Handbook of the British Association for the Advancement of Science / by Mrs William Fison.

M. le Comte de Persigny
with the compliments
of the Author
Mrs Wm Fison

March 26th 16 New Steine
Brighton.

HANDBOOK

OF THE

BRITISH ASSOCIATION

FOR THE

Advancement of Science.

By Mrs. WILLIAM FISON,

AUTHOR OF

"THE HANDBOOK OF THE NATIONAL ASSOCIATION FOR THE PROMOTION OF SOCIAL SCIENCE," "HINTS FOR THE EARNEST STUDENT," ETC., ETC.

Inscribed, by Permission, to

SIR RODERICK IMPEY MURCHISON, G.C.St.S.,

PRESIDENT R.G.S., DIRECTOR-GENERAL OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN, ETC.

"All nature is but art unknown to thee;
All chance, direction which thou canst not see;
All discord, harmony not understood;
All partial evil, universal good."

LONDON:

LONGMAN, GREEN, LONGMAN, AND ROBERTS.

MDCCCLIX.

PREFACE.

In 1856, when the British Association held its Meeting at Cheltenham, the author was engaged, by the editor of the *Leisure Hour*, to attend, and report its proceedings for that journal. Through the kindness of the founders of the British Association, Sir David Brewster, Sir Roderick Murchison, Dr. Daubeny, General Sabine, Professor Phillips, and others, the author was then put in possession of valuable materials for drawing up an account of the "Rise and Progress of the Association," which was at first only intended for the readers of the *Leisure Hour*, but subsequently was published under the title of "A Sketch of the Rise and Progress of the British Association."

The favourable reception of that little work, and a high estimate of the importance of a steady pursuit of abstract science, as one of the most essential elements in the material progress of Great Britain, have led to the publication of this "Handbook."

The author has dwelt at considerable length upon the losses entailed through what has been well called "*the prodigality of ignorance*," but she has been led to do so from a deep conviction, that the material loss is but a small part of that incurred, by neglect of scientific truths. Thus

the connexion of Sanitary Science with the moral and religious condition of a people, is now recognised, though unfortunately public opinion is not yet sufficiently enlightened fully to appreciate all the bearings that the Science of Public Health has upon the highest interests of a great nation. To assist in popularizing correct views on such subjects, is at once the privilege and duty, not only of eminent scientific men, whose discoveries lend a lustre to their country and their age, but of the humble votary of science, who seeks to create a more just appreciation of their labours in the popular mind.

The author has again to express her obligation to the distinguished founders and members of the British Association, who have, in various ways, assisted her in her present work.

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"In a national or universal point of view, the labour of the savant or speculative thinker is as much a part of production, in the very narrowest sense, as that of the inventor of a practical art; many such inventions having been the direct consequences of theoretic discoveries, and every extension of knowledge of the powers of nature being fruitful of applications to the purposes of outward life. * * * No limit can be set to the importance, even in a purely productive and material point of view, of mere thought. Intellectual speculations must be looked upon as a most influential part of the productive labour of society, and the portion of its resources employed in carrying on and remunerating such labour as a highly productive part of its expenditure."

MILLS'S "*Political Economy.*"

WHEN reviewing the material progress of a great nation, it becomes a matter of high importance to ascertain, what have been the elements which have most contributed to a successful development of its resources; and the question will naturally arise, as to the nature of those which will tend most to advance a further progress of the highest order. The subject assumes a still deeper interest, when considered with reference

to the influence exercised by the Anglo-Saxon race over the whole earth; an influence which we believe to be associated with the fulfilment of the designs of Divine Providence, for the Christian civilization of the world, and consequently to be fostered and cherished by those to whom it is committed, as a talent surpassing in value any that has ever been entrusted to a Christian people.

In the present day, when "science has created resources unheard of before, and has removed the local barriers opposed to industry, and when we are rapidly approaching to, if we have not yet arrived at, the period of wonderful transition, when nations must speedily acquire the levels due to these different amounts of intellectual development, when competition in industry becomes a competition in intellect, when the nation most quickly promoting the intellectual development of its artisans must, by an inevitable law, advance, whilst the country neglecting its industrial training, must as inevitably recede;"* we think we are right in indicating the steady pursuit of abstract science, and the intellectual and industrial training of all classes of our population, as objects of the highest importance to our country, viewed as elements, not only in her material progress, but to enable her to realize and carry out all those enterprises of Christian philanthropy, which it is alike her glory, and her privilege to originate.

It has been remarked, by one of the most eminent scientific men of the present day, that "Providence has placed this nation in a position in which the very condition of its existence seems to be progression."†

Nations, as with nature, know no pause in progress and

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* Dr. Lyon Playfair on the study of Abstract Science.

† Dr. Daubeny, F.R.S., on the Application of Science to Agriculture.

development, without a penalty being attached to such inaction;* and "if England would still continue in advance, it will not be from the abundance of her coal and iron, but because, uniting science with practice, she enables her discoveries in philosophy to keep pace with her aptitude in applying them."†

The fact that every scientific discovery or improvement becomes the common property of mankind, and is ultimately made subservient to the furtherance of their highest interests, would, in itself, be sufficient, we should think, to command the co-operation and sympathy of every Christian man, who sees, in this remarkable element of progress, a pledge for the fulfilment of many promises in God's Holy Word; but an indifference to the advancement of Science has nevertheless been our national reproach, many persons having considered it as a subject purely theoretical, and at the best "but a training of the understanding, instead of viewing it as a firm basis for the discovery of truth." And, even in the present day, we so constantly meet with those who do not understand, or appreciate scientific research, that we might well despair of ever seeing the formation of an enlightened public opinion on this subject.

But the progress of the past may well make us feel hopeful as to the future, when we look back and trace the growth of scientific discovery, and mark how rapid has been its advance during the last three centuries. "If we revert back to the intellectual wanderings of science in its search for truth, it becomes surprising how soon it shook off the trammels of ignorance, and developed into a glorious liberty. It is no mean task for intellect to leap over the barriers of ignorance: it is even more easy to go onward in new and untrodden paths.—The progress of

* Goethe adapted by Humboldt. † Dr. Lyon Playfair.

knowledge, the search after truth, can scarcely be recognised in its sublimity, by those who do not understand the errors which had to be swept away, before it could advance in an uninterrupted path."*

Even beneath the shadow of scholasticism, in the cloistered cell, were the foundations being laid of modern Science, by the observations and experiments of the simple-minded men, who pursued their investigations amid difficulties, of which we, who live in a happier age, can form no conception. It is certain that many facts relating to experimental philosophy were current during the Middle Ages. This we learn from the writings of Roger Bacon and others, but some power was wanting to give the existing elements of scientific progress life and unity. Knowledge could not ripen into general principles (however extensive that of the isolated observer might be) while requiring aids and appliances, which the solitary individual could not obtain. Discoveries of the highest value to human progress "even became corrupt in the dull stagnation of the mystery in which they were buried, and were used only as means of influence over the ignorant, as instruments of superstition or imposture, sources of delusion to their possessors themselves. Astronomy became astrology,—chemistry, alchemy,—natural philosophy, magic. Brewster has shown how the concave mirror brought up an apparition when it was needed, and Boutigny has revealed how the repulsive energies of heat ministered to the iniquity of the ordeal." †

Confined as the science of the time was to the narrow limits of the school philosophy, its progress was still further opposed by the intolerant spirit of the age, which could persecute a Copernicus and a Galileo.‡

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* Dr. Lyon Playfair. † Dr. Robinson.

‡ Centuries before the appearance of Lord Bacon, lived an obscure Monk named Roger Bacon, that "early star predicting dawn," who,

There were, doubtless, many solitary votaries of science, who, in their patient investigations into nature, might catch a glimmering of that light which dawned on the world, when the great representative of modern science, Francis Bacon, Lord Verulam, appeared.

It has been well said, that "there are two men who divide the philosophical history of the seventeenth century between them,—Bacon and Descartes. Speaking of the philosophy of this century, M. Cousin says, "Deux hommes l'ouvrient et la constituent."*

Substituting nature and experiment, for the tame and subtle speculations of the schoolmen, and the method of induction for the old system of Aristotle, the English philosopher entirely changed the course of inquiry, and exercised an important and highly beneficial influence upon future generations of scientific observers.

Fortunate in living at a time when one great object of the Reformation, viz., *the emancipation of the human mind*, had been widely promulgated, Bacon, when he laid the foundation of inductive science, did so with the spirit of a reverent minister and interpreter of nature. He believed in his Bible, and science, no less than philosophy, felt its influence.

From the time he stood forth as a wise truth seeker, and as the inductive philosopher, opposing himself to mere speculations and hypotheses, unprofitable scholastic discussions and subtleties, regarding the Word and the works of God as

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for his many discoveries in optics, chemistry, and astronomy, was charged by his brother Franciscans with practising the black art, and being possessed by the devil. He was kept in close confinement for ten years, his great offences being, that, through his scientific researches, he was in advance of his age, thus encountering the ignominy and persecution that have often been the portion of those who thus distinguish themselves. After ages have done justice to the obscure Friar.

* Two men originated and constituted it.

our only revelation, the dominion of the scholastic philosophy, of deductive *à priori* science began to pass away.

"Man," writes Bacon, in some of his grand aphorisms, "as the minister and interpreter of nature, does and understands as much as his observations on the order of nature, either with regard to things or the mind, permit him, and neither knows nor is capable of more."

"The sole cause and root of almost every defect in the Sciences is this, that while we falsely admire and extol the powers of the human mind, we do not search for its real helps."

"The subtlety of nature is far beyond that of sense or understanding, so that the specious meditations, speculations, and theories of mankind, are but a sort of insanity, only there is no one to stand by and observe it."

"There is no small difference between the illusive conceptions of the human mind and the ideas of the Divine mind—that is to say, between certain idle dogmas, and the real stamp and impression of created objects as they are found in nature."

With the progress of a free spirit of inquiry into the principles, laws, and limits of human knowledge, there arose attempts to systematize and combine them. The era of Bacon gave birth, as we have seen, to fresh and independent attempts of reason, to ground philosophical knowledge on experiment; and "the same century in which the 'Thema Cœli' of Lord Verulam, and the 'Nuncius Sidereus' of Galileo, saw the light, was glorified by the publication of the 'Philosophiæ Naturalis Principia Mathematica' of Newton."*

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* Professor Owen's Address, as President of the British Association at Leeds.

But the time was come when the lusty spirit of liberty and progress which had arisen with the Reformation, was to manifest itself in a principle of free spontaneous association, which, by the extensiveness of its operation, should play an important part in the extraordinary development of the succeeding age.

In the "New Atlantis" of Lord Bacon, he had prefigured an institution which he called "Solomon's House," which grand philosophical dream doubtless gave rise to the first Scientific Association of Great Britain.

"The end of its foundation," said this great philosopher, "is the knowledge of causes and secret motions of things, and the enlarging of the bounds of human empire to the effecting of all things possible."

In the first stage of its action, the principle of association linked together only a few scientific men, drawn to each other by a sense of kindred pursuits and powers. In 1645, a small club of such persons assembled weekly in a room above an apothecary's shop in the Strand, to discuss such subjects as Hervey's discovery of the circulation of the blood, &c. A year after this period, the principal members of this little scientific association congregated at Oxford, but so few were they in number, that they called themselves the *Invisible College*. A description was given of them by the Hon. Robert Boyle, in the following words:—"The best on't is, that the corner stones of the 'Invisible' are men of so capacious and searching spirits, that the school philosophy is but the lowest region of their knowledge."

But amidst the troubles of civil war, the little band again had to disperse, meeting again at the Gresham College, London, whence, after a year, they were obliged to leave, that the college might be used as a barrack for soldiers. In 1660, the meetings were again resumed, and in 1662, Charles

the Second constituted this band of philosophers "His Royal Society to Improve the Knowledge of Naturell Things, and all Useful Arts, Manufactures, Mechanic Practices, Engynes, and Inventions by Experiments." Such was the origin of the Royal Society of Great Britain, and among its members were the noblest and choicest of England's sons,—the pious and estimable Robert Boyle, the well-known John Evelyn, Sir Christopher Wren, the great naturalist Ray, Bishops Wilkins and Denham, the astronomers Flamstead and Halley; and last, but not least, it was to this little band of truth seekers, that Newton presented the "Principia," while it was also to them that was first communicated man's mastery over steam, when Savery exhibited before them his engine to raise water by means of fire.

For some time the Royal Society was little more than a collector of detached facts and observations, and as there was no other society when it was first established, devoting itself to the pursuit of any branch of knowledge, it received communications embracing a very wide range. The rapid increase of knowledge of all kinds rendered at last a division of labour necessary; and, in 1717, the institution of the Society of Antiquaries took away one large class of communications, while, seventy years later, the Linnæan Society was founded for the cultivation of Natural History. Another Society was formed to devote itself to Geology, another to Astronomy, and various other Societies were subsequently called into existence according to the exigencies of the age, leaving the parent stock only the more vigorous for the frequent disruptions of her progeny.

