe.
" 26, 1811 . .	"
" 24, 1812 . .	"
" 30, 1813 . .	T. H. Robinson.
" 29, 1814 . .	"
" 28, 1815 . .	"
" 26, 1816 . .	"
" 25, 1817 . .	Dr. Carbutt.
" 24, 1818 . .	"
" 30, 1819 . .	Mr. John Davies.
" 28, 1820 . .	"
" 19, 1821 . .	"
" 26, 1822 . .	"
" 18, 1823 . .	"
" 30, 1824 . .	"
" 29, 1825 . .	"
" 21, 1826 . .	"

April 20, 1827 . .	Mr. John Davies.
,, 18, 1828 . .	William Robert Whatton.
,, 16, 1829 . .	,,
,, 30, 1830 . .	,,
,, 29, 1831 . .	,,
,, 27, 1832 . .	,,
,, 26, 1833 . .	,,
,, 18, 1834 . .	,,
,, 24, 1835 . .	,,
,, 29, 1836 . .	Eaton Hodgkinson.
Aug. 11, 1837 . .	,,
April 17, 1838 . .	,,
,, 30, 1839 . .	,,
,, 28, 1840 . .	,,
,, 20, 1841 . .	,,
,, 19, 1842 . .	,,
,, 18, 1843 . .	,,
,, 30, 1844 . .	,,
Oct. 29, 1844 . .	Mr. J. P. Joule.
April 29, 1845 . .	,,
,, 21, 1846 . .	Francis Eugene Vembergue.
,, 20, 1847 . .	,,
,, 18, 1848 . .	,,
,, 17, 1849 . .	,,
,, 30, 1850 . .	Edward W. Makinson.
,, 29, 1851 . .	,,
,, 20, 1852 . .	,,
,, 19, 1853 . .	Mr. John Young Caw.
,, 18, 1854 . .	,,
,, 17, 1855 . .	,,
,, 29, 1856 . .	Mr. C. F. Ekman.
,, 21, 1857 . .	,,
,, 20, 1858 . .	,,
,, 19, 1859 . .	,,
,, 17, 1860 . .	,,
,, 30, 1861 . .	,,
,, 29, 1862 . .	,,

April 21, 1863 .	. Mr. C. F. Ekman.
„ 19, 1864 .	. „
„ 25, 1865 .	. Thomas Windsor.
„ 17, 1866 .	. Charles Bailey.
„ 30, 1867 .	. „
„ 28, 1868 .	. „
„ 20, 1869 .	. „
„ 19, 1870 .	. „
„ 18, 1871 .	. „
„ 30, 1872 .	. „
„ 29, 1873 .	. „
„ 21, 1874 .	. Francis Nicholson, F.Z.S.
„ 20, 1875 .	. „
„ 18, 1876 .	. „
„ 17, 1877 .	. „
„ 30, 1878 .	. „
„ 29, 1879 .	. „
„ 20, 1880 .	. „

ORDINARY MEMBERS.

Members from the beginning in 1781 *to April* 1881. *Those with a * were members at the latter date.*

DATE OF ELECTION.		
January	27, 1857 .	. Acton, Henry Morell.
„	11, 1881 .	. * Adamson, Daniel.
April	29, 1856 .	. Adshead, Joseph.
December	12, 1781 .	. Aikin, John.
January	21, 1805 .	. Ainsworth, James.
April	30, 1839 .	. Ainsworth, Ralph F.
January	26, 1847 .	. Albert, Dominic Fric.
„	22, 1861 .	. *Alcock, Thomas.
November	15, 1870 .	. Aldis, Thomas S.
January	24, 1854 .	. Allan, James.
October	31, 1817 .	. Allen, Joseph.
January	7, 1873 .	. *Allmann, Julius.
April	19, 1821 .	. Andrew, Robert.

DATE OF ELECTION.		
December	13, 1870 .	. *Angell, John.
January	22, 1861 .	. *Anson, Ven. Archdeacon George Henry Greville.
April	17, 1849 .	. Ash, William Henry.
October	19, 1824 .	. Ashton, Thomas.
August	11, 1837 .	. *Ashton, Thomas, jun.
February	18, 1862 .	. Ashworth, Henry.
December	26, 1781 .	. Ashworth, James.
October	31, 1871 .	. Ashworth, John.
November	4, 1796 .	. Ashworth, Robert.
,,	2, 1792 .	. Atkinson, John.
January	27, 1846 .	. Atkinson, John.
,,	14, 1784 .	. Atkinson, Joseph.
,,	8, 1813 .	. Atkinson, Thomas.
,,	13, 1804 .	. Atkinson, William.
November	3, 1874 .	. *Axon, William, E. A.
,,	14, 1865 .	. *Bailey, Charles.
	1781 .	. Baker, Joseph.
April	26, 1822 .	. Baker, Richard George.
October	19, 1821 .	. Bamber, Richard Parr.
April	30, 1824 .	. Bannerman, Henry.
January	23, 1824 .	. *Barbour, Robert.
December	10, 1790 .	. Bardsley, Dr.
November	14, 1865 .	. Barker, Thomas.
October	29, 1844 .	. Barlow, William.
January	27, 1852 .	. Barlow, N. B.
December	12, 1781 .	. Barnes, Rev. Thomas.
January	24, 1834 .	. Barrat, James, jun.
April	19, 1842 .	. Barratt, Joseph.
November	28, 1876 .	. *Barratt, Walter E.
February	15, 1786 .	. Barrit, Thomas.
November	1, 1797 .	. Barritt, Charles.
January	22, 1819 .	. Barrow, Peter.
November	12, 1867 .	. *Barrow, John.
May	23, 1781 .	. Barrow, John.
January	10, 1806 .	. Barton, Horatio.
,,	24, 1834 .	. Barton, Samuel.

DATE OF ELECTION.			
April	17, 1849 .	.	Bassnett, Rev. Richard.
January	21, 1840 .	.	Bateman, John Frederick.
"	26, 1858 .	.	*Baxendell, Joseph.
December	12, 1781 .	.	Bayley, Thomas Butterworth.
January	23, 1801 .	.	Bayley, W.
October	16, 1812 .	.	Bayliff, William.
January	26, 1847 .	.	*Bazley, Thomas.
April	19, 1853 .	.	Bazley, Thomas Sebastian.
January	26, 1827 .	.	Beard, Rev. J. R.
April	16, 1867 .	.	Beasley, Henry Charles.
November	27, 1877 .	.	*Becker, Wilfred.
"	26, 1878 .	.	*Bedson, Peter P.
April	30, 1839 .	.	Beeston, William Calvert.
January	25, 1848 .	.	Bell, Charles.
December	12, 1781 .	.	Bell, George, M.D.
November	15, 1870 .	.	Bell, Joseph Carter.
January	26, 1847 .	.	*Bell, William.
April	21, 1857 .	.	Bellhouse, Edward T.
"	11, 1781 .	.	Bennet, Rev. John.
November	15, 1870 .	.	*Bennion, John A.
January	26, 1858 .	.	*Benson, Davis.
April	26, 1799 .	.	Bentley, Gartside.
"	16, 1829 .	.	Bentley, John.
March	22, 1786 .	.	Bentley, Michael.
April	30, 1830 .	.	Bentley, Rev. Thomas Rothwell.
January	26, 1820 .	.	Berry, George Frederick.
"	23, 1844 .	.	Bevan, James.
December	12, 1781 .	.	Bew, George.
January	25, 1833 .	.	Bewer, Frederick.
"	24, 1854 .	.	Beyer, Charles.
December	15, 1868 .	.	*Bickham, Spencer H., jun.
February	5, 1783 .	.	Bill, John.
January	25, 1842 .	.	*Binney, Edward William.
"	26, 1838 .	.	Binyon, Alfred.
"	16, 1782 .	.	Birch, John.
November	15, 1870 .	.	*Bird, John Durham.
January	24, 1823 .	.	Birley, Richard.

DATE OF ELECTION.		
April	18, 1834 .	. Birley, Richard.
„	18, 1876 .	. *Birley, Thomas Hornby.
„	30, 1839 .	. Black, James.
January	26, 1821 .	. *Blackwall, John.
„	25, 1842 .	. Blake, George.
April	29, 1796 .	. Bontefleur, Mr.
October	29, 1824 .	. Boothman, Thomas.
January	27, 1837 .	. Boothman, Thomas, sen.
„	22, 1861 .	. *Bottomley, James.
„	23, 1855 .	. Bowman, Eddowes.
October	29, 1839 .	. *Bowman, Henry.
April	17, 1838 .	. Bowman, John Eddowes.
January	25, 1842 .	. Bowman, John.
November	16, 1875 .	. *Boyd, John.
April	18, 1834 .	. Brackenbury, James Blackledge.
„	20, 1792 .	. Bradshaw, John.
	.	. Brandt, C. F.
November	4, 1873 .	. Bridson, Joseph Ridgway.
April	26, 1811 .	. Brigham, William, jun.
January	25, 1859 .	. Brittain, Thomas.
April	21, 1857 .	. Brock, John.
„	17, 1855 .	. *Brockbank, William.
„	2, 1861 .	. *Brogden, Henry.
„	30, 1824 .	. Brooke, Edward.
„	25, 1794 .	. Brookes, Rev. Joshua.
January	24, 1823 .	. Brooks, Samuel Reeves.
„	23, 1844 .	. *Brooks, William Cunliffe, M.P.
„	24, 1860 .	. *Brothers, Alfred.
April	17, 1855 .	. Broughton, Frederick.
December	10, 1867 .	. Broughton, Samuel.
January	27, 1846 .	. *Browne, Henry.
„	21, 1840 .	. Buck, George Watson.
„	22, 1861 .	. Buckley, Rev. Thomas.
„	27, 1846 .	. Burd, John, jun.
November	12, 1872 .	. *Burghardt, Charles.
April	19, 1853 .	. Bury, Henry.
November	29, 1864 .	. Buxton, E. C.

DATE OF ELECTION.		
January	24, 1854 .	. Callender, William, jun.
"	26, 1847 .	. Calvert, Fred. Crace.
"	23, 1835 .	. Campbell, Henry Cadogan.
April	21, 1815 .	. Carbutt, Dr.
December	15, 1874 .	. *Carrick, Joseph.
January	25, 1859 .	. Carrick, Thomas.
"	26, 1858 .	. Casartelli, Joseph.
April	20, 1841 .	. Caw, John Young.
January	23, 1855 .	. Cawley, Charles E.
April	20, 1852 .	. Chadwick, David.
January	25, 1842 .	. *Charlewood, Henry.
April	30, 1839 .	. Chaytor, Gustavus.
December	16, 1791 .	. Chesshyre, Edward.
April	24, 1812 .	. Chippendall, John.
October	19, 1847 .	. Christie, David.
April	18, 1854 .	. Christie, Prof. Richard Copley.
January	23, 1824 .	. *Christie, Robert.
April	21, 1857 .	. Churchhill, George Cheetham.
"	27, 1810 .	. Clare, Peter.
February	18, 1862 .	. Clark, Thomas.
September	29, 1784 .	. Clarke, Henry.
April	20, 1841 .	. *Clay, Charles.
"	24, 1801 .	. Clayton, Edward.
"	24, 1801 .	. Clayton, John.
February	6, 1782 .	. Clegge, Ashworth.
April	29, 1851 .	. Cleminshaw, Charles.
"	19, 1853 .	. Clift, Samuel.
January	22, 1861 .	. Clifton, Prof. Robert B.
October	31, 1817 .	. Close, Thomas.
January	27, 1797 .	. Close, John.
"	9, 1807 .	. Clowes, William.
April	30, 1824 .	. Coates, Richard.
"	29, 1836 .	. Cobden, Richard.
"	20, 1792 .	. Collier, Joseph.
October	29, 1850 .	. Colston, Rev. John.
January	23, 1824 .	. Connell, Edward.
April	17, 1838 .	. Cooke, Thomas, jun.

DATE OF ELECTION.	
December 21, 1785 .	. Cooper, Thomas.
January 25, 1853 .	. Corbett, Edward.
October 20, 1837 .	. Cottam, Samuel E.
January 25, 1853 .	. *Cottam, Samuel.
" 25, 1859 .	. *Coward, Edward.
November 12, 1861 .	. *Coward, Thomas.
April 11, 1781 .	. Cowling, John.
January 12, 1810 .	. Cririe, W.
April 29, 1851 .	. *Crompton, Samuel.
January 22, 1839 .	. Crossley, John.
" 25, 1848 .	. *Crowther, Joseph S.
" 24, 1854 .	. Culley, Richard S.
November 1, 1833 .	. Cumber, Charles.
April 8, 1876 .	. *Cunliffe, Robert Ellis.
" 2, 1861 .	. *Cunningham, William Alexander.
January 22, 1861 .	. Curtis, John.
April 18, 1843 .	. Curtis, Matthew.
October 29, 1824 .	. Dadley, Henry.
February 7, 1854 .	. *Dale, John.
November 28, 1871 .	. *Dale, Richard Samuel.
1794 .	. Dalton, John.
April 19, 1842 .	. *Dancer, John Benjamin.
February 10, 1863 .	. Darbishire, G. Stanley.
January 25, 1822 .	. Darbishire, Samuel Dukinfield.
April 19, 1853 .	. *Darbishire, Robert Dukinfield.
January 21, 1862 .	. Darbishire, William Arthur.
June 13, 1781 .	. Darby, Robert.
April 26, 1811 .	. Darbyshire, James, jun.
January 24, 1854 .	. Davies, David Reynolds.
October 18, 1816 .	. Davies, John.
January 21, 1851 .	. Davies, Rev. John.
" 10, 1806 .	. Davis, Mr.
November 26, 1878 .	. *Davis, Joseph.
" 2, 1869 .	. *Dawkins, William Boyd.
April 25, 1794 .	. Dawson, John Charlton.
November 15, 1870 .	. Deacon, Henry.
" 15, 1842 .	. Dean, James Joseph.

DATE OF ELECTION.	
December 10, 1861 .	. *Deane, William K.
January 8, 1790 .	. Delap, Robert.
November 1, 1793 .	. Dennet, Mr.
April 24, 1818 .	. Dennison, Joseph.
March 18, 1879 .	. Dent, Hastings Charles.
January 24, 1794 .	. Devy, John Smith.
" 10, 1806 .	. Dewar, Dr.
" 23, 1855 .	. Dickinson, William L.
" 27, 1852 .	. Dickson, Thomas.
December 12, 1781 .	. Dinwiddie, Mr.
January 10, 1812 .	. Ditchfield, Mr.
" 10, 1812 .	. Dockray, Benjamin.
" 25, 1859 .	. Dorrington, James.
April 24, 1801 .	. Douglas, John.
January 27, 1832 .	. Douglas, John.
December 12, 1781 .	. Drinkwater, John.
November 15, 1786 .	. Drinkwater, Peter.
January 30, 1782 .	. Duckworth, George.
" 24, 1817 .	. Duckworth, William.
November 1, 1833 .	. Dugard, Rev. George.
March 22, 1864 .	. Duval, C. A.
April 24, 1818 .	. Dyer, Joseph C.
" 30, 1850 .	. Dyer, Frederick Nathaniel.
January 25, 1859 .	. Eadson, Richard.
December 12, 1761 .	. Eason, Alexander.
April 5, 1864 .	. Eastham, John.
" 28, 1820 .	. Edwards, John.
May 4, 1841 .	. Egerton, Lord Francis.
April 29, 1856 .	. Ekman, Charles Frederick.
January 24, 1854 .	. Ellis, Charles.
February 1, 1799 .	. Entwistle, Henry.
April 28, 1840 .	. Ethelston, Edwards.
" 28, 1840 .	. Evans, Richard.
January 25, 1833 .	. Everett, James.
" 26, 1798 .	. Ewart, Peter.
" 25, 1853 .	. Fairbairn, George.
April 30, 1850 .	. Fairbairn, Thomas.

DATE OF ELECTION.		
October	29, 1824 .	. Fairbairn, William.
”	30, 1849 .	. Fairbairn, William Andrew.
March	5, 1878 .	. Fairgrieve, Andrew.
April	29, 1825 .	. Fawdington, Thomas.
January	25, 1848 .	. Ferguson, Pearson B.
April	12, 1786 .	. Ferriar, Dr.
January	26, 1847 .	. Ferris, Octavius Allen.
”	27, 1832 .	. Fincham, Frederick.
October	21, 1851 .	. Finlay, Prof. Robert.
January	22, 1861 .	. Fischer, William Henry.
”	27, 1846 .	. Flaching, Edward.
”	27, 1846 .	. Flaching, James.
”	25, 1842 .	. Fleming, David Gibson.
April	30, 1824 .	. Fleming, Thomas.
”	18, 1828 .	. Fleming, William.
October	31, 1817 .	. Flint, Richard.
April	29, 1856 .	. Forrest, Henry Robert.
”	21, 1857 .	. Foster, Thomas B.
January	23, 1855 .	. Fothergill, Benjamin.
March	28, 1781 .	. Foxley, Rev. John.
December	1, 1784 .	. Foxley, Robinson.
April	17, 1860 .	. Francis, John.
”	29, 1851 .	. Frankland, Prof. Edward.
January	22, 1839 .	. Fraser, James William.
April	16, 1872 .	. Freeston, Rev. Joseph.
January	24, 1854 .	. Fryer, Alfred.
November	18, 1873 .	. Gamgee, Arthur.
February	6, 1877 .	. Garnett, William.
January	23, 1824 .	. *Garnett, William.
”	11, 1811 .	. Garforth, James Benjamin.
”	21, 1840 .	. *Gaskell, Rev. William.
April	29, 1836 .	. Giles, Samuel.
”	30, 1861 .	. Gladstone, Murray.
”	17, 1860 .	. Glover, George.
January	22, 1839 .	. Goodlad, William.
”	25, 1842 .	. Goodman, John.
April	20, 1847 .	. Gould, John.

DATE OF ELECTION.		
April	30, 1802 .	. Grant, Rev. Johnson.
January	26, 1821 .	. Greaves, Robert.
"	27, 1852 .	. Greaves, Robert.
October	31, 1794 .	. Green, Edward.
January	12, 1816 .	. Green, B. H.
"	24, 1823 .	. Green, Samuel.
"	24, 1817 .	. Greenway, Charles.
"	24, 1817 .	. Greg, Robert H.
October	30, 1849 .	. Greg, Robert Philips.
February	19, 1790 .	. Greg, Samuel.
April	26, 1833 .	. Greg, William Rathbone.
January	25, 1848 .	. Gregan, John Edgar.
November	26, 1790 .	. Gregory, Dr.
January	25, 1800 .	. Gibson, Mr.
"	21, 1831 .	. Glover, Thomas.
August	11, 1837 .	. Graham, John.
October	29, 1830 .	. Greaves, John.
January	23, 1818 .	. Grime, William Brireton.
November	3, 1874 .	. *Grimshaw, Harry.
April	21, 1863 .	. Grindon, Leopold Hartley.
"	26, 1799 .	. Grindrod, Rev. William.
"	26, 1811 .	. Grundy, Rev. John.
January	25, 1848 .	. Grundy, John C.
April	18, 1828 .	. Guest, William.
February	9, 1875 .	. *Gwyther, R. F.
May	23, 1781 .	. Haddon, Rev. Peter.
November	20, 1782 .	. Hadfield, J.
April	20, 1827 .	. Hadfield, William.
January	22, 1819 .	. Halkyand, John.
December	12, 1781 .	. Hall, Edward.
"	12, 1781 .	. Hall, Richard.
"	12, 1781 .	. Hall, Richard Edward.
April	18, 1781 .	. Hall, Rev. Samuel.
"	29, 1845 .	. Halley, Robert.
November	26, 1790 .	. Hamilton, Gawin.
"	28, 1865 .	. Hampson, Francis.
January	23, 1844 .	. Hampson, Richard.

DATE OF ELECTION.		
October	1, 1878 .	. Hannay, James Ballantine.
April	25, 1794 .	. Hanson, Joseph.
January	25, 1800 .	. Hanson, Edward.
„	10, 1812 .	. Hardie, Dr.
„	27, 1837 .	. Hardy, Dr. Robert.
April	30, 1878 .	. *Harland, William Dugdale.
October	30, 1849 .	. Harley, Robert.
February	9, 1864 .	. Harris, George.
December	5, 1781 .	. Harrison, Rev. Ralph.
October	19, 1858 .	. Harrison, William Phillip.
„	3, 1871 .	. Harrison, Thomas.
April	28, 1797 .	. Harrison, William.
November	4, 1862 .	. *Hart, Peter.
April	13, 1823 .	. Hartley, Jesse.
November	26, 1790 .	. Harvey, Samuel.
January	25, 1793 .	. Hatfield, Thomas.
„	22, 1839 .	. *Hawkshaw, Sir John.
November	20, 1789 .	. Hawkes, Rev. Mr.
April	26, 1793 .	. Hay, William.
January	25, 1793 .	. Hay, Charles.
December	16, 1873 .	. *Heelis, James.
April	19, 1859 .	. Heelis, Thomas.
November	15, 1842 .	. Henfrey, Charles.
January	10, 1806 .	. Hennel, James.
October	31, 1828 .	. *Henry, William Charles.
December	12, 1781 .	. Henry, Thomas.
April	29, 1796 .	. Henry, William.
November	1, 1864 .	. Heppel, George.
„	17, 1868 .	. *Herford, Rev. Brooke.
January	24, 1854 .	. Hetherington, John.
April	20, 1827 .	. Hewes, Thomas Check.
„	30, 1861 .	. Heys, William Henry.
February	6, 1789 .	. Heywood, Benjamin.
January	14, 1815 .	. Heywood, Benjamin, jun.
April	2, 1861 .	. Heywood, George Robert.
„	26, 1833 .	. *Heywood, James.
March	22, 1864 .	. *Heywood, Oliver.

DATE OF ELECTION.		
April	26, 1822 .	. Heywood, Richard.
January	9, 1807 .	. Hibbert, Robert.
November	24, 1784 .	. Hibbert, Samuel.
April	29, 1851 .	. *Higgin, James.
,,	29, 1845 .	. Higgins, James.
October	31, 1848 .	. Higson, Peter.
January	22, 1839 .	. Hobson, John.
April	2, 1861 .	. Hobson, John Thomas.
January	21, 1820 .	. Hodgkinson, Eaton.
April	24, 1818 .	. Hodgson, Isaac.
February	15, 1786 .	. Hodson, William.
,,	23, 1855 .	. *Holden, Isaac.
January	24, 1854 .	. Holcroft, George.
,,	27, 1846 .	. *Holden, James Platt.
October	29, 1824 .	. Hole, George.
April	20, 1847 .	. Holland, Phillip Henry.
January	21, 1805 .	. Holland, Thomas.
October	31, 1823 .	. Holland, Rev. Thomas Crompton.
April	25, 1794 .	. Holme, Dr.
,,	27, 1810 .	. Holt, D.
,,	26, 1793 .	. Holt, James.
,,	18, 1823 .	. Hopkins, Thomas.
March	21, 1871 .	. Hopkinson, John.
December	19, 1781 .	. Houghton, Rev. William.
January	23, 1824 .	. Houldsworth, Henry.
,,	25, 1842 .	. Howard, Richard Baron.
December	2, 1873 .	. *Howorth, Henry H.
November	4, 1791 .	. Hoyle, Thomas, jun.
February	7, 1854 .	. Hoyle, William Jennings.
April	30, 1824 .	. Hudson, George.
November	3, 1863 .	. *Hull, Edward.
January	27, 1797 .	. Hull, John.
,,	27, 1857 .	. *Hunt, Edward.
,,	25, 1859 .	. *Hurst, Henry Alexander.
,,	23, 1801 .	. Hutchinson, Mr.
April	26, 1811 .	. Hyde, John.
,,	18, 1823 .	. Hyde, John.

DATE OF ELECTION.	
November 13, 1866 .	. Jack, William.
October 31, 1794 .	. Jackson, Mr. (of Hunt's bank).
" 21, 1808 .	. Jackson, Charles.
January 27, 1857 .	. Jackson, George.
October 21, 1808 .	. Jackson, Roger.
April 25, 1788 .	. Jackson, Samuel.
March 22, 1864 .	. Jacob, Leslie.
January 27, 1837 .	. James, Faul Moon.
November 2, 1792 .	. James, Robert.
April 17, 1849 .	. Jamison, Alexander.
October 16, 1807 .	. Jarrold, Dr.
February 1, 1799 .	. Jenkinson, John.
January 24, 1823 .	. Jesse, John.
April 29, 1825 .	. Jesse, Joseph Albert.
November 13, 1866 .	. Jevons, William Stanley.
February 6, 1872 .	. *Jewsbury, Sidney.
October 7, 1805 .	. Johns, W.
April 30, 1850 .	. *Johnson, Richard.
January 22, 1856 .	. Johnson, William.
" 24, 1865 .	. Johnson, William B.
November 1, 1870 .	. *Johnson, William H.
" 26, 1878 .	. *Jones, Francis.
" 15, 1842 .	. Jones, Rev. Henry Longenville, M.A.
April 21, 1846 .	. Jones, Rev. Henry Halford.
October 19, 1821 .	. Jordan, Joseph.
April 18, 1848 .	. *Joule, Benjamin St. J. B.
January 25, 1842 .	. *Joule, James Prescot.
April 1, 1862 .	. Joy, David.
January 27, 1846 .	. Joynson, William.
October 30, 1818 .	. Kay, Alexander, jun.
January 23, 1829 .	. Kay, James Philip.
" 24, 1843 .	. Kay, Samuel, jun.
October 18, 1799 .	. Kay, Samuel.
January 24, 1817 .	. Kennedy, James.
April 29, 1803 .	. Kennedy, John.
January 27, 1852 .	. *Kennedy, John Lawson.