"If it were possible for any one of that small but illustrious band of philosophers—who just two centuries ago were associated in Gresham College for the purpose of mutually communicating and receiving knowledge, and who

there laid the foundation of the Society which is now assembled—to revisit the scene of his former labours, we may well conceive the delight which it would afford him to learn, that the success of that noble enterprise had been so much greater, than his most sanguine aspirations could have led him to anticipate. Not only would he find an ample development of sciences which were then in the embryo state of their existence, but he would find other sciences, not inferior to these in interest and importance, added to the list. He would find, that, instead of a limited number of individuals who were then occupied with scientific inquiries, whose labours were held in little estimation by the general public, and even held to be objects of ridicule by the presumptuous and ignorant, there is now a large number devoted to the same pursuits, and successfully applying to them the highest powers of the human intellect. He would perceive that, instead of being confined, as it were, to a corner, the love of knowledge is gradually becoming extended throughout the length and breadth of the land; and that of those whose position does not afford them the opportunity of penetrating to the inmost recesses of the temple of science, there are many who, having advanced as far as the vestibule, are enabled even there to obtain their reward, in the improvement of their own minds, and in being rendered more useful members of the community." *

But the principle of voluntary association which had been the instrument of binding together the scientific and learned in the Royal Society, was destined, at a future time, still further to manifest its mighty power; and we shall, in a future Chapter, have occasion, in tracing the Rise and Progress

* Address of Sir B. Brodie, Bart., as President of the Royal Society, December 9th, 1858.

of the British Association, to present a most remarkable exhibition of its efficiency.

Prior to the period of the foundation of this Society, the privilege of labouring to extend the boundaries of knowledge was the glory of a chosen few; and even when the age of Societies began, many years elapsed before this attempt was made to widen the portals of the palace of Truth, and throw down the barriers which rigidly enclosed the aristocracy of science.

Thus, till within a very recent period, the cultivators of science in Great Britain were, comparatively, few in number; and, as the larger proportion of our population were incapable of estimating its value, they rested happy and contented in their ignorance, looking upon science and scientific men with equal indifference; the name of the former being identical, in their minds, with crude theories and speculations of the wildest character, and the latter with that of men who, for the sake of such theories, were capable of the greatest extravagancies.

Quite unaware of the connexion between theoretical science, and the development of the industrial arts, and that abstract science is necessary to the full development of a nation's resources, "Practice, standing still in the pride of empiricism, and in the ungrateful forgetfulness of what science had done, reared upon its portal the old and vulgar adage, 'An ounce of practice is worth a ton of theory;'" and as it was incapable of appreciating the labours of the scientific man, so refused to believe in the high value of the science to which he devoted a lifetime.

While we may well regret that the claims of science and scientific men should have so long remained unrecognised to a proper extent, and that the cause of such neglect should be the inability of successive Governments, to appreciate the value of pure scientific research to a great nation, we do not

fail to remember that a part of this singular deficiency may be traced to the very character of the free constitution under which we have the happiness to live. The leading statesmen of Continental Europe, who have had ample experience of the working of a despotic system, which substitutes itself for the collective or individual action of the people, and which subordinates everything to its own initiative, to its own correction, authorization, supervision, intervention, and personal interest, state, in the most unhesitating manner, their conviction that the life and strength, the greatness and stability, of England, are the results of a constitution and a system of government under which "the chief interests of all civilized peoples—education, charity, police—strike their roots, and draw their sap from the inexhaustible reservoir of the independent wills and spontaneous sacrifices of twenty millions of Christian souls."

Count Montalembert, in his recent work on England, remarks :—

"If we descend from individuals to the mass, and if we seek to investigate profoundly the distinctive traits of the English people in its political action, we shall find that the characteristic virtue of English society is, exertion,—personal, prolonged, energetic, and spontaneous exertion. Now, every one knows that exertion is the first condition of merit and of virtue in our temporal life, as in our spiritual. The system of Government which excites most to exertion, to labour, to struggle, is that, then, which contributes the most to the morality of a nation, as to its honour. This is the peculiarity of a representative Government, perfectly comprehended and applied, in that particular which is most important of all, by the Anglo-Saxon race. There, no one dreams of requiring the Government to do everything, to provide everything, to teach everything, to decide everything. The

Englishman gives his money, his time, his name, to a work of charity or of public interest; he makes it his glory that the enterprise which he has thus adopted should be kept on a level with all the requirements and progress of the age; but in order to accomplish this, he does not dream of invoking or accepting the meddling hand of the agents of power, in regard to everything which his forefathers and himself have founded."

Another eminent statesman, the late representative of Prussia at the Court of St. James's,—Chevalier Bunsen,—thus speaks of the impressions which he had received after fourteen years' residence in England:—

"On my return to my own country, last summer, I began to compare the impressions with which I had left Germany, with the more ripe views which, through more extended study, and a more large experience, I had obtained. I confess, as a German and a Prussian, not without sorrow, that experience and reflection have convinced me of the truth of the political principle, that the system of centralisation is inconsistent with the education of the people to true freedom, and is a system which, in the long run, weakens more than it strengthens that authority of the State in behalf of which it is maintained. By centralisation I mean the common Continental system of governing merely by Government officials. The necessary operation of this system is to keep the people in perpetual tutelage, to interdict them from performing the slightest function of public life on their own motion, and to prevent the existence of any social organism alongside of itself." *

* "It is necessary," says Lieber, "to have seen nations who have been trained for centuries to submit to constant and minute police interference, in order to have any conception of the degree to which manly action, self-dependence, resoluteness, and inventiveness of proper means, can be eradicated from a whole community."

Chevalier Bunsen mentions, as one of the phenomena which stood forward to his mind's eye as signs of the times, both by the extensiveness of their operation, and by the pregnancy of their significance, the power of free spontaneous association, remarking that, in Great Britain generally, there is scarcely any great movement, or public work of which the roots are not to be found in that principle. The difference, then, between the comparative helplessness of the so-called paternally-governed nations of Europe, and the spontaneous energy and self-helping ability of the English people, may be traced to the difference of discipline—the one being a natural result of a state-superintending policy, while the latter is the consequence of a constitution which leaves much to the action of a free people.

Nor let us forget, when we justly arraign the past governing powers of our nation, that, whatever may be the duty of the national body, in that collective capacity as a Government, is their duty individually. Still further, it has been affirmed, and with truth, that a Government cannot be lastingly neglectful of a great duty, but because the individuals constituting the community are so.* We are too apt to speak, as if our Government, which, in our happy country, is essentially a representative one, were an affair entirely foreign to our own duty, will, action, and responsibility. When we assert, that, until within a recent period, the Government of Great Britain has been criminally neglectful, through every change of its Ministry, of the education and moral condition of the working classes, can we also say that the majority of persons of rank, influence, and intelligence, have, all the time, been earnestly engaged in seeking

* "The submission of a free people to the executive authority of Government, is no more than a compliance with laws which they themselves have enacted."—*Letters of Junius.*

remedies for such evils? Had such an enlightened spirit existed and prevailed widely in past years, England would not have lagged behind in the educational race.*

The truth is, that the advocates of education have had to combat an amount of prejudice and ignorance on the part of influential members of society, which might well have discouraged and paralyzed all exertion, had they looked for their reward, in the appreciation of their labours, to those around them.

We, therefore, must ascribe a great part of the glaring neglect of the improvement of the people which meets our eye, when we review our national history, to the ignorance of individual responsibility, to obligations lying on all classes of society, often irrespective and independent of the institutions and administration of Government.

But there are most significant and important signs in the present state of society in Great Britain, which are, to us, rich in promise for the future.

In 1790, one of the greatest statesmen of the day, Mirabeau, replied, to those who prophesied the downfall of England,—"England lost! In what latitude, let me ask, is she likely to be wrecked? I see her, on the contrary, active, powerful, issuing with renewed strength from every agitation, and filling up any hiatus in her constitution with all the energy of a great people." Had this illustrious Frenchman lived in our times, and beheld the breaking up of the old political divisions of Whig and Tory, the union of men belonging to every rank of society in the cause of national progress and popular improvement, we think he would, with a double emphasis, have reiterated his sentiments.

Some persons, who belong rather to the past than to the present age, imagine that, while all things around us

* See Foster on Popular Ignorance.

are in ceaseless motion, we may still preserve our relative position among them, if we contentedly stand still on the margin of the everflowing tide of progress; but it has been well said, "that, if we would partake of the advantages, 'pursue the triumph, and partake the gale,' our little bark must be attached to the vessel whose onward course we shall in vain attempt to check."

As we believe that all institutions which are incapable of advancing with the general tide, must, sooner or later, be swept away, so we recognise, in the power of England to fill up any hiatus in her constitution, a source of strength and duration of the greatest value.*

Believing it to be a general rule, "that that which is to last long is often slowly matured, and gradually improved," we rejoice to know that the deficiencies we now proceed to notice are slowly giving place to what will, doubtless, ultimately, expand into a system of industrial education, equal, if not superior, to that of Continental nations. We would gladly do anything in our power to hasten such a desirable change, and hope we shall not be misunderstood in the remarks we now proceed to make, which are based on facts of the highest importance.

It was declared by Mr. Huskisson, in his celebrated speech on the shipping interests, "that England cannot afford to be in arrear of any other nation in the progress of useful improvement." And another patriotic character, Mr. Douglas, of Cavers, in a pamphlet, called "The Prospects of Great Britain," thus speaks on this subject:—"Pre-eminence in knowledge is necessary to the existence of

* "This is not the liberty which we can hope,—that no grievance should ever arise in the commonwealth, that, let no man in this world expect; but when complaints are freely heard, deeply considered, and speedily reformed, then is the utmost bound of civil liberty attained that wise men look for."—*John Milton.*

Britain. In the resources of an extended territory, she is far behind the great nations of Europe,—France, Austria, and Russia, not to mention the rising States of America; but in the immediate application of moral energy and intelligence to all the purposes of a high civilization, no country can compete with Britain, were she enlightened as to her interests, and true to herself. No other country, with a nearly equal portion of liberty, ever did so little for science as Britain in proportion to its riches, population, and extent. Whatever has been done, has been effected by the efforts of individuals, not by the aid and encouragement of the State. The free cities of ancient and modern times have in general been eminent for their patronage of science and art; but the English seem anxious to justify the accusation brought against them, that they are merely a 'nation of shopkeepers,' and that their thoughts never soar above the profit and loss of their trade.

"The scientific pursuits, which are least remunerative to the student himself, contribute ultimately most to the advantage of the country. The higher regions of science, though barren to the cultivator, are the well heads from which the lower departments are refreshed and watered."

We would ask those who despise theoretical science, if they are aware that the first process of philosophical induction is to systematize and extend a knowledge of facts; and that, in their low estimate of philosophical research, they are throwing contempt upon the great prerogative of man, in the exercise of his reasoning powers, upon those facts.

"To the formation of science," Dr. Whewell has well observed, "two things are requisite—facts and ideas; observation of things without, and an inward effort of thought; or, in other words, sense and reason. Neither of these elements, by itself, can constitute substantial general know-

ledge. The impressions of sense, unconnected by some rational and speculative principle, can only end in a practical acquaintance with individual objects; the operations of the rational faculties, on the other hand, if allowed to go on without a constant reference to external things, can lead only to empty abstraction and barren ingenuity. Real, speculative knowledge demands the combination of the two ingredients—right reason, and facts to reason upon. It has been rightly said, that true knowledge is the interpretation of nature, and thus it requires both the interpreting mind, and nature for its subject, both the document, and the ingenuity to read it aright. Thus, invention, acuteness, and connexion of thought are necessary, on the one hand, for the progress of philosophical knowledge; and, on the other hand, the practice and steady application of these faculties to facts well known, and clearly conceived. It is easy to point out instances in which science has failed to advance, in consequence of the absence of one or other of these requisites."

"Art," writes Sir John Herschel, "is the application of knowledge to a practical end. If the knowledge be merely accumulated experience, the art is *empirical;* but, if it be experience reasoned upon and brought under general principles, it assumes a higher character, and becomes *a scientific art.*"

Science has been aptly designated as "the one word faithful and true to the sublunary scheme of things." "The abstract sciences," continues the same writer, "are the concentration of what has been established as true in the operations of nature—they are so much of certainty acquired in the midst of uncertainty. When sufficiently advanced to be directly applicable to the industrial and other arts, they convert the crawl of improvement into a race." Theory thus *is the rule,* of which practice is the example.