DATE OF ELECTION.			
April	18, 1823 .	.	Kennedy, Peter.
June	27, 1781 .	.	Kenyon, Rev. Robert.
January	24, 1854 .	.	Kershaw, James, jun.
May	16, 1781 .	.	Kershaw, Thomas.
January	11, 1811 .	.	Kinder, Henry.
November	26, 1867 .	.	Kipping, James Stanley.
October	19, 1821 .	.	Kirk, Benjamin.
November	29, 1786 .	.	Kirwan, Mr.
April	29, 1862 .	.	*Knowles, Andrew.
January	29, 1827 .	.	Lacey, Henry Charles.
October	21, 1791 .	.	Lamb, William.
April	27, 1810 .	.	Lander, Mr.
,,	26, 1822 .	.	Lane, Richard.
,,	30, 1830 .	.	Langton, William.
January	24, 1860 .	.	*Latham, Arthur George.
			Laurence, John.
December	15, 1863 .	.	*Leake, Robert, M.P.
January	1, 1790 .	.	Lee, George.
October	29, 1824 .	.	Lees, Aaron.
April	30, 1850 .	.	*Leese, Joseph.
,,	17, 1849 .	.	Leigh, John.
January	24, 1860 .	.	Leigh, John.
August	11, 1837 .	.	Leisler, John.
October	19, 1858 .	.	Lever, Charles.
,,	29, 1830 .	.	Lillie, James.
January	26, 1847 .	.	Lingard, John Rowson.
,,	22, 1856 .	.	Lingard, Thomas Taylor.
,,	27, 1826 .	.	Littler, Thomas.
October	3, 1871 .	.	Livesey, Thomas.
,,	3, 1781 .	.	Lloyd, George.
January	25, 1842 .	.	Lockett, John.
October	29, 1839 .	.	Lockett, Joseph.
April	30, 1830 .	.	Lomas, John.
January	21, 1840 .	.	Lomas, John, M.D.
,,	12, 1816 .	.	Lomas, William.
,,	27, 1852 .	.	Long, Isaac W.
,,	27, 1857 .	.	*Longridge, Robert Bentink.

DATE OF ELECTION.		
April	24, 1835 .	. Looney, Francis.
"	19, 1842 .	. Love, Benjamin.
"	19, 1870 .	. *Lowe, Charles.
January	24, 1854 .	. Lowe, George Cliffe.
December	12, 1871 .	. Lucas, Louis.
April	18, 1843 .	. Ludlow, Ebenezer.
"	30, 1850 .	. *Lund, Edward.
January	23, 1855 .	. Lund, George T.
"	25, 1859 .	. *Lynde, James G.
October	30, 1855 .	. Mabley, William Tudor.
"	5, 1875 .	. Mackereth, Thomas.
March	1, 1786 .	. Macnivan, Charles.
December	12, 1781 .	. Mainwaring, Peter.
October	20, 1846 .	. Makinson, Edward William.
January	24, 1823 .	. Makinson, William.
"	26, 1875 .	. *Mann, John Dixon.
"	22, 1839 .	. Mann, Robert.
"	27, 1846 .	. Mann, Robert Manners.
April	26, 1822 .	. Marriott, Christopher.
January	27, 1839 .	. Marriott, Thomas L.
April	27, 1832 .	. Marsden, William.
December	2, 1879 .	. *Marshall, Prof. A. M.
April	30, 1824 .	. Marshall, James E.
October	21, 1836 .	. Marshall, John.
November	4, 1873 .	. *Marshall, Rev. William.
April	16, 1829 .	. Marsland, Henry.
"	26, 1811 .	. Marsland, Samuel.
November	26, 1878 .	. Martin, Sidney Trice.
December	12, 1781 .	. Massey, James.
"	12, 1781 .	. Massey, John.
April	20, 1858 .	. Mather, Cohin.
December	11, 1789 .	. Mather, John.
November	1, 1864 .	. *Mather, William.
"	17, 1868 .	. *Mawson, John J.
"	13, 1789 .	. Maxwell, Thomas.
January	25, 1859 .	. *McClure, John William.
April	24, 1812 .	. McConnel, James.

DATE OF ELECTION.		
April	30, 1829 .	. McConnel, James.
„	20, 1827 .	. McConnel, Henry.
„	25, 1825 .	. McConnel, John.
„	17, 1838 .	. McConnel, William.
„	30, 1844 .	. McDougall, Alexander.
November	13, 1866 .	. *McDougall, Arthur.
January	24, 1823 .	. McFarlane, John.
„	27, 1797 .	. Meadowcroft, Richard.
April	30, 1830 .	. Meadows, James.
January	25, 1842 .	. Mellor, Thomas.
„	27, 1837 .	. Mellor, William.
March	18, 1873 .	. *Melvill, James Cosmo.
January	24, 1834 .	. Mertz, Philip.
March	8, 1864 .	. Micholls, Horatio.
December	30, 1879 .	. *Miller, John Bell.
November	20, 1782 .	. Mitchell, John.
October	31, 1794 .	. Mitchell, William.
January	25, 1859 .	. Molesworth, Rev. William Nassau.
October	16, 1801 .	. Monnsill, William.
January	14, 1815 .	. Moore, John.
November	27, 1877 .	. *Moore, Samuel.
October	29, 1830 .	. Mordacque, L. A. J.
„	29, 1861 .	. *Morgan, John Edward.
January	23, 1849 .	. Morris, Daniel.
November	1, 1870 .	. Morris, Walter.
January	25, 1859 .	. Mosley, George.
March	13, 1782 .	. Moss, Isaac.
October	31, 1794 .	. Moulson, R.
January	23, 1795 .	. Moxon, J.
„	11, 1811 .	. Moxon, Samuel.
March	22, 1864 .	. Mudd, James.
February	9, 1875 .	. Muir, M. M. Pattison.
January	14, 1815 .	. Murray, George.
„	14, 1815 .	. Mutrie, Robert.
May	16, 1781 .	. Nanfan, John.
December	30, 1791 .	. Nash, John.
January	23, 1795 .	. Nash, Thomas.

DATE OF ELECTION.		
January	26, 1838 .	. Nasmyth, George.
August	11, 1837 .	. Nasmyth, James.
January	25, 1848 .	. Neild, Alfred.
,,	24, 1854 .	. Neild, Arthur.
,,	27, 1852 .	. Nelson, James E.
February	7, 1854 .	. Neville, Thomas Henry.
January	24, 1860 .	. *Newall, Henry.
April	30, 1839 .	. Newbery, Henry.
,,	21, 1846 .	. Newman, Professor.
January	21, 1845 .	. Nicholls, John Ashton.
March	4, 1873 .	. *Nicholson, Francis.
April	28, 1820 .	. Nicholson, John.
December	14, 1785 .	. Nicholson, Matthew.
,,	16, 1791 .	. Nicholson, Thomas.
January	26, 1827 .	. Nicholson, William.
April	26, 1822 .	. Nield, William.
November	16, 1875 .	. *Nix, E. W.
October	21, 1836 .	. Noble, Daniel.
,,	31, 1854 .	. Noden, Edward Byron.
December	30, 1862 .	. *Ogden, Samuel.
,,	12, 1781 .	. Oldham, Joshua.
October	31, 1794 .	. Ollier, Thomas.
January	22, 1861 .	. *O'Neill, Charles.
,,	14, 1815 .	. Orme, Daniel.
December	5, 1781 .	. Orme, John.
April	30, 1844 .	. *Ormerod, Henry Mere.
January	26, 1841 .	. Ormerod, George Wareing.
November	4, 1791 .	. Owen, John.
April	30, 1839 .	. Owen, John.
February	5, 1850 .	. Owen, Joseph.
November	1, 1793 .	. Owen, Robert.
January	24, 1823 .	. Parkes, Josiah.
April	24, 1818 .	. Parkes, Samuel.
November	1, 1833 .	. Parkinson, Rev. Richard.
April	30, 1861 .	. *Parlane, James.
January	21, 1791 .	. Parr, Dr.
April	30, 1844 .	. Parr, George.

DATE OF ELECTION.		
January	22, 1861 .	. Parr, George, jun.
April	26, 1833 .	. Parry, John.
November	28, 1876 .	. *Parry, Thomas.
April	16, 1829 .	. Paton, Joseph.
October	21, 1825 .	. Patten, John.
March	20, 1866 .	. Patterson, John.
January	25, 1842 .	. Pauling, George E.
April	26, 1811 .	. Peel, Frederick.
"	20, 1841 .	. Peel, George.
"	26, 1799 .	. Peel, Robert, jun.
January	13, 1874 .	. *Pennington, Rooke.
December	12, 1781 .	. Percival, Thomas.
January	22, 1861 .	. Perring, John Shae.
April	13, 1785 .	. Philips, George.
December	12, 1781 .	. Philips, Robert.
October	29, 1830 .	. Phillips, Charles.
January	22, 1783 .	. Phillips, John.
December	26, 1781 .	. Phillips, J. Lee.
November	15, 1842 .	. Phillips, Montague.
"	10, 1784	Phillips, Thomas.
October	18, 1799 .	. Phillips, Waller.
November	29, 1870 .	. Piers, Sir Eustace F., Bart.
January	25, 1848 .	. Pincoffs, Peter.
"	22, 1861 .	. Pincoffs, Simon.
April	21, 1857 .	. Platt, William Wilkinson.
January	25, 1842 .	. Playfair, Lyon.
"	24, 1854 .	. *Pochin, Henry Davis.
April	17, 1860 .	. *Pocklington, Rev. Joseph N.
December	12, 1781 .	. Polier, Charles.
April	21, 1826 .	. Potter, Edmund.
		Potter, James.
January	23, 1824 .	. Potter, John.
November	3, 1784 .	. Powell, John
January	27, 1857 .	. Poynting, Thomas Elford.
February	1877 .	. Poynting, John Henry.
January	22, 1819 .	. Prentice, Archibald.
"	22, 1861 .	. Preston, Francis.

DATE OF ELECTION.		
January	22, 1839 .	. Price, David.
October	1, 1878 .	. *Priestley, John.
"	21, 1791 .	. Priestley, Joseph.
April	17, 1849 .	. Prince, the Right Reverend James, Bishop of Manchester.
January	23, 1824 .	. Pringal, Arthur.
April	29, 1831 .	. Pryce, John.
"	26, 1799 .	. Pye, Charles.
January	25, 1793 .	. Radcliffe, Rev. John.
"	22, 1836 .	. Radford, Joseph.
"	21, 1831 .	. Radford, Thomas.
"	22, 1861 .	. *Radford, William.
April	17, 1807 .	. Railton, John.
February	7, 1854 .	. *Ramsbottam, John.
April	11, 1781 .	. Rankin, Rev. William.
"	19, 1859 .	. *Ransome, Arthur.
January	13, 1809 .	. Ransome, J. A.
April	29, 1836 .	. Ransome, Joseph Atkinson.
January	26, 1847 .	. Ransome, Thomas.
April	30, 1839 .	. Ravenscroft, William R.
January	21, 1845 .	. Rawson, Robert.
"	23, 1824 .	. Reed, William.
		Reid, William.
November	16, 1869 .	. *Reynolds, Osborne.
March	4, 1791 .	. Richardson, Thomas.
January	25, 1859 .	. Rideout, William J.
April	26, 1811 .	. Robberds, Rev. John.
		Roberton, Captain William.
April	20, 1827 .	. Roberton, John.
March	23, 1880 .	. *Roberts, Lloyd.
April	18, 1823 .	. Roberts, Richard.
December	14, 1787 .	. Roberts, William.
January	24, 1860 .	. *Roberts, William.
December	27, 1864 .	. *Robinson, John.
February	1, 1799 .	. Robinson, Robert.
January	25, 1822 .	. *Robinson, Samuel.
October	31, 1781 .	. Robinson, Thomas.