Mathematical, mechanical, physical science, and chemistry, are the sources, we repeat, of a very large portion of our industrial wealth, and yet often have abstract researches of this nature been stigmatised as purely theoretical, "forgetting," as Humboldt observes, "that, in the observation of a phenomenon, which, at first sight, appears to be isolated, may be concealed the germ of a great discovery."* Another eminent philosopher thus speaks of the scientific processes by which one of the greatest discoveries of the age was made applicable to the purposes of common life:—"The steam-engine, in its rudest form, was the result of a chemical experiment. In its refined state, it required the combinations of all the most recondite principles of chemistry and mechanics; and that excellent philosopher, who gave this wonderful instrument of power to civil society, was led to the great improvements he made by the discoveries of a kindred genius on the heat absorbed when water becomes steam, and of the heat evolved when the steam becomes water."† It is true that the value of theoretical and abstract investigations is not always manifested in their immediate application. To

* "When Galvani first stimulated the nervous fibre by the accidental contact of two heterogenous metals, his contemporaries could never have anticipated that the action of the voltaic pile would discover to us, in the alkalies, metals of a silvery lustre so light as to swim on water, and eminently inflammable; or that it would become a powerful instrument of chemical analysis, and at the same time a thermoscope, and a magnet. When Huyghens first observed, in 1678, the phenomenon of the polarization of light, exhibited in the difference between the two rays into which a pencil of light divides itself in passing through a doubly refracting crystal, it could not have been foreseen, that, a century and a half later, the great philosopher Arago would by his discovery of *chromatic polarization*, be led to discern, by means of a small fragment of Iceland spar, whether solar light emanates from a solid body, or a gaseous covering; or whether comets transmit light directly, or merely by reflection."—*Cosmos of Humboldt.*

† Sir H. Davy.

perfect the series of developments, the labours of many minds may be required, and years may elapse before the full harvest is reaped.

The greatest practical discoveries of our time are the result of deep and patient study, the exponent of long-continued and often-repeated observations and experiments. When Boyle, in the seventeenth century, entitled his Essay, "Man's great Ignorance of Natural Things, or that there is no one thing in Nature whereof the Uses to Human Life are yet thoroughly Understood," he enunciated a truth, which we, of the nineteenth century, see daily further elucidated in scientific discovery,—"the history of the intermediate time being," as Sir John Herschel remarks, "but one commentary on the text."

Thus the cultivation of science creates resources not thought of before, and the intellectual development of a people, and the industrial training of its artizans, become objects of the highest importance, to enable one country to compete with others. As we know that abstract science, in its practical results, has no limits, so we must cease to place empiricism as its substitute, and not rest satisfied till we see a wide diffusion of the knowledge so essential to our continued national prosperity.

"Nothing," says Humboldt, "but serious occupation, with chemistry, and natural and physical science, can defend a state from the consequences of competition. Man can produce no effect upon nature, or appropriate her powers, unless he is conversant with her laws, and with their relations to material objects, according to measure and numbers. And in this lies the power of popular intelligence, which rises or falls as it encourages or neglects this study. Those nations which remain behind in manufacturing activity, by neglecting the practical applications of the mechanical arts, and of indus-

trial chemistry, to the transmission, growth, or manufacture of raw materials; those nations, among whom respect for such activity does not pervade all classes, must inevitably fall from any prosperity they may have attained; and this by so much the more certainly and speedily as neighbouring states, instinct with the power of youthful renovation, in which science and the arts of industry operate, or render each other mutual assistance, are seen pressing forward in the race." One of our own most eminent scientific men has called the phrase, "*practical man*," a title erroneously used by our English to envelope their ignorance,* and asserts that our reliance on the "*practical* or common sense of our population, is the sunken rock, directly in the course both of our agriculture and manufactures." "If," continues Dr. Playfair, "England keeps pace with other countries as a manufacturing nation, it must be by her sons of industry becoming humble disciples of science. Now that the progress of human events has converted the competition of industry into a competition of intellect, it will no longer do to plume and pride ourselves on our power of mere practical adaptations. It is miserable to see our industrial population glorying in their ignorance of the principles on which their manufactures depend, and vaunting their empiricism, or, as they term it, their *practice*."

It has been asserted, and we believe correctly, that while there is no country where national prosperity is more connected with scientific knowledge, through its agricultural, commercial, and manufacturing interests, than our own, and where heavier losses are incurred through neglect, in no part of the civilized world have science and its cultivators received less honour.†

This low appreciation of its value arises, in a great measure, from the ignorance that exists, even in the present day,

* Dr. Lyon Playfair. † Dr. Robinson's Address.

in the minds of certain individuals, in all classes of society, with regard to the intimate connexion between the development of the industrial arts and pure science. The vast importance of the former is realized by every inhabitant of our island, from the man of wealth, who lives in the enjoyment of every luxury the appliances of art and science can bestow, to the pariah of the crowded city, who, in the scant supply he is able to obtain of the necessaries of life, shares in the common benefit.

But to estimate, at its full value, all that science confers upon us, as the handmaid of the arts of native production, distribution, and transformation, and to recognise it, as the means through which their progress has been accelerated latterly to such a remarkable degree, requires an acquaintance with its primary elements, in which English education has been singularly deficient.

Much has undoubtedly been done, since the beginning of the British Association by that and kindred Societies, to diffuse more enlightened views, but still much remains to be accomplished, for the evil of which we speak is of too radical a nature to be easily uprooted. Lord Coke has said "that to trace an error to its fountain head is to refute it :" "a species of refutation, which," Mr. Bentham remarks, "is, with many understandings, the only one that has any weight ;" and we shall now, therefore, endeavour to show whence this strange indifference on the part of a great nation, has arisen.

Until very recently, the facilities for obtaining the mere elements of science in this country were few, and in this respect, both the Continent of Europe and the United States of America have been far in advance of England. It is true that, at our universities, mathematics has received due honour ; but there has been little or no encouragement paid to physical science in its many branches.

"It is melancholy," says Mr. Grove, in the Report of a Committee appointed by the British Association, "to see the number of Oxford Graduates who do not know the elementary principles of a telescope, a barometer, or a steam-engine. The contempt of anything manual or mechanical, which Bacon so strongly reproved, still prevails to a large extent among the upper classes. It is true that, by the recent statutes, physics are recognised; but they are not made compulsory or necessary. From what I saw when resident at Oxford, the *genius loci* is so far removed from such studies, that unless they are made compulsory, or tempting prizes are held out, the minds of young men will not, for an indefinitely long period, be directed into that channel; and thus, though the examination papers will look very well to the public, science will form no integral part of a university education."

Yet how ill adapted to the necessities of the times is the old and still cherished scholastic system of education introduced in the 14th and 15th centuries! "When," asks a living philosopher, "will our schools learn that dead literature cannot be the parent of living science, or of active industry?" We have ourselves often marked the inconveniences suffered by Oxford and Cambridge Graduates from their neglect of physical studies during their university education. "A man who has taken a first-class *in literis humanoribus*, may be ignorant of physics in the most elementary form, and be incapable of comprehending the first principles of machinery, or of forming a just and enlarged conception of the resources of this great country;" * and that this one-sided development of mind has been, to a great degree, the characteristic of our universities till within a very recent period, few, we think, will deny. Many noble exceptions are there to such a rule,

* Lord Rosse's last Address to the Royal Society.

but it may fairly be said, that if advance has been made in physical science in our ancient universities, "it has rather been in spite of, than by reason of the system pursued in those otherwise useful, noble, and magnificent institutions." "My own university (Oxford)," said the Earl of Harrowby, when, as President, he addressed the British Association, "to which I acknowledge, in other respects, the highest obligations, did little for physical science. True, that the study of mathematics, as an exercise and training of the understanding, received its honours there, though the genius of the place has never been favourable to the pursuit; true, that until comparatively a recent period, the honours of the sister university were exclusively, or nearly so, confined to the same science, and that the school of Newton has seldom been without names not unworthy of such a founder: but, even there, the mathematics were still too exclusively regarded as a mere training of the understanding, and not as an instrument for the discovery of further truth; and the fair tree of science, planted within the academic courts, though healthy and vigorous, was somewhat barren of fresh fruit: rich as it had been in the time of Newton, such, in a great degree, for a century and a half, at least, it remained. But to other than mathematical science, I believe I may say at either university, encouragement there was little or none."

The opportunities presented to those who could not afford to send their sons to the university were still more limited. Public and private schools, where Latin and Greek were the principal objects of study, were their only resource; while in the national schools for the poor, with trifling exceptions, reading and writing were considered sufficient.

While Germany and Switzerland, with their Real, Technological, and Scientific Schools, France with her Polytechnic

and other institutions, and America with her Lyceum System, were rapidly diffusing the elements of scientific knowledge among their population, Great Britain contentedly remained stationary.

When, in the beginning of this century, the elementary education of the children of the poor became a subject of national interest, there was still no recognition of the very defective state of education for the middle classes of society.

Centuries ago, the founders of our universities and endowed schools could bestow no greater help to progress than to provide for classical instruction (the only medium through which the student could obtain access to the learning of the age); but since that period, the Anglo-Saxon, and other modern languages, have expanded into most noble channels for the conveyance of thought, and, in their turn, have become the key to intellectual and moral progress. Not like our forefathers, who, in a less enlightened age, did the best thing in their power, the heads of our colleges and public schools, with strange infatuation, clung to old routine, and, while other countries were adapting their education to the progress of the existing period, condemned their students to toil on in the track prescribed at a time when those modern languages were as yet immature and unformed. The executive and legislative bodies, being thus composed of persons who had never received the elements of scientific knowledge, or an education calculated to give enlarged views of the requirements of national progress, were unaware of the dependence of the State for its full and happy development upon the wide extension of scientific knowledge, and an enlightened education.

If we trace the effect of these evils upon the lower classes, we shall find them operating to a most injurious extent. So low an estimate was put on the value of an educated popu-

lation, that the culminating point of most systems of agriculture was to improve different species of cattle, rather than to give attention to the labourer; and the danger of educating the lower orders was openly deprecated by their superiors in rank and position, on the ground that obedience was the legitimate offspring of ignorance.

The British Government neglected the education of the people, and, ignorant alike of the laws of God and man, the tiller of the soil, and the wretched denizen of the crowded city passed through life unaware that he was deprived of his most noble heritage, viz., the knowledge of his moral dignity as man, and his claim to the development of his intellectual and moral faculties. Slowly, and as yet but imperfectly, has a change been effected. Government has become aware of the mutual relation between an intelligent population and national prosperity, and a system of enlightened education is gradually spreading its beneficent influence. But it is a singular fact, that imperfectly developed as is the education of the poor, it has already made such progress, that it is, in many respects, in advance of that provided for the middle classes. "We should certainly," it has been well said, "have, in a very few years, a complete overturn of social order—'now servant is master and master is man'—if, when the son of any poor labourer in a common parish school may attain such knowledge as the pupil teachers of any well-regulated village school now possess, the squire's son were to be allowed, unmolested, to enter on the quiet possession of his acres, and stand for the representation of his county in Parliament, with that scanty modicum of misunderstood Latin grammar, and Horace committed most imperfectly to memory without being construed, which, we fear, is sometimes still dignified with the name of education. We are confident that there are many sets of freshmen at present in

our universities, who know less of arithmetic, history, geography, and, above all, of the Bible, than the first class of the parish school, frequented by their fathers' gamekeepers. Moreover, the middle schools, frequented by the children of small tradesmen and farmers, are notoriously much less efficient than our lower schools. It would not be sound policy, while we greatly improve the education of the children of the poor, to allow that of the higher classes to remain stationary."

The consequence of this primary defect in English education is to be traced through every rank and station of English society, and accounts for the past indifference of the State, dependent though it may be, for "the full development of its agriculture, its mining interests, its manufactures, and its commerce, upon the widest extension and the fullest cultivation of science."

We find that the executive and legislative bodies of our land had, thirty years ago, such inadequate and indistinct ideas of the ends proposed, and benefits to be conferred by science, that they did not scruple openly to express their dislike and contempt of its cultivators as dreamers and mere theorists. "The head of a great military department once said that he hated scientific officers! Any one of his officers could have told him that more money had been wasted and lives lost in that department, from sheer ignorance of science, than any one could think of without shame and sorrow. The question which I know to have been asked by another in high places, though milder in expression, was not less scornful—'Of what use is Science?'" * It is not long since another general officer gave it as his opinion, that "theoretical knowledge was not necessary in the army. An officer might be a good officer without any education at all, though the

* Dr. Robinson.

advantages of education would undoubtedly be of great moment to any one."

In the life of Sir H. Davy, written by Dr. Paris, the author remarks that a Government "that had bestowed a splendid pension (£1,200) for the *destruction* of human life, refused to listen to any propositions for the reward of one who had invented a machine for its *preservation.* This reversal of the objects of importance can never be redressed until the aristocracy shall be possessed of a competent share of scientific knowledge, and instructed to appreciate its value."

We have heard that one of our legislators not very long since, when speaking of his own ignorance with regard to science, lamented that he had been born in a pre-scientific era, referring, we presume, to the absence of scientific instruction in our schools and universities till up to a very recent period.

"The history of science and scientific men, of inventions and inventors, proclaims the melancholy truth, that England stands ignominiously behind every other nation in the patronage of Science and the Arts; and stands, too, with a statute book in her hand, defaced with unjust and oppressive laws, subversive of the highest interests of science, and hostile to the diffusion of knowledge and the progress of civilization. By her patent laws, she sells, exorbitantly and ruinously to inventors, all illusory privilege, bearing the Great Seal of England; while in her courts of law she strives to rob them of the boon she has conferred. By her laws of copyright, she seizes the property of authors, and refuses to the productions of the brain the protection which she accords to every other species of property. She prohibits the free importation of works of Science and Art, teeming with theoretical and practical knowledge, invaluable to the cultivators

of science, and calculated to promote even national interests. She imposes a tax upon paper, thus preventing the publication of works of profound science and learning, retarding the diffusion of knowledge, and impoverishing the unfortunate authors of valuable works which are too profound to be popular, and too expensive to be saleable." *

While other Governments give large endowments for the support of institutions connected with industrial science, England is the only state where science has not been sufficiently fostered to make the same advance as in other lands. The public look in general only to the empirical result, and are not yet thoroughly awakened to the importance of giving scientific training to those engaged in mechanical labour. It is true that great progress has been made in this respect, and that our School of Mines and other institutions attest a growing change in popular feeling; but until the elements of science are much more widely diffused than they are at present, we cannot expect to see an enlightened public opinion, and a due appreciation of the labours of scientific men.

The truth of the comparison made by Sir David Brewster between the patronage bestowed upon scientific men by foreign Governments and our own, cannot be denied. While he eloquently draws the painful contrast, he describes the honours received by Leibnitz, the great rival of our own Newton, not only in Germany, but in England. When George the First ascended the throne of Great Britain, he invited Leibnitz to this country. Sir David also mentions the names of Lagrange, Laplace, and other eminent scientific men, to whom honour and wealth were awarded by their respective sovereigns.

Napoleon Buonaparte, "the extraordinary man," he writes,

* Sir David Brewster.

"who then wielded the destinies of France, was not slow to honour the genius of the most distinguished of her citizens. He created Lagrange a Senator of France, a Count of the Empire, a Grand Officer of the Legion of Honour, a Grand Cross of the Imperial Order of Réunion; and when this illustrious person sunk under the weight of his years, his remains were deposited in that noble mausoleum on which France has engraved this inscription—'Aux grands Hommes la Patrie Reconnaissante.'"

Laplace, from the humble situation of Professor of Mathematics in the Military School at Paris, was made President of the Conservative Senate, was created a Count and Marquis, and received every mark of respect and affection, not only from Napoleon, but from Louis XVIII. and Charles X. In mentioning the honours conferred by princes on illustrious men, England, Sir David remarks, holds a very subordinate place, and he mentions her liberality to Newton as the only instance. He concludes this subject with the following powerful and energetic remonstrance against the nation's neglect of the immortal Watt:*—"He who buckled on the weak arm of man a power of gigantic energy,—who taught his species to triumph over the inertia of matter, and to withstand the fury of the elements,—who multiplied the resources of the State, and poured into the treasury the spring-tide of its wealth,—the immortal Watt,—was neither acknowledged by his Sovereign, nor honoured by his

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* The engine of Watt has proved the very Hercules of modern mythology, the united steam power of Great Britain being equal, it is estimated, to the manual labour of upwards of four hundred millions of men, or more than double the number of males supposed to inhabit the globe.—*Quarterly Review*, 1858.

The steam-engine is at work in every factory in the kingdom, and above fifteen millions sterling are annually gained by the nation in the saving of power alone.

Ministers, nor embalmed among the heroes and sages of his country."

We must not forget to mention that, when in 1824, five years after his death, a parliamentary vote was proposed for a monumental reward, Lord Liverpool had the boldness to answer, that there was no precedent for granting to intellectual merit what had been accorded to military and naval services, and that the Government might be embarrassed by similar claims. In consequence of this declaration of the Minister, a public meeting was held, at which some members of the Cabinet confessed that by the aid of steam the fate of a war might have been decided, and that, but for the inventions of Watt, *the safety of the State* might have been compromised, and yet the most simple token of a nation's gratitude was refused him by these statesmen.

But though the Prime Minister could not comprehend the claims of Watt in comparison with a Marlborough, a Wellington, or a Nelson, he called him "one of the most extraordinary men to whom England has given birth, one of the greatest benefactors of the human race."

Sir Humphrey Davy did not scruple to place Watt above Archimedes. "Look," said he, "at the metropolis of this powerful empire, at our cities, our villages, our arsenals, and our manufactures; examine the subterranean caverns, and the works executed on the surface of the globe; look at our rivers, our canals, the seas which bathe our shores, and everywhere you will find marks of the eternal benefits of this great man." "The genius which Watt has displayed in his admirable inventions," continues the President of the Royal Society, "has contributed more to show the practical utility of science to increase the power of man on the material world, and to multiply and diffuse the necessaries of life, than the labours of any person in modern times."

Mr. Huskisson, President of the Board of Trade, asserts that, considered in relation to the happiness of the human race, Watt's inventions appear to him to merit the highest admiration. He explains in what manner the saving in labour, the indefinite multiplication and the cheapness of manufactured goods, contribute to excite and extend civilization. "The steam-engine," he says, "is, therefore, not only the most powerful instrument in the hands of men for changing the face of the physical world, but it acts as an irresistible moral lever in urging forward the great cause of civilization."

Sir James Mackintosh declares, that "the discoveries of Watt have been the means of enabling England to sustain the most arduous and most dangerous conflict in which she has ever been engaged, and that no person has more evident claims than Watt to the homage of his country, and the veneration and respect of future ages."

The Academy of Sciences of the Institute of France conferred on Watt the highest honour in its power, by nominating him, in 1814, *one of its eight* foreign members. We believe the only academic titles the illustrious engineer received in his own country, were being elected Fellow of the Royal Society of Edinburgh in 1784, Fellow of the Royal Society of London in 1785, Member of the Batavian Society in 1787, and by a spontaneous and unanimous vote of the Senate of the University of Glasgow, the honorary degree of Doctor of Law was presented to him in 1806.

In an historical eulogium read before the Academy of Sciences at Paris on the 8th of December, 1833, by M. Arago, we find the following plain truths expressed. After detailing proofs of the high estimation in which Watt was held, the French savant thus proceeds :—

"This is, in short, what was thought and said of Watt

by ministers, statesmen, savants, and manufacturers, best qualified to appreciate him. Gentlemen, this creator of six or eight millions of labourers, of indefatigable and assiduous labourers, among whom no combination is to be repressed —no mutiny feared—labourers at a halfpenny per day; this man, who by brilliant inventions gave to England the means of sustaining a terrific struggle, in which even her nationality was never put in danger; this new Archimedes, this benefactor of all mankind, of whom future generations will bless the memory—what was done to honour him in his lifetime?

"The Peerage is, in England, the highest dignity and the highest reward. You will naturally imagine that Watt was made a Peer—it was never even thought of.

"If we must speak plainly, so much the worse for the Peerage, that it was never honoured with the name of Watt. Such an omission, in a nation so justly proud of their great men, naturally astonished me. When I inquired the cause, what, do you think, they replied to me? 'Those dignities of which you speak are reserved for naval and military officers, for influential orators in the House of Commons, for members of the nobility. *It is not the fashion*' (I do not invent, I quote exactly), 'it is not the fashion to grant them to savants, authors, artists, and engineers.' I knew well enough that it was not the fashion in Queen Anne's time, since Newton was not a Peer of England; but after a progress in science and philosophy of a century and a half, had I not a right to believe that the practice of giving people a destiny was abandoned?—that no one would longer dare at any rate to tell them to their faces, like the inflexible law of the Pharaoh's, 'Whatever may have been your services, your virtues, or your knowledge, none of you shall pass the bounds of his caste'—that an insane fashion (since fashion it

is) should no longer disgrace the institutions of a noble people.

"Let us depend upon the future. A time will come," continued the eloquent orator, "when the science of destruction will bend before the arts of peace,—when the genius which multiplies our strength, creates new products, and brings comfort to the mass, will occupy, in the esteem of man, that place which reason and good sense claim for it in the present day: then Watt will appear before the grand jury of the population of the two worlds. * * * *

"Formerly, the age of Augustus was spoken of, the age of Louis XIV.; eminent minds have already maintained that it would be right to say the age of Voltaire, Rousseau, and Montesquieu. For my part, I do not hesitate to assert, that when to the numerous services already rendered by the steam-engine, shall be added all the wonders which it promises to us, still grateful nations will speak also of the ages of Papin and Watt."

It will now be our endeavour briefly to show the practical results that have arisen in many branches of our commerce and national industry, from the causes we have mentioned, and the remarkable extent to which deficient scientific education has prevailed throughout all classes of society.

Passing to agriculture, we find that, even in the present day, one of the principal obstacles that exists to its proper advancement, is the want of a special education for all classes of agriculturists. One, who is celebrated as a practical farmer, has declared the agriculture of England to be behind every other industrial art; and the great chemist, Liebig, has said, that "if farmers be not furnished with the capital of science, the last which they at present think of providing, they will only waste their powers; but, armed with this invincible weapon, Great Britain will probably

cease to be indebted to foreign lands for one grain of her cereal food."

Dr. Daubeny, in his valuable work on the "Application of Science to Agriculture," thus describes the present race of farmers :—"As the Geologists of the present day cite, as a proof of the ignorance or neglect of their predecessors, that the stone required for the fortifications at Gibraltar was brought out from England, when it might have been obtained upon the very spot, so I conceive our descendants will marvel at the inattention to chemical science, evinced by the present generation of farmers, in exporting from distant regions, such as South America, substitutes, and those, perhaps, but imperfect ones, for that fertilizing material, of which the greater part is allowed to deposit itself unprofitably in the beds of our rivers.

"The present generation of farmers, living, as they often do, at a distance from the great emporia of science, and being in all cases engrossed by the daily routine of practical avocations, can hardly find much time to devote to the acquisition of theoretical knowledge; and of them, perhaps all that can be expected is, that they should arrive at a sense of its value, coupled with a desire that those who follow their footsteps may possess that information in which they feel their own deficiency.

"It is remarkable that of all the nations of civilized Europe, England is, perhaps, the only one which, till lately, was destitute of any public agricultural establishment. In France the establishment of Grignon, near Paris, supplies means of instruction for more than 100 pupils in the elements of physics, in chemistry, botany, and other branches of natural history. In the kingdom of Wurtemberg, that of Hohenheim, near Stuttgard, to which is assigned one of the royal palaces, provides a still more complete course of

education of a similar kind. In Bavaria, Prussia, Lombardy, and even in the Tuscan territory, the respective Governments have evinced an equal solicitude.

"In these establishments theory goes hand in hand with experience. Considering the great national importance of these subjects, the immense increase in the produce of the country that accrues from any discovery in the principles of husbandry, the supplying means for carrying on these objects would seem to be precisely one of those objects which should engage the attention of societies.

"The best friends to the interests of this important branch of the community are those who strive to disseminate as widely as possible amongst agriculturists a knowledge of the theory as well as of the practice of the art, whether it be by rendering our village schools the vehicle of some instruction of this kind to the labouring poor, by establishing seminaries and colleges of a higher grade, to impart the requisite knowledge amongst the farmers, or, lastly, by introducing such provisions in the system pursued at our Universities, as may induce the future landlords and legislators to avail themselves of those means of instruction in the physical sciences, which the bounty of a long train of benefactors has placed within the reach of every student during his residence at the University.

"So long as observation and experience were deemed all that was requisite to the successful pursuit of agriculture, very little education or knowledge of any sort was deemed an essential preliminary.

"The son had only to follow the father about his farm for two or three years, and to observe the mechanical operations for the preparation of the land for the various crops, the seasons of the year at which they were performed, and the feeding and general management of the live stock. This

slight degree of information, together with the means of purchasing a sufficient stock, was considered sufficient to constitute the farmer. But when the attention of men of science was turned in this direction, it became apparent that the then existing practice of agriculture had no sound foundation to rest on, that the composition of the manures applied to them was unknown, that the mode in which these crops assimilated the food provided for them was unknown.

"The principles and facts promulgated by scientific men—the analyses published of various soils, manures, crops, and the obvious advantages which attended the adoption of draining upon more scientific principles—the introduction of implements of various kinds founded on more just conceptions of the laws of mechanics, and the more effective application of power—all combined to convince teachable minds that much was yet to be learned by those who were interested in obtaining from the soil the utmost that it was capable of yielding, without deterioration and at the lowest scale of expense."