DATE OF ELECTION.		
January	13, 1809 .	. Robinson, T. H.
April	25, 1788 .	. Robinson, William.
January	12, 1864 .	. Rogerson, John.
„	21, 1805 .	. Roget, Peter.
„	27, 1837 .	. Romlley, Henry.
„	26, 1858 .	. *Roscoe, Henry Enfield.
November	1, 1797 .	. Ross, Thomas.
December	14, 1869 .	. Routledge, Robert.
January	25, 1842 .	. Royle, Allen.
October	21, 1791 .	. Rupp, George.
November	1, 1793 .	. Rushforth, Richard.
January	23, 1844 .	. Rylands, Thomas Glazebrook.
April	18, 1848 .	. Salt, Samuel.
„	29, 1851 .	. *Sandeman, Prof. Archiblad.
January	12, 1816 .	. Sandford, Benjamin.
„	26, 1847 .	. Satterthwaite, Michael.
October	30, 1829 .	. Saulter, Henry.
„	20, 1815 .	. Saunderson, T. W. B.
April	29, 1831 .	. Scholes, Thomas Seddon.
December	13, 1870 .	. *Schorlemmer, Carl.
January	25, 1842 .	. *Schunck, Edward.
November	18, 1873 .	. *Schuster, Arthur.
April	7, 1863 .	. Schwabe, Edmund Salis.
„	20, 1847 .	. Schwabe, Sali.
February	7, 1854 .	. Scott, Prof. Alexander J.
April	30, 1824 .	. Serjeant, Edwin W.
January	23, 1855 .	. Sharp, Edmund Hamilton.
April	28, 1797 .	. Sharp, John.
October	29, 1824 .	. Sharp, John.
April	17, 1838 .	. Sharp, Rev. John.
January	12, 1816 .	. Sharp, Thomas.
„	25, 1833 .	. Shaw, George.
„	24, 1823 .	. Sherratt, John.
October	30, 1836 .	. Shuttleworth, John.
April	29, 1851 .	. Sichel, Ferdinand.
„	20, 1852 .	. *Sidebotham, Joseph.
		Simmons, W.

DATE OF ELECTION.	
December 26, 1865 .	. Simpson, Henry.
January 25, 1859 .	Slagg, John, jun.
	Slater, Rev. Fr.
February 23, 1869 .	. Smart, Robert B.
January 26, 1838 .	. Smith, Geo. Sam. Fereday.
November 28, 1876 .	. *Smith, James.
April 22, 1808 .	. Smith, Joseph.
November 12, 1872 .	. Smith, Henry Arthur.
April 29, 1845 .	. *Smith, Robert Angus.
,, 16, 1829 .	. Smith, Samuel.
November 14, 1871 .	. Smith, Watson, jun.
December 13, 1864 .	. Sonstadt, Edward.
October 21, 1825 .	. Souchay, Charles.
January 25, 1859	. *Sowler, Thomas.
,, 22, 1839 .	. Spear, John.
April 29, 1851 .	. *Spence, Peter.
December 27, 1864 .	. Spencer, Joseph.
January 27, 1852 .	. Standring, Thomas.
October 30, 1835 .	. Stanway, John Holt.
January 24, 1834 .	. Stephens, Edward.
April 20, 1847 .	. Stephens, James.
November 1, 1870 .	. *Stewart, Balfour.
January 22, 1819 .	. Stone, Aaron.
,, 23, 1849 .	. Stone, Daniel.
October 6, 1863 .	. *Stretton, Bartholomew.
January 26, 1858 .	. Stuart, Charles Patrick.
January 7, 1814 .	. Stuart, Robert.
October 29, 1844 .	. Sturgeon, William.
November 29, 1870 .	. Syson, John Edward.
January 25, 1859 .	. Tait, M. L.
April 28, 1840 .	. Tate, William J.
,, 18, 1834 .	. Taylor, Charles.
,, 25, 1781 .	. Taylor, Charles.
,, 18, 1828 .	. Taylor, John Edward.
January 22, 1856 .	. Taylor, John Edward.
April 26, 1833 .	. Taylor, Rev. James.
January 26, 1821 .	. Taylor, Rev. John James.

DATE OF ELECTION.		
April	22, 1808 .	. Taylor, John.
March	22, 1870 .	. Teale, James.
April	20, 1852 .	. Thom, David.
January	27, 1846 .	. Thom, John.
April	18, 1854 .	. Thompson, James.
January	25, 1859 .	. Thompson, James.
April	18, 1823 .	. Thompson, John Bent.
January	23, 1824 .	. Thompson, William.
April	15, 1873 .	. *Thompson, William.
January	21, 1820 .	. Thomson, Edmund Peel.
,,	27, 1826 .	. Thomson, William.
October	20, 1815 .	. Thorpe, Robert.
November	2, 1869 .	. Thorpe, Thomas Edward.
April	17, 1860 .	. *Trapp, Samuel Clement.
March	28, 1781 .	. Travis, Rev. Mr.
April	29, 1836 .	. Turner, James Aspinall.
,,	19, 1821 .	. Turner, Thomas.
January	24, 1860 .	. Unwin, William Cawthorne.
April	25, 1794 .	. Vause, Rev. John.
October	21, 1831 .	. Vembergue, Eugene.
April	30, 1861 .	. Vernon, George V.
December	12, 1781 .	. Wakefield, George.
January	30, 1782 .	. Walker, George.
October	19, 1827 .	. Walker, John Gouldie, jun.
January	27, 1857 .	. Walker, Robert.
December	7, 1798 .	. Walker, Mr., F.R.S.
January	22, 1790 .	. Walker, Thomas.
,,	26, 1841 .	. Wallace, Rev. Robert.
April	30, 1802 .	. Walshman, John.
December	30, 1879 .	. *Ward, Thomas.
October	26, 1785 .	. Ward, Mr.
November	18, 1873 .	. *Waters, Arthur William.
January	24, 1823 .	. Watkin, Absolom.
November	4, 1873 .	. Watkins, James.
April	26, 1793 .	. Watkins, James.
January	25, 1859 .	. Watson, John.
,,	12, 1816 .	. Watson, Peter.

DATE OF ELECTION.	
December 15, 1874 .	. *Watson, Prof. Morrison.
February 6, 1789 .	. Watt, James, jun.
January 27, 1874 .	. *Watts, John.
December 29, 1868 .	. Watts, William Marshall.
January 27, 1857 .	. *Webb, Thomas George.
October 15, 1861 .	. Whalley, John.
January 25, 1822 .	. Whatton, William Robert.
" 25, 1828 .	. Wheeler, Thomas.
April 26, 1811 .	. White, Arthur Bourne.
December 12, 1781 .	. White, Charles, F.R.S.
March 28, 1781 .	. White, John.
October 26, 1785 .	. White, Thomas.
January 26, 1858 .	. *Whitehead, James.
February 9, 1869 .	. Whitehead, Walter.
January 23, 1782 .	. Whittaker, James.
March 27, 1782 .	. Whittaker, Rev. Mr.
January 22, 1839 .	. *Whitworth, Sir Joseph.
October 19, 1847 .	. Wightman, Alexander.
January 25, 1842 .	. Wild, Charles Heard.
" 25, 1859 .	. *Wilde, Henry.
December 29, 1868 .	. Wilkins, Augustus S.
January 26, 1821 .	. Wilkinson, Thomas Jones.
" 26, 1841 .	. Wilkinson, Matthew A. Eason.
April 19, 1859 .	. *Wilkinson, Thomas Reade.
November 3, 1874 .	. *Williams, William Carletou.
April 19, 1853 .	. Williamson, Samuel Walker.
" 29, 1851 .	. *Williamson, William Crawford.
" 25, 1781 .	. Wilson, John.
" 15, 1814 .	. Wilson, William.
November 28, 1781 .	. Wimpey, Mr.
March 8, 1864 .	. Windsor, Thomas.
October 31, 1871 .	. Winstanley, David.
January 26, 1841 .	. Winstanley, Thomas Woodcock.
" 9, 1807 .	. Winstanley, Dr.
" 21, 1851 .	. Withington, George Bancroft.
" 27, 1826 .	. Withington, George.
October 16, 1801 .	. Wood, Charles.

DATE OF ELECTION.			
April	17, 1807	.	Wood, George William.
January	22, 1819	.	Wood, Kinder.
			Wood, Ottiwell, jun.
„	22, 1836	.	*Wood, William Raynor.
October	30, 1855	.	Woodcock, Alonzo Buonaparte.
January	26, 1841	.	Woodcroft, Bennet.
April	17, 1860	.	Woodcroft, Rufus Dewar.
„	21, 1846	.	Woodhead, George.
„	30, 1839	.	Woods, Edward.
November	15, 1842	.	Woolley, James.
April	17, 1860	.	*Woolley, George Stephen.
October	29, 1819	.	Worthington, Henry Thomas.
April	28, 1840	.	Worthington, Robert.
November	17, 1863	.	*Worthington, Samuel Barton.
February	21, 1865	.	*Worthington, Thomas.
December	12, 1781	.	Wright, John, M.D.
November	1, 1864	.	*Wright, William C.
„	9, 1785	.	Wynne, Mr.
January	26, 1841	.	Yates, Joseph St. John.
April	26, 1799	.	Yates, Thomas.
October	19, 1847	.	Young, James.

HONORARY MEMBERS.

From the beginning in 1781 *to April* 1881.

April	20, 1847	.	Adams, John Couch, F.R.S.
„	18, 1843	.	Agassiz, Louis.
December	12, 1781	.	Aikin, John.
April	18, 1843	.	Airy, George Biddell.
February	7, 1843	.	Alwyne, The Most Noble Spencer Joshua.
April	16, 1790	.	Anderson, James.
„	18, 1843	.	Arago, Francois Jean Dominique.
	1792	.	D'Azyr, Felix Vicq.
„	30, 1783	.	Baker, Sir George, Bart.
December	21, 1785	.	Banks, Dr. Joseph.

DATE OF ELECTION.		
April	18, 1843 .	. Barlow, Peter.
February	25, 1784 .	. Beattie, James.
April	30, 1790 .	. Bertholet, Mons.
,,	18, 1843 .	. Berzelius, Jens Jacob.
February	7, 1843 .	. Bessel, Prof. Fred. William.
April	18, 1843 .	. Biot, Jean Baptiste.
January	23, 1849 .	. Bosworth, Rev. Joseph.
April	18, 1843 .	. Brewster, Sir David.
February	7, 1843 .	. Brisbane, General Sir Thomas MacDougall, Bart.
		Brydone, Patrick.
October	2, 1782 .	. Buchanan, John.
February	7, 1843 .	. Buckland, Rev. William.
April	17, 1860 .	. Bunsen, Prof. Robert.
January	25, 1859 .	. Cayley, Arthur.
March	24, 1784 .	. Chorley, Dr. Edwood.
October	30, 1866 .	. Clifton, Robert B.
November	12, 1783 .	. Cooper, Thomas.
,,	12, 1790 .	. Crell, Dr. Laurence.
February	23, 1864 .	. Crum, Walter.
May	15, 1782 .	. Currie, Dr. James.
April	28, 1868 .	. Darwin, Charles.
,,	21, 1784 .	. Darwin, Erasmus.
January	23, 1795 .	. Deivan, Dr. J. R.
October	2, 1782 .	. Delaval, Edward Hussey.
April	21, 1784 .	. Dillon, John Talbot, Knight.
October	30, 1782 .	. Dobson, Matthew.
March	8, 1786 .	. Drinkwater, Captain.
April	30, 1844 .	. Dumas, Jean Baptiste.
March	9, 1869 .	. Dyer, Joseph C.
		Enfield, Rev. William.
February	7, 1843 .	. Erman, Dr. Adolphe Paul.
January	22, 1836 .	. Ewart, Peter.
October	30, 1782 .	. Falconer, William.
April	18, 1843 .	. Faraday, Michael.
October	8, 1783 .	. Fothergill, Dr. Anthony.
April	6, 1869 .	. Frankland, Edward.