"A population," continues Dr. Daubeny, "multiplying at the rate, it is said, of 700 a-day, can only be maintained by improved methods of culture. As clearer views with respect to the principles of agriculture would render the utility of scientific knowledge to farmers more palpable, so, on the other hand, would increased knowledge on the part of the latter create a stronger sense of the value of these apparently speculative inquiries.*

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* In a lecture, entitled "Hints on the Education of the Young Farmer," delivered by William Edwards, Esq., to the Framlingham Farmers' Club, on the 27th May, 1845, and which was printed in the *Farmers' Magazine*, after recommending instruction in general sciences, he thus speaks of the difficulties encountered by the farmer in obtaining suitable education for his sons:—"The ways and means by which such a preliminary education as I have advised can best be

Partaking of the deficiency in the middle-class education of which we have before spoken, the farmer has had no opportunity of obtaining any idea of the value of scientific knowledge viewed in relation to agriculture. Those who might have attempted some years ago to introduce any innovation into the accustomed mode of farming, could best tell the vast amount of prejudice and ignorance that has had to be encountered by any daring individual, who might think it desirable that the agriculturist should avail himself of the improvements introduced by modern science. Yet, when we know that nine-tenths of the fixed capital of all civilized nations is embarked in agriculture, it surely becomes important that such great interests should partake of the progress of the age; and when we remember that in our own country consumption has, since 1824, overtaken production, we ought to have some regard for those applications of

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obtained, it is not so easy to point out, as it is to insist upon the necessity for it. The existing schools are generally and notoriously inadequate. In most branches of business, regular training is deemed essential to success; but it is too true that any man of desperate fortunes and superficial attainments may *set up for a schoolmaster*, and by means of a well written, and probably well paid for prospectus, obtain that confidence, which too commonly those who bestow it are incompetent to judge, even by the event, whether it has been well or ill placed. Whilst proprietary schools and colleges are established for the education of the clergy, surgeons, lawyers, engineers, designers, and various other classes, I see no reason why the intelligent and active farmers of England should not have their agricultural colleges for the education of their own sons. Such colleges should be conducted by masters well selected, and properly paid for instructing in the purely literary and scientific branches of a liberal education. The establishment should have appended to it a farm of sufficient extent to show all the necessary operations in the various modes of operation in which the pupils *should take a part*, and so from their entrance combine practice with theory. The individual expense ought not to be greater than that of schools wholly insufficient for young farmers, and to which they are too frequently sent to learn *a little* of *many* things, not *much* of *any*, and *none well*."

scientific truths, which teach us how we may increase to an immense extent our productive power.

Let it be remembered that England now imports food annually to the amount of some forty-five millions sterling in corn, wheat, barley, oats, beans, meal, and flour, and that her population is increasing at an enormous ratio.

At a recent meeting held at Moscow on the 9th January, 1858, in honour of the emancipation of the serfs, M. Babet, the eminent Professor of Political Economy at the University of Moscow, well said, "Our task is not to double, but to increase tenfold, our productive power, our labour, our wealth, unless we wish to see taken away from us, by nations more advanced than ourselves, the markets which are ours by tradition, and by our geographical position." *

The rapid progress which has been made in agriculture of late years is undoubtedly due to the application of scientific principles, which have raised it from an empirical art to the dignity of a science. An American statesman (Mr. Everett) observes, "There is, I believe, no exaggeration in stating, that as great an amount and variety of scientific, physical, and mechanical knowledge is required for the most successful conduct of the various operations of husbandry, as for any of the arts, trades, or professions."

A striking instance of the value of chemical and other scientific knowledge, and of its being brought successfully

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* We must pause for a moment to admire the spirit that now animates the Russian Government, which is making extraordinary efforts, involving great sacrifices, and no slight revolutions, social and political, to maintain its markets, and to secure its agricultural supremacy. It is gratifying to see a great country rising from the slumber of ages, and recognising at last the truth long since delivered by Montesquieu, as a fact in political agricultural economy, that it is not those countries which possess the greatest fertility which are the best cultivated, but those which have secured the most liberty.

to bear upon agriculture, was shown, when, in 1843, Baron Liebig proposed, in a letter he wrote to the late Sir Robert Peel, that the coprolitic and bone beds which Dr. Buckland had pointed out to him in a recent tour through England, should be used as substitutes for bones in agriculture.

The farmers in the neighbourhood of Felixstow, in Suffolk, had often noticed numerous oval or rounded pebbles which lie scattered through the loose sandy material of which their soil is composed. These pebbles were generally collected in heaps on the land, that they might not hinder farming operations; and at length Professor Henslow, of Cambridge, was led to examine them. The aid of chemical analysis was then called in, and these pebbles were found to consist of from 50 to 60 per cent. of phosphate of lime. "Numerous sheep's teeth and bones of the tympanum of the ear of the whale, referred by Professor Owen to distinct species of Cetacea, completed the solution of the problem relating to the real origin of this deposit." Thus were these phosphatic relics of ancient animal life, which had accumulated in large masses in various localities, revealed as unexpected sources of valuable manure, and the result has been, that a demand has been created for this new mineral fertiliser. Dr. Daubeny mentions, in one of his lectures delivered at the Botanic Garden, Oxford, that he had been informed by a gentleman, who is the proprietor of some mills at Harwich, (at which the nodules are reduced to powder, and thus rendered fit for conversion, through the agency of sulphuric acid, into superphosphate,) that nearly 10,000 tons of it are annually dug up, reduced to powder, and consumed. The landed proprietors of the district in which the coprolites are found benefit to the extent of from £300 to £1,500 a-year through this discovery; the value of land has risen, while 500 men, boys, and women are

employed the greater part of the year in digging up the material, and preparing it for market.*

Did our space permit, it would not be difficult to show the importance of every branch of science to the farmer.

While geology teaches the precise nature and relations of soils, (knowledge of the highest importance to the cultivator and drainer of land,) chemistry solves questions as to the constituent ingredients of the food of plants. Botany aids the farmer by disclosing the nature of the rust, mildew, and smut that attack his cereals—the secrets of the mutual adaptation of plants to the soil—of their special habits, and natural structure, their increase and decrease.

* "In 1842," writes Dr. Lyon Playfair, "I had the pleasure of travelling with the Dean of Westminster and Liebig over different parts of England. Among other places, we visited a lime-stone in the neighbourhood of Clifton, where, in former times, saurian reptiles had been the pirates of the sea. There, along with the relics of the fishes, on which they had preyed, were their own animal remains. Coprolites existed in great abundance, and proved the extraordinary number of the reptiles which must have existed. The interesting question arose, as to whether these coprolites contained the animal ingredients of so much value in animal manure. The question was, in fact, not yet solved by the chemist, and we took specimens, in order to confirm, by chemical analysis, the views of the geologist. After Liebig had completed their analysis, he saw that they might be made applicable to practical purposes. * 'What a curious and interesting subject for contemplation! In the remains of an extinct *animal* world, England is to find the means of increasing her wealth in agricultural produce, as she has already found the great support of her manufacturing industry in fossil fuel—the preserved matter of primeval forests—the remains of a vegetable world!' I well recollect the storm of ridicule raised by these expressions of the German philosopher, and yet truth has triumphed over scepticism, and thousands of tons of similar animal remains are now used in promoting the fertility of our fields. The geological observer, in his search after evidences of ancient life, aided by the chemist, excavated extinct remains, which produced new life to future generations. Two years before this, the same German philosopher, in his researches into the food of plants, had drawn attention to the importance of guano as a manure, and by his intellect, wafted fleets to the Ichaboes, and to the Incas."

Zoology and Physiology still further assist by the information they bestow with relation to domestic animals, their various breeds, the rearing of stock, and their commercial value; while Meteorology reduces for him many phenomena apparently unapproachable by calculation to known laws. Science shows that a true weather-almanac may not be an impossibility, as, in every department of her varied operations, nature obeys fixed laws, which man has to observe, classify, and tabulate. Thus strikingly does any apparently abstract science exert a direct and instantaneous action on the pursuits of every-day life.*

When we remember how much Great Britain has achieved in agriculture, with such a small organization for public instruction, in knowledge bearing upon it, we may well look forward with hope to her future, when once her agriculturists shall receive an education fitted to enable them to appreciate and profit by all the advances of science.

Of those who have been the pioneers of their country in agricultural improvements, it will be found that they have derived their advanced ideas from their intercourse with those who, either on the Continent or in their own country, were known as men of science.

We are not aware to what extent the late Lord Leicester availed himself of his intercourse with De Fellenburg, of Hofwyl, to gather information on scientific farming, but we know that these two remarkable men corresponded on the subject, and, doubtless, some of the improvements carried out on the estate at Holkham were owing to suggestions derived from the scientific agriculturalist of Hofwyl. At a time when others blindly followed in a beaten track, Lord

* Let it be remembered that the Astronomer Royal, who is always one of the most eminent scientific men in Europe, is the superintendent-in-chief of the *Nautical Almanac*.

Leicester, then T. W. Coke, Esq., adopted and recommended to all his tenantry an improved system of practical farming.*

* Prejudices of Farmers.—In Young's time, farmers very rarely ventured beyond the boundaries of their own locality; the market or the fair were their chief opportunities of intercourse, and then there was too much eagerness to sell or buy, too much excitement from beer, to enable them to discuss anything of an improving tendency. Besides, the farmer was a man of prejudices; he would scarcely look over a hedge to watch the progress of an experiment. When the father of Mr. George Turner, of Barton, Devon, the well-known breeder of Devon cattle and Leicester sheep, who had learned something in his visits with stock to Holkham, began to drill turnips, a well-to-do neighbour looked down from the dividing bank, and said to the son—"I suppose your father will be sowing pepper out of a cruet next!" A Mr. Cooper, who went into Dorsetshire from Norfolk, could only get his turnips hoed by working himself year after year with his labourers, and refusing to be tired out by their deliberate awkwardness for the purpose of defeating his design. After he had continued the practice for twenty years, and all the surrounding farmers had witnessed the vast benefits to be derived from it, not a single one had begun to imitate him. Mr. Cooper, with two horses abreast, and no driver, ploughed an acre of land, where his neighbours, with four horses and a driver, ploughed only three quarters of an acre. Yet not a labourer would touch this unclean implement, as they seemed to think it, and no farmer, with such an example perpetually before his eyes, chose to save on each plough the wages of a man, the keep of two horses, and the extra expenditure incurred by the diminished amount of work performed in the day. No longer ago than 1835, Sir Robert Peel presented a farmers' club at Tamworth with two iron ploughs of the best construction. On his next visit the old ploughs with the wooden mould-boards were again at work. "Sir," said a member of the club, "we tried the iron, and we be all of one mind, that they made the weeds grow." When Young recommended the Dorsetshire farmers to fold their ewes, they treated the idea with contempt, saying that "the flock, in rushing out of the fold, would tread down the lambs." Jethro Tull said that the sowing of artificial grasses was so long before it became common amongst farmers, that though Mr. Blith wrote of it in Cromwell's time, yet thirty years ago (about 1770), when any farmer in the country was advised to sow clover, he was certain to say, "Gentlemen might sow it if they pleased, but they (the farmers) must take care to pay their rent." And now the case is so much altered,

This great agriculturist and noble-hearted man had not the advantage of all the aids that chemistry and geology now bring to bear upon agriculture, but he did the very best thing in his power, by holding annual meetings at Holkham, where he gathered around him all the men of science and practical skill he could obtain at that time. Sir Joseph Banks, Sir H. Davy, Mr. Gressenthwaite, (the only agricultural chemist of the day,) were thus brought together, with other eminent men; and many of the results of those interesting meetings were of a highly important character to both the hospitable entertainer and his numerous tenantry.*

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that, although rents are increased, and the profit of clover is less since it has become common, they cannot pretend to pay their rent without sowing it.—PHILIP's *Progress of Agriculture*.

* We have heard a revered relative, the late James Fison, Esq., of Thetford, Norfolk, (who was accustomed to form one of the party at Holkham, during many successive yearly visits,) speak of the remarkable influence exercised over the farmers of Norfolk, in the removal of their prejudices and ignorance, by the exertions of the late Earl.

We would do honour to the memory of a nobleman who thus raises himself an enduring monument in the affection of his tenantry, and the gratitude of a numerous class of his countrymen, now well represented by the intelligent Norfolk agriculturist. An interesting account of a visit to Holkham will be found in *Chambers' Journal*, some years back, written by Mr. Fison.

CHAPTER II.

Losses incurred in the Mechanical Arts—Evidence of Engineers, &c., as to Importance of Educated Workmen—Albert Escher, Esq.—William Fairbairn, Esq.—M. Coquiel on English Deficiencies in Industrial Training—Sacrifice of Life in Mines through Ignorance—Losses in Mines—Importance of Geological Science in Preventing Loss—Metallurgy, Losses from Ignorance of—Opinions of Scientific Men—Loss of Shipping and Human Life through Ignorance—Benefit of Improved Education for Sailors—Reports of Scientific Men on this Subject—Losses of Life through Ignorance of Sanitary Laws—in Large Towns—Villages—Pharmacy—Losses incurred through Ignorant Dispensers of Medicine—Importance of Improved Education for all Classes—Attention now paid to this subject.

"What struck me most in England was the perception that only those works that have a practical tendency awake attention and command respect; while the purely scientific, which possess far greater merit, are almost unknown. And yet the latter are the proper and true source from which the others flow. Practice alone can never lead to the discovery of a truth or a principle. In Germany it is quite the contrary. Here, in the eyes of scientific men, no value, or at least but a trifling one, is placed on the practical results. The enrichment of science is alone considered worthy of attention. I do not mean to say that this is better; for both nations the *golden medium* would certainly be a real good fortune."—*Letter of Baron Liebig to Professor Faraday.*

If we turn from agriculture to the mechanical arts, we shall find the same want of scientific knowledge with the same results.

It is stated "that in the magnificent Exhibition made in 1855 by the French nation, whether of raw materials, manufactures, or art productions, our country has been left behind-hand in many of the branches where she has heretofore boasted her superiority." An intelligent writer on this subject remarks, that "Our ignorance of certain acknowledged principles of hydraulics appears in our hydraulic

machinery. In the iron trade, especially in the adaptation of manufactured or cast iron, we stand lamentably behind both the French and Russians. Our chemicals can hardly be tested by the side of those made in France and Germany, where the progress of chemistry has been daily increasing. The superiority of foreign lands commences in many branches of industry, the moment where either science or taste is concerned. Our producers and our workmen have been practising their arts by experience only, little guided by scientific laws."

Forcibly, indeed, must these truths have been brought home, to elicit from the *Times* the remark, that "As for the British people, if they do not look to it, we shall soon have to ask what is our distinguishing excellence."

Here, again, as in agriculture, the defect is to be traced to the want of industrial colleges, mechanical training or trade schools, such as are to be found in almost every town in France, Prussia, Saxony, Austria, Switzerland, and Piedmont—schools where the scientific elements involved in mechanical art, the true alphabet of science, are taught.

We find that in France, owing to the admirable system of elementary instruction, and the acquaintance thus formed with scientific knowledge by all classes, the diffusion of knowledge, the extension of education, and advancement of science, are objects appreciated at their right value by all orders of society; and we may mention that in Paris, where classes on industrial subjects are held in connexion with the Museum of Arts and Manufactures, a thousand workmen and women attend constantly every evening from November to June.*

* "Foreign nations, and especially our neighbours and allies, the French, are much superior to the English in the style of many articles of manufacture,—and in some cases they beat us, in conse-

At the Great Exhibition of 1851, when the jurors were unanimous in their praise of English tools and machinery, we still find no allusion to our scientific supremacy—but as one of the French jurors expressed it, "The English shine and stand above all nations in the department of machinery; but even there they do not work so much by means of their excellency of knowledge as by means of their capital, and in everything they have recourse to excelling mechanical means. Their hardware and edge tools likewise exhibit the effects of the low price of raw material."

The important question arises, how can the scientific knowledge, in which the English of all ranks have been

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quence, altogether out of the market. One reason of the superiority of foreign workmen is this,—that *their eyes and hands are trained from an early age in drawing and design.* Arrangements for this purpose have existed for many years in the common schools of France and Germany; consequently, the people of those countries have a better judgment than ourselves in many matters of taste, and designers from abroad are often employed in this country, when Englishmen would be employed, if they were better educated. Hence our Government has very properly established a system for spreading the knowledge and practice of drawing through our whole population."

Perhaps the force of what has been said will be better felt, if I quote the words of a practical London silversmith on this subject:—"At present we seldom find an English workman who understands a drawing when placed before him: give him a ready-made article to copy, and he will do so tolerably well, showing he has the elements of good and sound workmanship in him; but place a drawing before him, and it is like talking to him in a strange language; he does not enter into the idea put before him. This arises from his never having learned to draw. On the Continent, we believe, all workmen learn to draw: we have employed several foreigners, and never yet found one who did not well comprehend a drawing at first sight, and many of them draw and design themselves, but when they do not, they work out another's drawing with a good deal of original taste and delicacy."—*Rev. J. Howson's Address to the Working Classes of Liverpool.*

deficient, be grafted on the practical labour in which we have excelled?

Our industrial classes have "hitherto relied on their unenlightened dexterity and the empirical success which resulted from experience, and were wont to scoff at the idea of learning anything from a mere theorist." All their energies being occupied with material objects, the properties and relations of matter have had no further interest for them, than as such considerations affect production and consumption.

The deepest and most acute thinkers of the present day unite in indicating the path we must tread, if, as a nation, we would not be distanced in the race of industrial competition.

It has been observed, with relation to the general character of the discoveries with which the Exhibition of 1851 made us familiar, that the direction they indicate is such as might be expected from this age—the successful effort to supersede mechanical by chemical agency.

In the second Report of the Commissioners we find memorials from the manufacturers of Birmingham, Bristol, Halifax, Hull, Oldham, Sheffield, and the Potteries. The memorialists from Hull "perceive that unless a system of industrial education is extended to this country, so as to enable our manufacturers to apply increased science and skill to our manufactures, England cannot keep her position in the great industrial competition of all nations." Thus we find the great commercial and manufacturing districts of our country demanding, with importunity, the industrial education of our people, to enable us to compete with countries which have, in consequence of our neglect, taken the lead.

Countless profits had been derived by these capitalists from the devoted and earnest labours of a few unrequited

scientific men, before the practical application of a few great principles in science and art was recognised as the source of the wealth of the former. Still longer time has it taken to awaken in their minds the consciousness and conviction of the mine of wealth that lies at their feet, when once scientific education shall reach the artificers, mechanics, and agricultural population of our country.

In the evidence taken by Edwin Chadwick, Esq., Secretary to the Poor Law Commission, and given by employers with relation to the influence of training and education on the value of workmen, we see the following striking facts elicited as to the comparative eligibility of educated and uneducated workmen for employment.

Albert Escher, Esq., an engineer residing at Zurich, whose firm employs upwards of a thousand workmen in machine making, and cotton mills and cotton manufactures, in Switzerland and Italy, being asked what were the differences in English, Swiss, German, and Italian workmen, replied, "As workmen *only*, the preference is undoubtedly due to the English, because, as we find them, they are all trained to special branches, on which they have had comparatively superior training, and have concentrated all their thoughts. As men of business, or of general usefulness, and as men with whom any employer would like to be surrounded, I should, however, decidedly prefer the Saxons or Swiss, but more especially the Saxons, because they have had a very careful general education, which has extended their capacities beyond any special employment, and rendered them fit to take up, after a short preparation, any employment to which they may be called. If I have an English workman engaged in the erection of a steam-engine, he will understand that and nothing else; he will understand only his steam-engine, and for other circumstances, or other branches of mechanics,

however closely allied, he will be comparatively helpless to adapt himself to all the circumstances that may arise to make arrangements for them, and give sound advice, or write clear statements and letters on his works in the various related branches of mechanics. The Saxon, or the educated workman, will, under the same circumstances, much sooner advance, and become a foreman or manager; in other words, he will be found by his employer more generally useful. The Scotch workmen in our employ get on much better than the English, which I ascribe chiefly to their better education; knowing their own language grammatically, they have comparatively good facility in acquiring foreign languages. They have a great taste for reading, and always endeavour to advance themselves in respectable society; but they are lower in school education, and have less general information, than the Saxons, or other northern Germans.

"In the present state of manufactures, where so much is done by machinery and tools, and so little is done by mere brute labour, (and that little is diminishing,) mental superiority, system, order, and punctuality and good conduct—qualities all developed and promoted by education—are becoming of the highest consequence.* There are now, I consider, few enlightened manufacturers who will dissent from the opinion, that the workshops peopled with the greatest number of educated and well-informed workmen

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* "Whilst, in respect to the work to which they have been specially trained, English workmen are the most skilful, they are, in conduct, the most disorderly and unruly (and, in saying this, I express the experience of every manufacturer on the Continent to whom I have spoken, and especially of the English manufacturers, who make the loudest complaints). These characteristics do not apply to the English workmen who have received an education, but attach to the others in the degree in which they are in want of it." —*Albert Escher, Esq.*

will turn out the greatest quantity of the best work, in the best manner."

Evidence to the same effect, with regard to the importance of educated workmen, was given by William Fairbairn, Esq., of Manchester, who remarked: "There has, indeed, arisen a new and very important class of mechanics in this country within the last fifteen years; viz., those who are required for the construction and management of new works, such as the railroads, the locomotive engines, the engines required in steam navigation, and the machinery for carrying on the manufactures of the country. I think it very desirable that public means should be extended to increase, by education, the number of this class of mechanics, who are at once moral in their conduct, and highly important to the manufacturing prosperity of the country.

"It appears to require mental training in early life to enable a man to arrange a sequence of operations in the best manner for clear and efficient practical efforts. Men with such a capacity we rarely find, except among those who have had a school education. Occasionally, self-educated men arise, who, under the influence of strong motives, do more for themselves than any existing methods of school education could have done for them; but these men are extremely rare; they are but solitary instances."

In accordance with these views, Mr. Fairbairn, more than twenty years ago, took measures to advance the education of mechanics, and, as President of a Lyceum for the use of the working classes, gave a strong impulse to their improvement. This was an institution of a more practical nature than most mechanics' institutes, and furnished the means of instruction in arithmetic, mathematics, drawing, and mensuration, by classes, lectures, reading-rooms, and museums. It is pleasing to know that there have been numerous striking instances of

improvement obtained by attendance at the classes of the Lyceum.

One employer of labour gave it as his evidence, that had the attention he had paid to the education, dwellings, and recreation of his workmen been only undertaken as an investment of capital, it would have been a profitable one. "I would not, as a pecuniary speculation, consent to take less than £7,000 for my set of workmen," he said, ("upwards of 800,) in exchange for the uneducated and uncultivated workmen of another manufacturer opposite. We find the steadiness of the men induces steadiness of work, and comparative certainty in the quantity and quality of the produce."*

In a Report made in 1853, by M. Coquiel, to the Belgian Government, on Industrial Education in England, he thus speaks of our deficiencies: — "The school of mines and science applied to the arts, projected in 1839, was not inaugurated till 1851. Before that, no institution existed in the United Kingdom where the different sciences applied to the exploitation of mines were taught. It is surprising that a country whose riches and prosperity are due in a great measure to mines, from which minerals are produced, amounting to the annual value of twenty-four millions sterling, that

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* Speaking of the recreations he had provided for the work-people, he said :—"Thou mayest think it strange for one of my persuasion," (he was one of the Society of Friends,) "but it is true, I have paid for a big drum and some horns, to give them mirth after their hours of labour." The employer here touches upon a subject of the greatest importance, in its relation to the improvement of the social condition of the working classes. Too little attention has been paid to the fact, that the poor man and his family require provision made for healthy recreation of mind and body; and we rejoice to see that people's parks, playgrounds for children of the poor, &c., are now becoming matters of public consideration.—*See Handbook of the National Association for the Promotion of Social Science.*

is to say, to nearly four-ninths of the whole produce of Europe, and from whose soil is extracted annually more than thirty-five million tons of coal alone, has not thought of furnishing to the numerous population, occupied in working its mines, the means of acquiring the most elementary scientific notions of their art. And yet the industry of which we speak is precisely that which can least do without scientific knowledge. The help of geology and chemistry is required to discover the formation, and determine the nature, of a mineral; that of physics and mechanics for the exploitation, strictly speaking, of the mine; that of mettallurgy to treat the metal when it is extracted from the earth. At every moment (and the instances are but too numerous in England) ignorance of science may not only occasion the death of miners, but the loss of immense capital, or at least deprive capitalists of the advantages which a more intelligent mode of working would have offered to them. Might it not be said that the English, to whom nature has been so generous, so prodigal, act somewhat in the same manner as those southern nations do to whom heaven has given warmth and food almost for nothing, and who had rather fold their arms in the face of these favours, than apply their intelligence and their strength in profiting by them? Indeed, all the countries of Europe, less gifted than England in respect of mineral riches, have established schools to compensate for their relatively unfavourable position by improvements in the means of working.

"That which creates the most surprise is, that the companies and proprietors of mines, so rich, so extensive, so numerous as they are in Great Britain, have not established schools from which they might themselves obtain the greatest advantages. They had before them the example of the immortal Watt, who, having obtained a patent for the

ingenious improvements which he had introduced into the steam-engine, established at Soho, near Birmingham, a preparatory school, in order to teach the workmen not only the new series of works which he was about to entrust to them, but the principles of the operations themselves,—drawing, measuring, adjusting, &c."

The lamentable sacrifice of life and health, which is entailed by the want of scientific knowledge in mining, cannot fail to strike those who examine into the details of an occupation which particularly demands skill and care in overcoming danger. There occur annually, in the coal mines of Great Britain, 1,000 fatal accidents; out of every eight colliers, one dies a violent death, and in other mines there is nearly the same proportion of accidents.

The folly and fool-hardiness of our miners (the result of their ignorance) show itself in the fact, that almost all the most destructive explosions, for the last few years in our mines, are to be attributed to the use of naked lights. The fire-damp, which often destroys many lives at one explosion, might be approached with perfect security were the safety-lamp, the indispensable condition of safety, always employed; but there is so much ignorance among those who have the lives of their fellow-workmen in their power, that this magnificent discovery in mining science is often entirely set aside, and thus hundreds of our fellow-creatures, who are labouring for our comfort, are liable to be sacrificed to ignorance.