DATE OF ELECTION.		
		Franklin, Benjamin.
January	24, 1860 .	Freis, Elias.
February	7, 1843 .	Frisiani, Paul.
March	24, 1784 .	Frossard, Dr., of Lyons.
January	9, 1807 .	Garthshore, Dr. Maxwell.
April	18, 1843 .	Gay-Lussac, Joseph Louis.
,,	17, 1849 .	Girardin, M.
,,	16, 1790 .	Girtanner, Dr.
January	23, 1866 .	Graham, Thomas.
		Gregory, George, D.D.
,,	22, 1861 .	Haidinger, Wilhelm.
February	7, 1843 .	Hamilton, Sir William Rowan.
,,	7, 1843 .	Harcourt, Rev. William Venables.
April	19, 1853 .	Hartnup, John.
November	1, 1797 .	Hatchett, Charles.
		Hawes, Dr. William.
December	12, 1781 .	Haygarth, J., M.D.
April	30, 1867 .	Henry, Dr. Joseph.
,,	18, 1843 .	Herschell, Sir John Frederick.
December	14, 1785 .	Hey, Mr., of Leeds.
		Hibbert, G.
January	25, 1848 .	Hind, John Russell.
,,	23, 1866 .	Hofmann, A. W.
April	2, 1867 .	Holland, Sir Henry, Bart.
January	25, 1853 .	Hopkins, William.
October	2, 1782 .	Houlston, Thomas, M.D.
January	12, 1869 .	Huggins, William.
April	18, 1843 .	Humboldt, Baron Alexander von.
October	30, 1782 .	Hunter, Alexander.
April	30, 1872 .	Huxley, Professor.
February	7, 1843 .	Jacob, Prof. C. G. J.
April	19, 1810 .	Jenner, Dr.
October	8, 1783 .	Johnstone, Dr.
November	19, 1783 .	Kintner, Mr.
October	19, 1852 .	Kirkman, Rev. Thomas Pennington.
		Kirwan, Richard.
November	1, 1797 .	Lambe, Dr. William.

DATE OF ELECTION.	
October 31, 1848 .	. Lassell, William.
April 2, 1783 .	. Lavoisier, Monsieur.
	Lettsom, J. C.
February 7, 1843 .	. Liebig, Justus.
December 18, 1782 .	. Llandaff, Rev. the Bishop of.
April 30, 1872 .	. Lloyd, Rev. Humphrey.
December 14, 1869 .	. Lyell, Sir Charles, Bart.
	MacMorland, Patrick.
November 1, 1797 .	. Magee, Rev. William.
January 9, 1782 .	. Magellan, G. H.
December 7, 1798 .	. Marslam, Mr., F.R.S.
October 31, 1794 .	. Maseres, Baron.
January 24, 1794 .	. Massey, James.
April 17, 1849 .	. Mercer, John.
February 7, 1843 .	. Mitscherlich, Eilert.
January 25, 1859 .	. Morgan, Augustus De.
„ 24, 1854 .	. Morin, General, M.A.
April 18, 1843 .	. Moseley, Rev. Henry.
January 26, 1821 .	. Mosley, Sir Oswald.
April 4, 1781 .	. Moyes, Henry.
„ 30, 1844 .	. Murchison, Roderick Impey.
November 9, 1785 .	. Nicholson, William.
April 30, 1844 .	. Owen, Richard.
„ 18, 1843 .	. Peacock, The Very Rev. George, Dean of Ely.
November 1, 1797 .	. Pearson, Dr. George.
April 29, 1851 .	. Playfair, Lyon.
	Platiere, Mons. Polard de.
	Poiteoir, Mons.
January 22, 1856 .	. Poncelet, General.
September 19, 1784 .	. Pope, Rev. John.
February 25, 1784 .	. Porteous, Right Rev. Beilby, Lord Bishop of Chester.
January 23, 1866 .	. Prestwich, Joseph.
	Priestley, Rev. Joseph.
April 30, 1872 .	. Quetelet, Prof. Adolph.
November 1, 1797 .	. Radcliffe, Rev. John.

DATE OF ELECTION.		
January	23, 1866 .	. Ramsay, Andrew Crombie.
December	5, 1781 .	. Ramsbotham, Dorning.
April	19, 1859 .	. Rankine, W. J. Macquorne.
		Rathbone, William.
January	23, 1849 .	. Rawson, Robert.
April	19, 1859 .	. Reichenbach, Carl, Baron von.
January	30, 1861 .	. Roberts, Richard.
December	7, 1798 .	. Robison, Prof.
October	27, 1784 .	. Roscoe, William.
April	26, 1799 .	. Rumford, Sir George Paul, Bart. and Count.
December	22, 1784 .	. Rush, Dr. Benjamin, of Philadelphia.
April	30, 1844 .	. Sabine, Lieut.-Col. Edward.
,,	30, 1872 .	. Sachs, Dr. Julius.
,,	30, 1872 .	. Schimper, Prof. W. P.
February	7, 1843 .	. Sedgwick, Rev. Adam.
October	20, 1846 .	. Sibson, Rev. Edmund.
March	13, 1782 .	. Simmons, Dr. Samuel Foart.
January	25, 1800 .	. Smith, Dr. James Edward.
December	14, 1869 .	. Sorby, Henry Clifton.
April	30, 1872 .	. Stenhouse, Dr. John.
,,	29, 1851 .	. Stokes, George Gabriel.
January	22, 1861 .	. Sylvester, James Joseph.
April	28, 1868 .	. Tait, Peter Guthrie.
January	24, 1854 .	. Tayler, Rev. John James.
,,	25, 1800 .	. Tennant, Smithson.
April	18, 1843 .	. Thenard, Le Baron.
		Travis, Rev. G.
,,	30, 1872 .	. Trécul, Monsieur A.
		Trossard, Rev. Mr.
,,	29, 1851 .	. Thomson, William (Glasgow).
November	12, 1783 .	. Turner, Rev. William.
April	28, 1868 .	. Tyndall, John.
November	1, 1793 .	. Van Swinden, J. H.
April	20, 1847 .	. Verrier, Le.
November	1, 1793 .	. Vince, Rev. Samuel.

DATE OF ELECTION.			
October	2, 1782	.	Volta, Mr.
April	21, 1784	.	Wakefield, Rev. Gilbert.
October	2, 1782	.	Wall, Dr. Martin.
„	2, 1782	.	Warltire, John.
April	30, 1872	.	Watson, Hewett Cotterel.
March	12, 1783	.	Watson, Dr.
February	25, 1784	.	Wedgwood, Josiah.
January	22, 1808	.	Werner, Prof. A. G.
February	7, 1843	.	Whewell, Rev. William.
March	12, 1783	.	Whitehurst, Dr.
			Whittaker, Rev. J.
April	30, 1850	.	Woodcroft, Bennet.
February	1, 1799	.	Wright, Dr.
December	13, 1786	.	Young, Arthur.

CORRESPONDING MEMBERS.

From the beginning in 1781 *to April* 1881.

April	19, 1810	.	Acton, Mr.
January	25, 1800	.	Adair, James N.
April	17, 1860	.	Ainsworth, Thomas.
„	26, 1793	.	Alexander, William.
January	25, 1793	.	Astbury, Dr., of Newcastle.
October	29, 1861	.	Bache, Prof. A. D.
April	19, 1810	.	Bailey, Butterfield.
„	24, 1812	.	Bailey, Lieut. James.
„	30, 1802	.	Banks, J.
January	22, 1861	.	Buckland, Prof. George.
October	31, 1794	.	Buxton, Samuel.
February	5, 1867	.	Cialdi, Alessandro, Commander.
March	8, 1870	.	Cockle, Sir James.
November	1, 1793	.	Copeland, Alexander, of Dumfries.
December	2, 1791	.	Dawson, John, of Sedbergh.
January	23, 1866	.	De Caligny, Anatole, Marquis le
„	21, 1805	.	Denholm, James.
April	26, 1799	.	Deriabin, A., of Russia.
„	24, 1812	.	Dewar, Henry.

DATE OF ELECTION.		
January	23, 1824 .	. Dockeray, Benjamin.
November	1, 1797 .	. Falconer, Rev. Thomas.
April	2, 1861 .	. Fardel, Max Durand.
January	7, 1862 .	. Fedrico, Laneia di Brolo.
April	18, 1823 .	. Fischer, Prof. Gotthelf.
January	25, 1859 .	. Folis, Augustus le.
February	1, 1799 .	. Fontana, Mr.
,,	4, 1791 .	. Garnett, Dr.
January	7, 1862 .	. Gistel, Prof. Dr. Johannes.
December	2, 1791 .	. Gough, J.
April	21, 1846 .	. Gough, Thomas.
January	10, 1812 .	. Granville, Dr.
October	18, 1799 .	. Green, Edward.
November	1, 1793 .	. Guthrie, Dr. Matthew.
April	30, 1819 .	. Hall, Marshall.
October	21, 1808 .	. Hamilton, Rev. G. J.
April	30, 1850 .	. Harley, Robert.
January	21, 1851 .	. Harris, William Thaddeus.
December	7, 1798 .	. Haworth, Dr.
January	22, 1861 .	. Henry, Prof. Joseph.
October	31, 1800 .	. Henry, Peter.
April	19, 1821 .	. Herberski, Vincent.
January	22, 1819 .	. Hibbert, Samuel.
April	26, 1793 .	. Hoffmann, Mr., of Berlin.
January	10, 1812 .	. Holland, Dr. H.
November	1, 1793 .	. Holme, Edward.
,,	1, 1793 .	. Holt, John.
January	13, 1804 .	. Johnstone, Dr. John.
,,	22, 1839 .	. Just, John.
April	21, 1846 .	. Kirkman, Rev. Thomas P.
November	1, 1797 .	. Lambe, Dr. William.
March	18, 1879 .	. Letourneux, Monsieur A.
January	27, 1857 .	. Lowe, E. J.
,,	23, 1818 .	. Lowe, John.
October	21, 1808 .	. Lowny, Wilson.
January	12, 1810 .	. Lyall, Robert.
,,	25, 1793 .	. Lyon, John.

DATE OF ELECTION.			
April	24, 1801	. .	Maese, James, of Philadelphia.
"	21, 1846	. .	Marshall, Samuel, of Kendal.
October	29, 1861	. .	Maury, Captain M. F.
January	25, 1848	. .	Miller, John Fletcher.
"	21, 1825	. .	Milligan, Edward.
April	28, 1797	. .	Milne, James.
"	19, 1864	. .	Mitchell, Captain John.
January	7, 1862	. .	*Nasmyth, James.
April	26, 1793	. .	Nicholls, Francis.
January	14, 1815	. .	Otley, John.
October	16, 1807	. .	Percival, Edward.
November	15, 1833	. .	Perez, Dr.
April	26, 1822	. .	Perkins, Jacob.
"	29, 1851	. .	Pincoffs, Peter.
February	4, 1791	. .	Riddell, Mr.
November	18, 1808	. .	Roget, Dr.
January	12, 1869	. .	*Saint Venant, Barré de.
April	20, 1798	. .	Scherer, Dr. Alexander.
February	5, 1867	. .	*Schönfeld, Edward.
April	17, 1838	. .	Schouch, Daniel Koechlin.
"	19, 1821	. .	Scoresby, Captain William.
"	29, 1796	. .	Scott, Helenus.
October	30, 1835	. .	Sibson, Rev. Edmund.
April	30, 1839	. .	Sims, Oliver.
"	26, 1799	. .	Taunton, Mr. (Surgeon of the Cornwall Fencible Cavalry).
January	23, 1801	. .	Thomas, James.
October	21, 1808	. .	Thomson, John.
"	18, 1816	. .	Turner, Rev. William, jun.
January	12, 1869	. .	Venant, Saint.
"	24, 1834	. .	*Watson, Henry Hough.
"	23, 1795	. .	Wemys, Major.
April	20, 1798	. .	Wilkinson, Charles.
"	19, 1853	. .	Wilkinson, T. T.
January	21, 1791	. .	Willis, Mr.

APPENDIX A.

Page 7. I received the following from Mr. Morse Stephens, Oxford :—

'The following short chronology of Marat's earlier life will show where there may be a fragment of truth, and what is undoubtedly false. Marat was born 1743 at Neufchatel ; left home 1759 ; published "Essay on Man" 1773 in London. Here comes the great lacuna, from 1759–1773. He asserts that he travelled in France, spent some time at Bordeaux and Paris (the latter fact is certainly indicated by the pamphlet I have unearthed), spent a year in Holland, and then came to England. He states in his later writings that he spent eleven years in England : he undoubtedly went back to Paris, when he received his Court appointment in 1777—so that I date his arrival in England at 1766 or 1767. What did he do between 1766 and the publication of his book in 1773? He undoubtedly studied science much and read much, for his book on "Man" is full of classical and mediæval lore. He also thoroughly learnt English. I am inclined to think he spent those years studying medicine, and later in practice in London, as we find him a well-known doctor in 1776, and sufficiently famous to be summoned from England to fill a Court post at Paris in 1777. Now it is just possible that he may have taught French at the Unitarian Academy of Warrington in the earlier years of his stay, say 1767–69, though I should be inclined to doubt it. The point deserves investigation, and I should be glad if you could help me, but the latter part of the extract is utterly impossible. The trial of Le Maitre for the robbery at the Ashmolean took place in 1778, when Marat was in Paris, writing scientific books, and a well-known person of fashion. The later part of the quotation falls with this, for we know every year of Marat's Paris life, when he used to entertain such men as Dr. Franklin. If the Mara of the Warrington Academy was that Marat, you must show he was not Le Maitre, no very difficult thing to do, as their identity, or the fact of Le Maitre's being Mara, is not alluded to at all in the trial. That done, the Mara of Warrington may be our Marat, for his original name was Mara, and he probably did not Gallicize it till he began to publish. I hope you will excuse this long rigmarole, but you have brought it on yourself by taking such a kindly interest in my work. Now if you can in any way manage to prove the *years* in which Mara was at Warrington, we can work tentatively on that basis; and again, would it be too much to ask if you know anyone at Dublin, who would work up the Medical record between 1797 and 1773, to see if Marat took a degree there, or became a student there? He declares he spent a year in Dublin, and it would be a great help to know when it was.'

Still there is a problem. There is evidence that a similar name was in the Warrington Academy books, and later investigations have not found it. Has it been erased? There was the Place called Mara's Walk in Warrington, from the Bridge to the Bank Quay. Mr. Bright, in volume xi. of the 'Transactions of the Historical Society of Lancashire and Cheshire,' says that he cannot find Marat's name in the minutes of the Academy, and thinks Mr. Turner must have made a mistake. Mr. R. D. Darbishire too cannot find the name. Still the general belief in Warrington and the name of the place, "Mara's walk," cannot be put aside along with Mr. Turner's words. But the best reason for believing in the difference of the men is perhaps in the Christian names. The revolutionist was Jean Paul, but we learn from Mr. Beamont (of Orford Hall, Warrington) that the name of the teacher there was Jean Pierre. Jeremiah Mara took his degree in arts in 1762 or 1773 in Dublin.

APPENDIX B.

Page 202. The following summary has been sent me by Mr. Frank Nicholson :—

The Manchester Academy was instituted February 22, 1786, on which day a 'very respectable meeting of gentlemen' unanimously agreed that 'an academy should be established in Manchester, on a plan affording a full and systematic course of education for Divines, and preparatory instruction for the other learned professions, as well as for civil and commercial life. This institution will be open to young men of every religious denomination, from whom no test or confession of faith will be required.'

The first session was opened September 14, 1786, by an address from Rev. Thos. Barnes, D.D. (Professor of Hebrew, Metaphysics, Ethics, and Theology).

Thomas Percival, M.D., F.R.S, was the first chairman. The Rev. Ralph Harrison (elected a member of the Literary and Philosophical Society, December 5, 1781 [1]) was Professor of Classical Literature. The first name on the roll of regular students is James Percival; further comes Peter Henry, also of Manchester. In the next year (January 1787) Edward Holme, of Kendal (M.D., President of the Literary and Philosophical Society, 1844–47), and (September 1787) William Henry (M.D., Vice-President 1817 onwards).

In March 1788, Hector Mortier (of Catteau, near Cambray) was admitted. In a paper by the late J. Moore, Esq., F.L.S., in Harland's 'Collectanea' ('Chatham Society's Publications,' vol. lxxii.) he is identified with Marshal Mortier, Duc de Treviso,

[1] See List, p. 33.

killed by Fieschi's infernal machine in 1843. Probably, however, Hector was a younger brother of the Marshal.

Lewis Loyd, admitted September 1789, was appointed assistant classical tutor in the Academy 1790-92. He afterwards became a banker, and was, I believe, the father of Samuel James Lloyd, the present and first Baron Overstone.

In 1791 John Moore (President of the Literary and Philosophical Society, 1851-4, and F.L.S.) was admitted a student.

In 1793 John Dalton was appointed tutor in Mathematics and Natural Philosophy, and held that appointment until 1800. So the 'New College' (page 202) is the *Manchester Academy*, to which belongs the credit of having brought Dalton to Manchester.

In 1796 (January 7), Samuel Hibbert was admitted a student, (afterwards Hibbert-Ware, M.D., author of 'The Foundations of Manchester,' etc.).

In 1798, the Rev. George Walker, F.R.S., became Professor of Theology (President of the Literary and Philosophical Society, 1805-6), and appears to have acted as Principal until 1803, when the Academy was removed to York, where it was carried on as 'Manchester College, York,' until 1840. In that year it returned to Manchester as 'Manchester *New* College,' with Wallace Robberds, Kenrick, Martineau, J. J. Tayler, and Newman on its list of professors. In 1853, it removed to London, where, as 'Manchester New College, London,' it is now occupying University Hall, Gordon Square, W.C.

APPENDIX C.

E. W. BINNEY, F.R.S., F.G.S., &c.

Our President, whilst this volume was printing, was Edward William Binney. He exercised a great deal of influence in the Society from his strong will and a general tone of common sense in his remarks, as well as from his position as the leading geologist in matters relating to the carboniferous rocks and coal. He was born at Morton, in Nottinghamshire, in 1812, and seems to have lost his father's care early, but a brother came to his help and enabled him to serve his apprenticeship to a solicitor in Chesterfield. Afterwards he completed his study in London, and came to Manchester in 1836. It does not appear that he had then any love of geology when he arrived, but he had a belief that by studying questions relating to coal he might be largely employed by coal-owners. He was thus led to the science in which he took the deepest interest, and to the peculiar department of it which he never left. His capacity for long walks gave him a great advantage. He was tall and powerful, and he had no wish to seek society. Indeed, he always spoke in a disparaging manner of the usual social intercourse in the middle and upper ranks, and delighted in rambling over the county and mixing with the men he chanced to meet, studying their ways and learning their observations. It was in this way that he came to take much interest in the scientifically inclined working man, and he had a particular pride in speaking more highly of him than of the more learned or elaborately trained. Indeed, it was his opinion that to be a straightforward man and to observe well, seeing clearly the way before one, was the most pleasant object in life.

That he himself was fitted for clear and accurate, as well as long-continued and patient observation, soon became manifest, and we have a list of papers written by him and extending over forty-two years, and 134 in number.

Except during a few of those earlier years, when John Leigh, F.R.C.S., now medical officer of health, and then his intimate friend, was his fellow lodger, he lived at Cheetham Hill (Manchester), attracted by its sandy soil, but spent his days at his business, or in reading at the Athenæum, or in attending to the affairs of this Society, in which he took a deeper interest than any member, if we are to judge by the trouble he took in directing its minutest details, so that for many years little was done without his will. His attention to business was so great that for thirty years he had not been absent from it for a fortnight at a time.

He attended well the meetings of the British Association for many years, and at the Geological and Palæontological Societies was well-known as a contributor, whilst his studies of the flora and wood of the coal measures have helped greatly to make an important era in our knowledge. The writer must leave a geologist to sum up his labour and define his position as a scientific man. Of the 134 papers of which we have a list, some are certainly only slight notices, but others show laborious search, and have been left unfinished.

He joined Mr. Young in beginning works for the manufacture of paraffin oil, adding his savings to the small amount that was available at the time, after Mr. Young (now Dr. Young, of Kelly) had found it necessary to have aid in order to enlarge his establishment and begin his Scottish works, the supply of oil in Derbyshire having failed. The firm was in our town called by the name of E. W. Binney & Co. The partnership continued during the existence of the patent, and Mr. Binney retired with a handsome sum, which he greatly increased by his investments. He spent a large portion of his later years at Douglas, in the Isle of Man, where his house, Ravenscliff, gave him a fine view of the Bay and of the sea, and was still to a great degree sheltered.

Mr. Binney was a remarkable man. He knew many people, but visited few, but to these few he was very strongly attached, whilst his tenacity of purpose prevented him from having sympathies with many, and caused him to put many people in an attitude of opposition without making them enemies. In science he read very widely, but never wrote on anything outside the first field of his geological interest.

He had a peculiar horror, even loathing, for men who made a display, and, although a rich man, he lived in great simplicity. He admired great men it is true, but his chief love was for the poor man who gained knowledge, although finding it difficult to gain bread. Thus he took up the case of Samuel Bamford, the author of 'The Life of a Radical,' and did not cease till he induced the Government to grant him a sum from the Civil List. A similar kindly feeling prompted him to great attention to the botanist, the author of 'The Flora of Manchester,' a remarkable man, who was known to Mr. Binney only when age had overtaken him. For many years Mr. Buxton sat for hours daily in the office reading. He was a shoemaker, and a poor man, and had never made above ten shillings a week all his life, and he lived of course in a poor street. It was remarkable, however, how fine his taste was, and how well informed he was found on all subjects, an educated gentleman, timid and shy as a child. Mr. Binney helped him to have his book published, and to obtain for it a fair sale. The delicacy of his treatment of this man was remarkable when men of great importance in the eyes of society were sent away with a growl.

His pleasure in promoting and attending meetings of the scientific working-men was great.

It has already been mentioned, when speaking of Mr. Sturgeon, that the small annuity obtained was owing to the persistency of Mr. Binney.

Still a purely benevolent life would have been most distasteful to Mr. Binney ; he was a man of business and a geologist. Geology had at an early period put out of his mind much of his knowledge of other sciences, and his attention to the many affairs on hand very much in later years interfered with his geology. He has left a fine collection of geological specimens, and a fortune to his wife and family, consisting of three sons as well as three daughters.

It was his strong desire to have the rooms of the Society retained, but enlarged ; and he intended to assist in raising a fund of five thousand pounds for this purpose, and also for obtaining the services of a librarian and editor. The Society has certainly suffered by his loss in this respect, but it has not the less suffered by the absence of his face and the full sympathy and clear sense which he introduced into so much of the work of the Society, although we often thought that, liberal as he was in politics, time had made him too conservative of some of our forms.

Professor W. C. Williamson mentions as the first appearance of Mr. Binney as a geologist, a paper read by him in 1835 in conjunction with John Leigh, F.R.C.S. This paper was 'On Fossils found in the Red Marl at Newtown, in the valley of the Irk.'

The earliest paper recorded seems to be in the Trans. of the Geol. Soc. vol. i. p. 35, entitled a 'Sketch of the Geology of Manchester and its Vicinity.' It was the work of three years, and showed in a remarkable degree the energy of the author's character. It was followed rapidly by others, on the coalfields of Lancashire and Cheshire, on the marine shells of the Lancashire coalfields, and on the fossil fishes.

The inquiries which were of most interest to him were the constitution of coal and the conditions under which it grew. Next to these subjects came the action of glaciers and icebergs in distributing clay and boulders over the two counties especially in which he took interest.

He calculates the Lancashire and Cheshire coalfield as 6,600 feet in thickness, commencing with the lowest millstone grit and terminating with the red clays of Ardwick and Manchester. He says, 'In all the floors which I have examined, which are eighty-four in number, remains of Stigmaria ficoides have been found.' Again, he says, 'Coal floors show no evidence of strong currents of water necessary to drift forests of timber from neighbouring lands, but have every appearance of a hardened mud brought by sluggish water with scarcely any current.'

Continuing to extract a few sentences from the paper on the origin of coal, vol. viii. of the Society's Mem. New Series, we have

'Nearly all the coal seams more or less display evidence of common coal plants, especially Stigmaria, Sigillaria, and Lepidodendra, pulverulent carbonaceous matter like charcoal, or show woody structure under the microscope. On the other hand, the roofs or strata immediately above the seams of coal nearly always present some evidence of currents of water. Sandstone roofs present exactly such an appearance as a strong current of water flowing over a tract of luxuriant vegetation would now produce, namely, prostrate trees lying in all directions, mingled with sand.'

'The black shale roofs indicate even a more quiet and gentle flow of water than those composed of lime. . . . . We find that the strong currents of the lower field were not favourable to the formation of thick and numerous seams of coal, but that the tranquil and quiet waters of the middle one were; while the waters of the upper field, although equally quiet and tranquil, having been charged with peroxide of iron and carbonate of lime, were not favourable to the formation of thick and valuable seams.'

'The occurrence of thick seams of coal lying amidst the most tranquil of aqueous deposits, and the rareness of such seams in the coarse gritstones of the lower field, seem to prove anything but that the vegetable matter now forming coal was drifted into the places where it is found; else we should expect fully as great if not a greater amount of vegetable matter, where we find evidence of a stronger current.'

'Wherever the plants grew the strata in which they were found were no doubt deposited from water, and show no evidence of having been dry land. . . . . When the deposits were in a plastic state the animals walked across it and left their tracks; subsequently the sun or air, by desiccating the clay, produced wide tracks, and the water at length returning again filled both the feet marks and cracks, and made a beautiful cast of them in sand.' Mr. Binney describes some in this paper, and others found by himself are described in a paper entitled, 'On some Trails and Holes found in Rocks of the Carboniferous Strata, &c.' ('Mem. Lit. and Phil. Soc.,' vol. for 1852.)