Neglect, and ignorance of the first principles of pneumatics and ventilation, give rise to evils of the greatest magnitude. "As far as has been hitherto ascertained, the sacrifice thus entailed amounts to no less than cutting off the miner's life twelve years before his time, shortening his years of productive labour by one-third, aggravating un-

necessarily the toil and suffering of those who gain their living underground. In Cornwall it is commonly asserted that the cost of the deep mines is so great, in consequence of the heat and the 'poor air,' that they cannot be carried deeper, whereas science, abundantly confirmed by practice, shows that the deeper the shaft, the greater is the amount of natural veniltation produced by it. The state of the mines in this country, which are liable to explosion of fire-damp, strongly manifests the want of scientific knowledge." * Thus the scientific arrangement for ventilation, which is enforced by law in the fire-damp mines of France, Belgium, and Prussia, being rarely carried out in English collieries, the gas accumulates, and ultimately explodes when a naked light approaches it.

So strongly at last was public feeling aroused with regard to the importance of instruction being given, both to those entrusted with the management of mines and the miners themselves, that at the request of a Committee of the House of Commons, a Meeting of the coal trade of Great Britain was held in London in May, 1854, at which the following Resolutions were passed :—

RESOLVED—

That it is the opinion of this Meeting that a large number of accidents in collieries arise from the ignorance and recklessness of the miners themselves, and that increased education would greatly tend to decrease the number of accidents arising from such causes ; and, in the opinion of this Meeting, the owners of collieries should, in connexion with the workmen, make such arrangements, in a financial point of view, as will accomplish this desirable object.

It was also further

RESOLVED—

That this Meeting is of opinion it would be of essential service, in the future management of mines, and, consequently, have a ten-

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* Herbert Mackworth, Esq., Government Inspector of Coal Mines.

dency towards the prevention of accidents, if a central mining school or college, of a practical nature, was established in some convenient and suitable colliery district, with branches therefrom and connected therewith, for the education of mining engineers and other officers or subordinate persons to be entrusted with the management and conducting of the mines of this country; and that the Committee now sitting on accidents in mines be solicited to take this subject into their serious consideration, with a view of recommending the Government to afford such aid as they may deem advisable and requisite, to establish and support so necessary and laudable a measure.

This was followed by a strong expression of opinion on the part of the Committee.

"Your Committee cannot too strongly recommend the establishment of similar institutions in other districts, at which the branches of science bearing upon mining should be taught.

"Facilities would thus be afforded for imparting to the superintendents or overlookers, upon whom the daily and hourly conduct of the mines necessarily falls, an amount of scientific information which could not fail to induce greater vigilance in carrying out rules and precautions, obvious enough to scientific men, but which it is difficult, if not almost impossible, to have faithfully realized in practice *by those who, however willing to do their duty, do not fully understand or appreciate the value of such rules and precautions.* Your Committee believe that the increased scientific information thus afforded to this class of men (the overlookers) would prove an important step towards lessening the number of accidents in coal mines, and more especially those arising from defective arrangements of ventilation; and they would urge upon Government to foster, by grants in aid, the establishment and maintenance of mining schools throughout the country."

It is interesting to know that a large number of intelligent

workmen are no less eager to obtain the advantages of which we have spoken, than an enlightened Government can be to bestow them. Few facts have come to us with more striking significance than the one, of the eager attention with which 650 working men, night after night, have been seen listening with deep attention to lectures on physics, chemistry, metallurgy, geology, natural history, and mineralogy; while no less than 1,500 applications were made within a few hours, to attend those lectures given by the eminent Professors attached to the Government School of Mines. Let our working brothers have full scope given for the cultivation and development of the mental powers an all-wise Creator has bestowed upon them; and we fear not but that they will amply vindicate and uphold the intellectual character of the Anglo-Saxon race.

Till within a short period, scientific education being left to chance, the consequence was, that those who could afford it went on the Continent, to study in the mining schools provided by different Governments; while the majority of the miners remained in their ignorance, some few endeavouring to fight through the difficulties in their way, but the greater part, conversant with only the practical details of their daily labour, in their own immediate district, utterly unacquainted with the progress of others in their calling elsewhere. It has been well asked, "Are our miners less deserving of attention than those of other lands, or are they supposed so dull and disinclined to knowledge as not to be capable of profiting, as well as the miners of other nations, by instruction? Let those who thus believe visit our mining districts, especially such as are metalliferous, where the miner has so often to gain his daily bread by the exercise of his judgment, and they will speedily be undeceived. They will find men as able and willing to profit by instruction as

elsewhere in our land. They will see many with powerful minds who have risen from amid all their difficulties, adding continually and greatly to our stock of practical knowledge, but who yet would evidently have accomplished far more, if, in their early day, they had possessed the advantage of starting with the knowledge of the time applicable to their pursuits. It is to be deplored that so much of the mass of important facts known to such men have been lost from the want of a system by which it could have been preserved for classification and use in further advance. Too much has perished with the remarkable men who have from time to time appeared in our mineral districts."*

The natural advantages possessed by the British islands, with regard to the abundance of coal and iron, are great in comparison with the other countries of Europe, and in several of the latter it is only by a most careful application of science and practice that profit can be effected. In some cases, did the same indifference to scientific knowledge exist as with us, the mining operations in certain districts would have to be suspended. Thus Sir Henry de la Beche mentions that within the last few years, at Reichenstein, in Silesia, some mines that had remained unworked for five centuries were, by a new method of obtaining gold from poor auriferous ores, (that was discovered by Professor Plattner,) worked again, with considerable profit, for gold.

Many instances might be related of the heavy losses that have arisen in mining operations in Great Britain, owing to the utter destitution of means for mineralogical education in our mining counties. The miners of Cornwall long directed all their attention to the tin with which that county abounds, not recognising the value of the copper ores till a comparatively recent period. Even at the beginning of the

* Sir Henry de la Beche.

present century, the valuable sulphide of copper was thrown as worthless into the Atlantic; and an old writer informs us that many thousand pounds' worth of the rich black ore, or oxide of copper, was washed into the rivers, and discharged into the North Sea from the Old Pool Mine. At the time when these mistakes were made in England, mining science was so advanced in other countries, that the value of the same ores was there understood.

On one occasion, a man of high character was requested by two friends to join them in a mining speculation, to work a deposit of an unusual ore they had found. A person at Birmingham, calling himself a mineral chemist, had been consulted, and he affirmed that the specimen shown him was an ore of molybdenum, worth £8 per ton. The gentleman first mentioned travelled, with his two friends, to the place where, in a remote valley of Wales, was the mass of the substance in question. The party, having collected further specimens, returned to make further arrangements for forming their Mining Company. The more cautious manager, without telling his friends, sent some of the ore for analysis to a scientific chemist in London. The reply of the latter was, that the specimen was a shining black slate clay, only fit to make bricks.

In another case, a party of credulous speculators were attracted to a certain spot by the appearance of some rather ferruginous slate rock. They erected the necessary machinery, built a blast furnace, but soon found their speculation end in ruin, based as it was on ignorance.

Dr. Robinson remarks, "That there is not a single element of our commercial prosperity in which the vivifying power of science might not be felt, in which the loss arising from want of that certainty of action which mere unenlightened practice can never attain, does not reach an amount

which, if stated in figures, would astound the most thoughtless."

In Geological Science this observation is most strikingly corroborated. In coal mines, metallic mines, in laying down lines of road, in the choice of materials for building, large fortunes have been lost, that might have been saved had a slight knowledge of Geological Science been possessed by the projectors.

How much capital would have been saved had every speculator in mines, every landed proprietor who possesses such property, known some of the simplest principles of this science. The phrase, "unfortunate in mining speculations," often means, entirely ignorant of the law of super-position of strata, of disturbance of beds, and consequent unconformity. "When these are made a part of every well advanced schoolboy's education," says Professor Ramsay, "at all events, ignorant or mistaken men, misnamed practical, could not so readily delude the credulous or unwary into ruinous speculations; the iron-charged water of a spring, the colour of a rock, or the mere association of limestone and shale, might cease to induce explorations for coal among those who, hastening to acquire wealth, too often only precipitate their ruin."

The familiar and important truths which are daily taught in our School of Mines are yet far from being generally spread throughout our land; thus we still constantly hear of the most fruitless and absurd undertakings being commenced—some so ludicrous from the persistency with which the speculator pushes on his operations, in defiance of the opinion of scientific men, and the information given, that they must provoke a smile.

It is not long since that Professor Ramsay received a letter from Mr. Aveline, one of the geologists of the survey,

in which he said, "I have a narrow slip of coal measures running between the Permian, the new red beds, and the old red sandstone, that you saw at Bewdley. A person found out the only place where the coal is well shown, and sunk a pit; but, finding the coal worthless, *he has gone a little way off, on the old red sandstone*, where he is sinking after the most approved manner, bricking his shaft round. He is going through some very hard sandstone." The explanation gratuitously offered by scientific advisers was here disregarded, and the practical men announced, in their last report, that they were on the very verge of discovering coal —a position in which, we fear, they are likely to remain, self-placed on the horns of a dilemma.

In Herefordshire, a person, more confident than sagacious, and ignorant of geological laws, first built his engine-house and sheds, then boldly sank a shaft into carboniferous limestone shale, in search of beds of coal which could not exist.

The traveller through Pembroke, Radnor, Carmarthen, Montgomery, Merioneth, and other parts of Wales, will see the black slates of those counties dotted with shafts, borings, and levels, sunk or driven in vain searches after coal. While the work advances, practical men cry, "The indications are good, go a little deeper;" these indications being simply, that the lower silurian shales (which are utterly barren of coal) are often black and carbonaceous looking, their oozing springs discoloured in the same way as the coal measure shales, by the presence of oxide of iron.

"Even a slender amount of science infused into the general education of the country, would strongly tend to prevent the increasing recurrence of such ruinous absurdities. The truly practical man—the scientific mining engineer—reasons and advises on very different principles. He is conversant with geological maps and sections; his experienced

eye distinguishes the geological relations of the deep and wide-spreading strata of which a country is composed, and, as a rule, he knows the utmost limits of the ground where it is safe to adventure; and further, if he add to this a general knowledge of the organic forms that characterise these formations, a glance will tell him (however black the shale, or ferruginous the water) that rocks containing graptolites, trilobites, lingulæ, and pentameri, were formed untold ages before the commencement of our carboniferous epoch." *

At the point where the labours of the miner terminate, those of the metallurgist commence, but so little diffused is effective metallurgical knowledge in our country, that the most serious mistakes are frequently made. Thus, from a want of this knowledge, large sums of money have been lost in our mines. Many instances have occurred, as we have before stated, where ores have been allowed to be washed down into the sea or into rivers, their value not being known.

On the estates of the Duke of Argyle, in Scotland, some works were abandoned, as the copper was not found sufficient to pay for the cost of obtaining it. The ores which contained this copper had been regarded as only valuable on that account, and much was thrown aside as not worth dressing. The Duke, struck with a peculiar character in the ore, took specimens of it to the School of Mines in Jermyn Street for analysis. It was found that it contained 11 per cent. of a valuable metal called nickel, which is extensively employed in different alloys, such as what is popularly called German Silver. There were other portions of the ore still richer in

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* Professor Ramsay's Introductory Lecture to the Course of Geology, School of Mines.

this metal, and that which had been thrown away and dispersed has been valued at from £30 to £40 per ton.

Even after nickel was found in this ore, an assay being made elsewhere by those not so skilled in metallurgy as the scientific men in Jermyn Street, it was asserted that the ore did not afford it.

It may be said, and with truth, that metallurgical processes are often well conducted by men whose knowledge is entirely based upon experience, without any acquaintance with science. To this it may be answered, that, although the practice of metallurgy has been developed to an extraordinary degree in Great Britain without specific scientific instruction, and though "most of the fundamental phenomena of metallurgy were discovered and regularly applied to the wants of man before the physical sciences, properly so called, existed," * yet that the magnitude of production, of which we have spoken, does not necessarily imply correspondingly great skill. The instance we have quoted above, as occurring on the Duke of Argyle's estate, is but one out of thousands, where similar losses have occurred from want of metallurgical knowledge, and where similar gains would have resulted, had the aid of skilful metallurgists been available.

If we were to enter into detail upon the losses experienced to our country, through ignorance and neglect of science, in every department of our wealth as a nation, we might bring forward an amount of loss that would astonish those who have never given consideration to this momentous subject.

It is a most important fact, that a belief is entertained by scientific men, and supported by official inspectors, that no

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* Le Play, Description des Procédés Metallurgiques. Paris, 1848.

railway accident occurs which might not have been prevented, had proper precautions, involving, perhaps, great outlay, been taken.