It has sometimes been stated that Mr. Binney owed his fortune to his knowledge of coal, because he was associated with Mr. Young in the manufacture of paraffin oil, and because he had observed petroleum coming from a peat bed at Down Holland, near Ormskirk. This is a mistake. Dr. Lyon Playfair's statement is correct that he received the account of the flow of petroleum in a coalfield belonging to his brother-in-law, Mr. Oakes, at Alfreton, in Derbyshire, and told Mr. Young of it. That has long been in print and well known, and it is strange that whilst the actors are still living a new story should turn up. Mr. Binney was a friend of Young's, and was taken to see the spring, but not till after it was actually being utilised. When it was exhausted after about two years, a new source was looked for, but even then Mr. Binney did not assist, as the Boghead cannel was shown to Mr. Young by Mr. Bartholomew, then manager of the City and Suburban Gasworks, Glasgow, and now, if not then, a coal-owner in Scotland. This evidence was given at a trial in Edinburgh, was never questioned, but other notions have quietly intruded themselves.

Mr. Binney's opinions on coal and peat were taken up as Mr. Bowman left them, and the difference may be judged by the following quotations.

Transactions of the Manchester Geological Society, Vol. I., p. 92. *On the Origin of Coal; and the Geological Conditions under which it was produced. By J. E. Bowman, F.G.S. and F.L.S. Read January* 30, 1840.

'. . . . But the experiments of Dr. MacCulloch following those of Hatchett and other previous investigators, have since so satisfactorily proved its vegetable origin, that I shall only need to touch briefly on this division of my subject.

'In the ordinary process of vegetable putrefaction and destruction, a variety of compound gases are formed by the reaction of their elements, and carbon alone, or rather carbon united to a portion of hydrogen, remains behind. The experiments thus alluded to are in perfect harmony with this natural process, and have proved the following facts:—That all vegetables, including wood, are chiefly composed of oxygen, hydrogen, and carbon; that in peat, which is the first or incipient stage of their decay produced by the action of water, the two latter elements form a hydro-carbonaceous compound, which communicates its brown colour to water; that peat itself does not appear to contain any bitumen, but that this latter substance in some of its modifications, as asphaltum, mineral tar, oil, or naphtha, is generated by the slow conversion and formation of the hydro-carbonaceous compound under pressure, during which the complete separation of the hydrogen from the carbon that takes place, and the consolidation of the latter, is completed; this, however, is a slow process, and a lengthened time is necessary to complete it. That bituminised wood, Surturbrand, Bovey coal, &c., as well as vegetables and peat, contain hydrogen and carbon, and in greater proportion according to the degree of closeness and pressure to which they have been subjected under beds of soil, clay, &c.; that a sufficient length of time being allowed, mere pressure and exclusion from the atmosphere are sufficient to convert bituminised peat and lignite into coal; and lastly, that the action of air and water on vegetable substances is similar to that of fire, though much slower and less complete.'

Page 105. 'My opinion is simply this. That the trees and vegetables from which the beds of coal are derived, grew on the identical spots the latter now occupy, when each bed was successively the surface, and probably but little raised above the level of the waters, either as detached islands or extensive plains or savannahs; that these surfaces, during the settling of the earth's crust, were one after another submerged and covered with sediments from turbid waters, or with drifted clay, sand, and shells which buried up the plants; that these sedimentary deposits gradually accumulated till they formed a new surface, which in time produced another growth of plants and trees, and after a second period of rest were in their turn submerged and covered up by other deposits; and that similar intervals of repose with intermittent occasional subsidences, were repeated during the entire period of the coal formation. As each vegetable surface sunk beneath the waters, it gradually became converted into coal by processes already explained, and the successive deposits of mud and sand became consolidated into shales and sandstones.'

Page 108. 'There is a peculiarity in the texture of coal which has not received the attention it deserves. If it be closely examined, it will be found to consist of a series of parallel horizontal laminæ, varying in thickness from the fourth to the sixteenth of an inch, often adhering closely together, but sometimes with an intermediate layer of fibrous glossy charcoal, in broken portions, which causes it to separate easily. These laminæ are best observed in the cross fracture, and often exhibit considerable difference in compactness and lustre, some being so much more bituminous and shining than others, that they may be traced for a great length. This structure, though in some coal seams indistinct, is so general that it seems to point to some law which the chemical geologist might advantageously investigate.'

It is not meant to assert that these views expressed by Mr. Bowman were original, but they are put in his own words to show the steps by which Mr. Binney was led to his own views regarding both the origin of coal and conditions of peat.

Transactions of the Manchester Geological Society. Vol. VIII. Session 1868–69. *On the Petroleum found in the Down Holland Moss, near Ormskirk. By E. W. Binney and John Hawkshead Talbot. Read March* 30, 1843.

Page 46. 'On the composition and origin of the petroleum. . . . . Although it is by no means uncommon to find traces of an oily matter floating upon the surface of the water that drains out of peat bogs in the low mosses of Lincolnshire and other parts of England, the authors believe that the occurrence of peat so strongly impregnated with petroleum as that found in Down Holland has not yet been noticed.

Page 47. 'On first inspecting the peat, the authors imagined that the petroleum had its origin from some spring which flowed up through the moss from a fissure in the strata underneath ; but after examining these deposits, composed of silty clay, sand, till, and most probably portions of the new red sandstone formation, and finding the lower bed of peat not only destitute of petroleum, but quite dry, they became convinced that the oil could not have come from below. They next considered that it might possibly proceed from a spring which rose out of the higher land at Halsall or Down Holland, and then flowed down into the moss ; but the peat on the eastern side, although moist and nearest to the source of any spring flowing from that part (if such were the case), was totally destitute of petroleum. The only remarkable feature connected with the upper bed of peat is the western portion of it being covered up with a bed of sand, and being probably sometimes subject to an infiltration of sea-water, according to Mr. Harkness's information. These circumstances, added to the fact of the petroleum being found most plentifully at the edge of the sand, lead the authors to the conclusion that it is produced by the decomposition of the upper bed of peat under the sand.

'The chemical process by which such singular effects have been produced is a subject more fitted for the consideration of the chemist than the geologist, but the authors suppose that the petroleum is the result of slow combustion in the peat, and has been produced by a process partly analogous to that which takes place in the destructive distillation of wood in close vessels, where, owing to a total absence of oxygen, the combination of hydrogen and carbon, in the form of hydro-carbons, is effected.'

At a meeting of the Manchester Geological Society, December 18, 1860, a paper was read on the same subject by Mr. Binney. A note says, '. . . . I cannot suppose but that it must have been produced by a process partly analogous to that which takes place in the destructive distillation of wood in close vessels, where, owing to the limited or total absence of oxygen, the combination of hydrogen and carbon in the form of hydro-carbons is effected.'

In explaining the decomposition of peat Mr. Binney quotes Liebig's opinions concerning slow combustion, and wishes to show that hydro-carbons may be formed in peat in this way ; but it seems as if Mr. Bowman's views were as clear on the subject as Liebig's, and they were published in January, 1840, whilst Liebig's preface dates from September of the same year. Liebig does not allude to peat, but to organic substances generally. The views, however, of Mr. Bowman and Mr. Binney are not well supported ; we do not know of any formation of hydro-carbons other than gaseous by the decay of woody fibre. Both seem to have forgotten that peat contains resinous matter in considerable amount. Still this has always been found very solid, and we cannot wonder that when the woody fibre decays the resin should remain, but we have still a difficulty as to the oily matter, which has not yet, so far as we remember, been found in ordinary peat.[1]

The most important work undertaken by Mr. Binney, and carried out with great pertinacity so far as he could spare time from his business, was the explanation of the position which the principal coal plants have to each other. A most important feature in the inquiry was the proof that the so-called Stigmaria were the roots of the Sigillaria and also of allied genera such as the Lepidodendron. The discovery of a number of specimens new to geologists put him in a peculiarly favourable position, and this position he held for many years, whilst he somewhat slowly produced his description. It is from these, his most elaborate, as well as somewhat late papers, that we shall cull extracts, giving in his own words the position which he claimed for himself.

Memoirs of the Literary and Philosophical Society, Manchester, Vol. VIII. New Series. III. On the Origin of Coal. Read December 1, 1846, *by E. W. Binney.*

Page 172. 'The long processes radiating in quincuncial order from the Stigmaria to a considerable distance did not allow of its being so easily drifted, therefore it was allowed to have grown in the position where it is found, and called an aquatic plant. As it was always met with in the coal floors, it was supposed to have been a kind of harbinger of dry land, filling up, by its rapid growth, the swamps until a bed of soil was formed for the growth of the larger trees, like the Sigillaria, &c. This view was taken by many authors, who represented the vegetable matter, now forming coal, to have grown on the spots where it is now found on dry land.'

Page 173. 'As before stated, the seams of coal are generally found lying upon a fine deposit of hardened clay or silt, indicating great quietude in its formation, and scarcely any trace of a current.

[1] The author gave this view in 'A Study of Peat,' *Mem. Lit. and Phil. Soc.* vol. v. 3rd series, p. 330. He has also shown that the resinous of hydro-carbonaceous matter can be found in the mosses from which the peat was formed.

In fact, we have in the floor a fine rich soil, well calculated to have produced a luxuriant crop of vegetation, full of immense numbers of Stigmaria ficoides, now proved by the trees of St. Helen's and Dukinfield to be nothing more than the roots of Sigillaria.[1] So their presence under the seams of coal is now fully accounted for, being merely the roots *in situ* of the forests of Sigillaria, that have chiefly formed the beds of coal found lying above them. These fossils are of great value in accounting for the true formation of coal seams, and must for ever do away with the drift hypothesis, so far as concerns those seams in which they are found in the floors, and establish the rival theory which attributes the formation of coal seams to vegetable matter, grown upon the identical places where it is now found.'

Page 175. 'Although the stems of Sigillaria have been generally noticed in the roofs of coal seams, it is by no means to be inferred that they are not to be found in other portions of the carboniferous strata. They no doubt have been found more frequently in the roof than other places ; but that part can be better examined than other strata in a mine. The fossil trees at St. Helen's, all Sigillaria, were four in number, and occurred in a deposit of grey indurated silty clay, lying about eighteen yards two feet above a foot coal, and fourteen yards one foot under a yard seam ; the bases of the stems lying about eight feet above a white gritstone rock, and the stems proceeding upwards in the warren, which was completely traversed, as far as it could be traced, by Stigmaria ficoides ; so if the whole of the rock had been on in the quarry, the stems would probably have reached up to the Roger seam of coal.'

Page 177. 'Lately has been discovered in the floor of the Victoria Mine, Dukinfield, near Manchester, at the depth of eleven hundred feet from the surface, a magnificent specimen of Sigillaria, which exhibits in the stem the respective characters of the species pachyderma, reneformis, and organum, and true Stigmariæ traced eighteen or twenty feet as its roots. The stem was about two feet high, and could not be traced into the coal

[1] *Phil. Mag.* for March 1844, and October 1845 ; also *Quarterly Journal of the Geological Society* for Nov. 1846.

and cannel seam above. Four main roots appeared to have proceeded from the base, but only one has been preserved entire and lodged in the museum of the Manchester Geological Society. This, after proceeding some distance, divides into two roots, and each of these latter into two more, which run in a horizontal direction as Stigmaria, at a depth of two feet under the coal. Their extremities have not been reached, although they were traced upwards of twenty feet.'

Page 194. 'We are at present in want of a correct vertical section of the earth's crust, showing the materials composing its various beds, and the nature of their organic remains. When this is supplied, we shall be enabled to trace back the physical history of our globe, and furnish the mathematician with data from which to calculate, with absolute certainty, the changes which have taken place in the solid particles of our planet, and to determine whether some of the most important of them have not been effected by the slow and silent process of the radiation of heat, rather than by more actively energetic causes.'

Carboniferous Flora. Part II. Observations on the Structure of Fossil Plants found in the Carboniferous Strata. Memoirs of the Palæontographical Society, 1871. *This treats of Lepidodendron, Lepidostrobus, and Flemingites with their relation to Sigillaria.*

Page 33. '. . . One good specimen showing the organs of fructification connected with the stem and foliage of the plant is worth any number of detached fragments. It has been my good fortune to become possessed of a specimen showing such three portions of a plant; and therefore it has occurred to me that no time should be lost in describing it, although in due order, probably, it ought to have been delayed to a later portion of the monograph.'

Page 60. '. . . This monograph, no doubt the reader will have perceived, was intended to be of a descriptive character rather than an attempt to trace the analogy of those plants, the remains of which have formed our valuable beds of coal, with living vegetables. My endeavours have been to collect materials and give them to the public for botanists to work upon. The subject is surrounded with difficulties ; and, although it has been my good fortune to meet with many specimens in a fair state of preservation, the specimen, as a rule, when the internal structure is well preserved, is in a fragmentary condition, and when several parts of a plant are found connected together we are not favoured with structure, as is the case of the beautiful fossil plant last described.'

Carboniferous Flora. Part IV. 1875, *pp.* 98 *and* 99. *General Observations on Sigillaria, Anabathra, Diploxylon, and Stigmaria.*

'. . . . . Ever since the time when the Fossil plants of the coal measures first attracted attention, Sigillaria has occupied a chief place in the minds of botanists : for it is to be met with in the strata near most seams of coal, in a more or less perfect state of preservation. The trunks of this genus are of two kinds, namely, those distinctly ribbed and furrowed with leaf-scars on the ribs at greater or less distances, and those with the leaf-scars contiguous, and covering the whole surface of the trunk ; both having them in a spiral arrangement around the axis. Nearly one hundred species have been described by different authors, who have made numerous species out of the same trunk ; various parts of it being in a bad or good state of preservation. No doubt, when we are better acquainted with the true nature of the plant, the number of species will be greatly reduced.

'For a long time Sigillaria and Stigmaria were regarded as distinct genera of plants, and even now, on the Continent, some distinguished palæontologists are disposed to remain of that opinion. In the specimens first described by me, in the "Philosophical Magazine" for 1844,[1] which were found in Mr. Littler's quarry, near St. Helen's, Stigmaria was clearly traced to the trunks of the large, irregularly ribbed and furrowed Sigillariæ, showing little, if any, traces of leaf-scars ; but it was there distinctly stated that around these trunks smaller trunks were found standing, which

[1] *Phil. Mag.*, ser. 3, vol. xxiv. p. 168 ; and 1845, vol. xxvii. p. 241, &c.

showed all the characters of Sigillaria reniformis, with Stigmaria rootlets in the adjoining strata, pointing in the direction of the root, but not absolutely proved to be connected with it. On viewing the specimens as they originally stood in the quarry before their removal, little doubt could be entertained as to all the trees there found having had Stigmariæ for their roots. In some specimens, however, afterwards described by me in the "Philosophical Magazine" for 1847, ser. 3, vol. xxxi. p. 259, the connection of Stigmaria, as a root, with Sigillaria reniformis, S. alternans, and S. organum, was clearly proved.[1]

'The regularly ribbed and furrowed Sigillaria, with distinct leaf-scars, generally found flattened and compressed in the sandstones and shales, are seldom of so large a size as those irregularly ribbed and furrowed stems described by me under the name Sigillaria vascularis, sometimes attaining seven feet in diameter. In the fossil forests of trees standing erect in the coal-measures, which have come under my observation, nearly all belong to the last-named genus. In the Pemberton Hill cutting, on the railway between Wigan and Liverpool, six out of thirty stems, from one to two feet in diameter, exhibited the scars of Sigillaria reniformis, S. alternans, and S. organum, the remaining twenty-four belonging to S. vascularis. On the numerous fossil trees found in cutting the Clay-Cross tunnel, on the Midland Railway, near Chesterfield, in the specimens found in the deep pit at Pendleton, some of which were more than fifty feet in height; in that from the Victoria pit, Dukinfield, now in the Manchester Museum; in those on the Manchester and Bolton Railway at Dixon Fold, described by Messrs. Hawkshaw and Bowman; and in the large stems from the Trap-Ash, of Laggan Bay, discovered by Mr. Wünsch—there was no evidence of distinct leaf-scars, but only irregular ribs and furrows. All the specimens except the last-named were seen and examined by me *in situ*. The only example of a very large Sigillaria showing distinct leaf-scars, which has come under my observation, is specimen "No. 49" of Sigillaria reniformis, now in the Museum of the School of Mines in Jermyn Street. Unfortunately, all the above-mentioned specimens, except those from

[1] See also *Quart. Journal of Geol. Soc.*, vol. ii. p. 391.

Laggan Bay, afford no traces of internal structure. These last, however, some of which are about two feet in diameter, afford evidence of the structure of the thick inner bark, termed by me the outer radiating cylinder, and the woody or inner radiating cylinder of barred tubes, containing vascular bundles and medullary rays, enclosing a medulla, composed of barred tubes, in all respects exactly similar in structure to the large Sigillaria vascularis, with irregular ribs and furrows, described by me in the "Philosophical Transactions,"[1] and the smaller specimens, exhibiting on their outsides scars of Lepidodendra, described in the "Quarterly Journal of the Geological Society."[2] These large and small specimens gradually pass one into the other, as numerous specimens in my cabinet, in addition to those figured, amply testify. Many persons have become accustomed to class my small specimens, the first ever described showing a medulla of vascular tubes, as Lepidodendron, from their external characters, without regarding their inner radiating cylinder and its singular medulla, so totally different in arrangement to the vascular Cylinder and medulla of orthosenchymatous tissue of Lepidodendron Harcourtii, before described in this monograph.'

Page 145 '. . . When Brongniart described his Sigillaria elegans, the Rev. Mr. Harcourt's Lepidodendron, Lindley and Hutton's Stigmaria, and Mr. Witham's Anabathra, he had before him all the materials then known for examining the structure of those plants that the coal-measures had afforded. Subsequently Corda added the Diploxylon cycadoideum. Then Goeppert described his Stigmaria with the vascular bundles in the pith. But in all these specimens, except the last, the structure of the piths was more or less wanting. The first time that anything was published as to stems with vascular tubes in their piths was in my paper in the "Quarterly Journal of the Geological Society," and this was further extended in my memoir in the "Philosophical Transactions," where were described larger specimens of Sigillaria vascularis and Diploxylon cycadoideum, all showing structure similar to that of the smaller ones first described, with the exception of the Diploxylon having the edges of the woody bundles of the inner radiating cylinder

[1] For 1865, p. 579 *et seq.* [2] Vol. xviii. 1862, p. 111.

slightly lunette-shaped, and running into the pith, like those described by Corda in his specimen, but in a less degree. . . . . .

'. . . . It appears to me desirable for the present to limit the genus Lepidodendron to the old type; and, therefore, I object to Mr. Carruthers taking my small specimens as Lepidodendron, and Professor Williamson taking my large as Diploxylon vasculare. My names are only provisional, but I think it better that they should remain until we know more of the fructification of the plant.'

Page 146. '. . . . In examining the structure of coal-measure plants we labour under great difficulties, owing to the fragmentary state of the specimens, and we have to collect evidence gradually and with patience. It has never been my practice to pretend to do much more than to collect the best specimens, and to carefully describe them, in accordance with the advice of that great botanist, the late Dr. Robert Brown, who more than once stated to me that such was the course he should recommend, and which he himself would adopt. To other more experienced botanists is left the task of comparing the ancient with the modern flora.'

It is therefore clear that Mr. Binney did not consider that he had finished the subject; and who can finish a subject? Other men more experienced in vegetable morphology have taken it up, and to them, and notably to Prof. W. C. Williamson, F.R.S., the task of continuing the observations of Mr. Binney is left, and in continuing we of course expect that improvement is part of the labour. Prof. Williamson has on several occasions objected to the views of Mr. Binney, who certainly did not pretend to a great knowledge of botany and vegetable physiology. This was not pleasant to Mr. Binney, but progress must be made, and Prof. Williamson spoke in the true spirit of a friend as well as of a scientific man.

Mr. Binney's views on many subjects were opposed to those of the community, and he never fully recognised the value of careful training. He certainly preferred the work of the student who was not trained academically. He was irritated by the destruction of the Natural History Society and by the removal of the Geological Museum to the Owens College. He was afraid that the Literary and Philosophical Society might be nullified in a similar manner, and determined to make it independent. Unfortunately he waited too long. His views are preserved in a speech he made at the Geological Society on the transference of its museum. It is in the proceedings of that Society as follows :—

(*Vol. VIII. Annual Meeting held in Museum, Peter Street, on Tuesday, October* 27, 1868. *G. C. Greenwell, Esq., F.G.S., President, in the chair.*)

Page 10. Mr. Binney : 'You are to consider what, in the event of getting rid of your museum, you are to do for a meeting place for this Society. There is now no Natural History Society. I hold that geology is to be advanced as a science, not merely by young boys in classes at college, but by practical amateur cultivators. Manchester has always stood preeminent for working scientific men. What have we to hope from Owens College with regard to our Society? Look back to see what its professors have done for us. When we are in the city of Dalton, the Henrys, Hodgkinson, Roberts, and a host of men who have raised it to its present position, why should we look to universities or colleges? What help has been received from them in building up this great hive of industry? It has nearly all been done by amateurs and practical men. I should like to ask gentlemen connected with the coal trade of Lancashire what assistance they have had from professors of science, either at Owens or any other college ; or what they expect for the advancement of the sciences of geology and mining from colleges, or young boys brought up at colleges? A college certainly can educate a man, no one doubts that ; and a good man when well educated will be better than one without education ; but still, it is impossible to have men made to order by colleges and other similar institutions. I consider that a city and a district like ours should have a Geological Society with a museum independent of a college. The latter may give a taste for geology, but for the advancement of the science a society is needed.'

Although beginning with an objection to colleges, he acknowledges their value before he ends. But he ceased to attend the meetings of the Geological Society here.

The character of Mr. Binney was a remarkable one: he had many of the characteristics of a great man, many of those of a little one. He would often take a wonderful pleasure in pleasing, and often seemed not to care how he hurt. He admired progress, but kept his habits unchanged, and his opinions, right or wrong, on almost all subjects and persons; he admired nature, yet he never made a journey much out of his way to see any of the great and beautiful things of the world. He had some fine poetic feelings as to the condition of creation, and some large views, but he never read books of literature, and was contented with those early known to him. He was really shy, and one may say in a sense, timid, yet roused he was defiant of every one. He was a gentle and pleasant companion, a most uncompromising foe. He was a most careful observer of many things, and yet not diligent enough to write them down; he delighted to *cogitate* on subjects without noting the results.

Mr. Binney died at Cheetham Hill, Manchester, on December 19, 1881.

Dr. Joule presented the Society with an admirable portrait of Mr. Binney by Mr. W. H. Johnson, and it hangs on the walls of the meeting room as a characteristic remembrance of a man who has been a friend, pleasant, sympathetic and wise, during an intimacy which to a few of us in the Society has lasted nearly forty years. His family have reason to thank him, and scientific history will not soon forget his labours among vegetation of the past, illustrating calm days in which coal grew to enrich us, or among the boulders and till, explaining the method in which they were deposited, making for us a pleasant or interesting land to dwell in.

APPENDIX D.

Account of some Remarkable Facts observed in the Deoxidation of Metals, particularly Silver and Copper, by Samuel Lucas, Esq., of Sheffield (*Read March* 6, 1818). *In a letter to Mr. Dalton. Memoirs of Lit. and Phil. Soc. Manchester, vol. viii.*

Page 271. . . . 'Dear Sir,—When I had the pleasure of seeing you in Manchester, I mentioned having observed that pure silver, when melted and while in a fluid state, had the property of uniting with a small proportion of oxygen, not only from the atmosphere, but also from other bodies which gave it out at a suitable degree of heat, as some of the nitrates for instance; and that the oxygen thus absorbed remains united with the silver only so long as it continues in a fluid state, or while fluid, until some substance be applied having a more powerful attraction for the oxygen. In proof of this I now send for your inspection a few specimens of silver that has been in the different states, and which carry the external marks; and also a bottle of the gas collected from silver, which had been exposed to the influence of the atmosphere by cupellation.' . . .

Page 272. . . . 'If, instead of cooling gradually, it be made to assume the solid state suddenly by pouring it into water, still the same phenomena occur; an ebullition takes place, and oxygen gas is evolved; but as the silver is so much divided and passes so suddenly from the fluid to a solid state, the protuberances are proportionally minute, and are spread more equally over the whole surface, as will be seen in specimen No. 2.' . . .

Page 273. . . 'Thus, if charcoal be spread, for a few moments only, on the surface of silver that has absorbed oxygen, the whole of the oxygen will immediately be taken from it ; no ebullition or escape of gas occurs, whether it be cooled gradually, as in specimen No. 4, or when poured into water as in No. 5.' . . .

Page 274 (note). I found this gas to contain 86 or 87 per cent. of oxygen.—J. D.

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