Thus the Railway Commissioners, in their Report for 1848, observed, "All who have had occasion to consider the state of our knowledge with respect to the strength of materials, are aware that a multitude of experiments, and the investigations of scientific men, have established the laws on which the relation between the several dimensions of beams of different materials, their stiffness, and their ultimate strength, depends, when exposed to an action not differing in an important degree from a steady load. * * * But the last few years have rendered necessary the construction of a number of bridges, intended for the use of heavy trains passing at great speeds, in designing which, the known laws relating to the strength of materials are most probably inapplicable; while the experiments requisite to ascertain those which may be applicable are beyond the means of individuals to make, and the highest degree of science will probably be required in combining the results of any experiments bearing on the subject. Neither can the solution of the question be left to time, or to the experience which might be obtained at once, for the guidance of engineers who may have to design or improve such works, of which a great number are likely to be constructed within a short period."

There are causes of destruction occasioned by large operations, which the progress of engineering and other practical sciences is bringing daily more under human control.

The structure of large edifices, gregarious employment, and locomotion, are all, more or less, the sources of great calamity, owing to the culpable ignorance or negligence of those who have a charge over the safety of others. Many dangerously defective public structures have been erected at

different times, in direct contradiction to the sound old principle of the Romans, that no structures of a character calculated to endanger public life should be allowed to exist.

As a maritime country, England has to mourn over the lives and property annually sacrificed, partly from the want of elementary knowledge in our brave seamen, and, to a great degree, from unscientific construction in the vessels which bear the treasures of our national industry. Nearly three ships daily are lost, most of them perishing from these causes. It has been estimated that the average loss of property in British shipping is £3,000,000, and this is a minor consideration compared with the loss of life.* The greater portion of our coasts are also without the means of saving the unhappy mariner who is shipwrecked upon his own shore. Many lives would be saved if all vessels were provided with life-boats.

The sailor is too often a fatalist, who, having been early imbued with the idea that his calling is one of inevitable peril, does not seek so much to obviate his danger as to wait his time, enjoying the present, and setting at naught pre-

* In 1,500 miles of the Scotch coast, there are only eight life-boats established, and no more than seventy-five are provided for 2,000 miles of the English coast, whilst eight life-boats are all that belong to Ireland. Eight hundred seamen perished on the east coast of England during the winter of 1852-3, and 2,000 British seamen elsewhere. Form any years a well-organized system of life-boats has existed at Liverpool, through which hundreds or thousands, we might say, of lives have been saved. The Royal National Shipwreck Institution has rescued nearly 9,000 lives by its life-boats and other means since its establishment, but the subject is too important in its bearings to be left to private institutions, and it surely ought to be a national undertaking to provide a well-organized system of appliances for saving life on all the coasts of Great Britain and Ireland.—See most interesting reports on this subject in the volumes of the British Association.

cautions which he considers despicable. The deficiencies in the education of our seamen have thus often led to most deplorable results, and many are the instances we could narrate of loss of life which has arisen from circumstances that might have been avoided, had proper instruction been communicated to those entrusted with its care.

When the Royal Naval School at Greenwich first began its work, many fears were expressed by certain persons, that the boys would be over educated, and that insubordination would be the result. The orthodox education of the true British seaman, as Dr. Lyon Playfair has observed, was considered to be a miserable amount of reading and writing, with the additional variety of being attached to the whipping-post. This mental and physical training, however, was not found sufficient to render the Greenwich boy anything but a bad and insubordinate man, "and captains of ships were thoroughly dissatisfied with the Greenwich contributions to their vessels. A bold change was then introduced, and the boys, gathered up from the sweepings of Wapping and Portsmouth, were treated with kindness, and viewed as fit subjects for intellectual training. They were generally taught mathematics, chemistry, mechanics, and navigation; in addition to this, elementary instruction. The latter did not suffer, but was much improved by the opening out of the faculties by the senses, and at the same time reading and writing were learned more efficiently. Nay, more, the boys were taught as if they were to be captains, to take latitudes and longitudes, and to navigate ships, and at fifteen they were drafted, as of old, into the navy and into merchant ships." "Did this high education," asks Dr. Playfair, "unfit them for their position as ordinary seamen? On the contrary, they were found much more fit. There were fewer desertions than formerly, and scarcely any records of bad behaviour,

and the captains who declined their services before, now eagerly demand them. It is true they rise in life, and from common seamen become warrant officers and masters of ships; but," continues the Professor, "this is just as it should be, and is a logical result of their increased knowledge. Depend upon it," he exclaims, with as much enthusiasm as judgment, "that knowledge will never unfit a man to be a citizen of the world. Ignorance will lead a man astray, and, as the father of false notions, will give birth to an enemy of Social Progress; but true Knowledge can only produce loyalty, patriotism, love of order, and love of duty." *

A false economy and ignorance of elementary scientific principles led to the abolition of institutions invaluable to a great commercial and maritime country. We refer to the Board of Agriculture, Board of Longitude, School of Naval Architecture, and School of Naval Instruction, which ceased to exist because unappreciated by Government.

We would ask those who think that such institutions are unnecessary, and who do not perceive the importance of scientific principles being the guide of those who direct our national expenditure for the navy, if they are aware of the urgent necessity of adopting every appliance produced by modern science and skill, and of the enormous difference created in maritime warfare by such inventions as the screw? It will, perhaps, be scarcely believed, that at a moment when effective ships were required to place our fleet fully beyond the competition of our neighbours in 1854, we were building line-of-battle ships on the old principle of sailing vessels, and that at a time when the coun-

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* Speech of Dr. Lyon Playfair at the Anniversary of the People's College at Sheffield.

try, being roused to a sense of its danger, was lavish of its resources.

To those who may still think that abstract science is unnecessary as an element in the progress of a maritime country like England, we would bring forward the opinions of some of our most eminent practical men in connexion with naval architecture.

"I look," observes Mr. Scott Russell, in his Report on the Measurement of Ships for Tonnage, "for the advancement of naval architecture rather to the association of naval constructors and men of science with each other, and the mutual communication of their notions and knowledge, than to empirical efforts of legislation; and I hope for progress in navigation rather from the general advancement of education and knowledge among all who are concerned in shipping, than from any trammels which, in the disguise of assistance and regulation, Government might be induced to impose on the captains and owners of the ships."

Dr. Woolley, another member of the Committee, remarks, "No doubt the more science is brought to bear on ship-building, the greater will be the economy both as regards the first cost and the management of vessels, and owners will consequently be able to charge a lower price for the carriage of goods and passengers."

Mr. Atherton says, "The application of statistical science in connexion with shipping, as a means of inquiry into the principles of mercantile steam transport economy, is, I say, a new subject of inquiry, to which the British Association, and, I must add, the Society for the Promotion of Arts, Manufactures, and Commerce, have given public vitality. The question of Maritime Transport Economy has a bearing on public interests analogous to the operation of the rail and the telegraph."

"It is only by statistics," writes Mr. Atherton, "that the deficiencies of our present maritime system can be properly searched into and brought to light; and it is only by the force of statistical exposition that the required remedies can be devised."

In our great cities, how many lives have been lost from ignorance of the causes which shorten life, by producing disease in every form! The impure air and water of towns have at last become subjects of national consideration; but the Report laid before the British Association by Dr. Southwood Smith, shows to what a fearful extent their deadly influences have prevailed among the class whose industry forms the foundation of our national wealth, before due attention has been paid to the subject. It has been stated, that the annual waste of life and sacrifice of health reduced to equivalents in pounds, shillings, and pence, under the heads of sickness, funerals, and labour lost, is represented by a grand total for England and Wales of £14,873,931, or little less than £15,000,000 sterling. Of this enormous sum, the metropolis contributes very nearly £2,000,000, and Lancashire upwards of £4,000,000.*

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* Dr. Hall, of East Retford, who has exerted himself zealously in the Sanitary cause, thus speaks of deaths from one preventible source alone, typhus fever: "We have yearly in England above 160,000 attacks of this loathsome disease, which may be prevented; a disease which does more to pauperize our population, to fill our workhouses with widows and orphans than any other, and for this reason—the typhus fever, for the most part, attacks men and women in the prime of life, from twenty to forty. This is the age at which the working classes marry; and if the father of a family is cut off, the widow and her children are cast for support on the poor-rates. This is a painful cause of pauperism, and it becomes more so from its permanence. A widow so left with children is seldom married a second time. From the books of the Unions, it appears to take place only in one case out of thirty. No wonder, then, that the Poor Law Unions have to support 40,000 widows and 100,000

"One broad principle," writes a reviewer in the *British and Foreign Medico Chirurgical Review*, "may be safely enunciated in respect of sanitary economics—that it costs more money to create disease than to prevent it; and that there is not a single structural arrangement chargeable with the production of disease, which is not in itself an extravagance."

Dr. Simon says, "Sanitary neglect is a mistaken parsimony. Fever and cholera are costly items to count against the cheapness of filthy residences, and ditch-drawn drinking water. Widowhood and orphanage make it expensive to sanction unventilated workplaces and needlessly fatal occupations." And let it be remembered, that, while one medical man states that, under favourable sanitary conditions, fever is unknown, another, M. Bauderes, a French physician, has well expressed its controlability, in words that should be impressed upon all classes: "*On pourrait le faire naitre et mourir a volonté.*" Of 391 deaths from fever in one Report, the Registrar adds, "Of these, without hesitation, I would speak as entirely preventible."

When we find that nearly one-half the prevalent diseases are due to different forms of atmospheric impurity, arising from decomposing animal and vegetable matter, it surely becomes a question of importance as to the remedy which can be provided for such evils.

Much as may be done by simple sanitary measures to alleviate existing evils, it is evident that "for the prevention of the diseases arising from these causes, the sanitary physician

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orphans year by year." And, again, Dr. Hall states, "The deaths of infants in Preston, under one year, were, in well-conditioned streets, 15 deaths to 100 births; middling-conditioned streets, 21 deaths to 100 births; ill-conditioned streets, 38 deaths to 100 births; worse-conditioned streets, 44 deaths to 100 births."

must direct his requisition not to the apothecary, but to the professors of new arts, which are only partially created,—the art of the sanitary architect and the art of the sanitary engineer."* Science is needed in every step that we take, when we have to solve such gigantic questions as are offered to our consideration in the disposal of the sewage of our large cities.

Professor Owen did not hesitate to say, at the Leeds Meeting of the British Association, that "Were agriculture adequately advanced, the great problem of the London sewage would be speedily resolved. Can it be supposed, if the rural districts about the metropolis were in a condition to avail themselves of a daily supply of pipe-water, not more than equivalent to that which a heavy shower of rain throws down on 2,000 acres of land, but a supply charged with thirty tons of nitrogenous ammoniacal principles, that such supply would not be forthcoming, and made capable of being distributed when called for within a radius of 100 miles? I believe that, were the call made as loudly as it undoubtedly would be under the exigences of a more advanced stage of agricultural mechanics, the skill of our engineers, with the constructive powers of our machine-makers, both carried to a degree of perfection which the world never before saw, would speedily and successfully meet the call, and leave nothing but the rainfall of the metropolis to seek its natural receptacle—the Thames.

"To send ships for foreign ammoniacal or phosphatic excreta to the coast of Peru, and to pollute by the waste of similar home products the noble river bisecting the metropolis, and washing the very walls of our Houses of Parlia-

* "Sanitary organization has pushed its material up to a certain point, and left it there."—*Blackwood's Magazine.*

ment, are flagrant signs of the desert and uncultivated state of a field where science and practice have still to co-operate for the public benefit.

"To promote this co-operation, effectual aid may be given by a recently established kindred Association, through the advancement of the legislative and administrative sciences. For it is *the present condition of those social sciences* which forms the chief obstacle to the practical application of sanitary science. Of this science, it may be confidently averred, that, besides providing means for the relief of town populations from excessive sickness, it has, in a sufficient number of instances, provided means for the prevention of the pollution of rivers, as well as for applying the manure of towns to fertilize the land.

"But quantities of azotic, ammoniacal, and phosphatic matters are still suffered to run to waste; and, as if to bring the wastefulness more home to the conviction, those products, so valuable when rightly administered, become a source of annoyance, unremunerative outlay, and disease, when, as at present in most towns, imperfectly and irrationally disposed of.

"For the most part, thought is taken only how to get rid of these products in the easiest and quickest way. The metropolitan authorities have hitherto carried the chain of reasoning no further. They have turned them into the Thames, the receptacle nearest at hand; but in so doing have failed in their prime intention. The metropolis is not even rid of its excreta; but they are returned upon it, and accumulated with increased noxious and morbific power, on the strands of the valley that bisects it; appealing, as is notorious, summer after summer, to the very Legislature itself, with unintermitting and importunate odours, compelling the attention of the possessors of lands and houses to this important subject."

Liebig, the great agricultural chemist of Europe, has forcibly expressed his opinion on this subject. "I am firmly of opinion," he says, "that if England is to remain an agricultural country, she must avail herself of the animal and vegetable residues produced in large cities."

Dr. Southwood Smith, in the evidence he gave before the Health of Town Commissioners, when speaking of the fact, that it would be practicable to make the very refuse removed go far towards defraying the expense, remarked, "There are certain adjustments established between the physical and the organic kingdoms, and between the two great divisions of the organic kingdom, which we should do well to bear in mind, even in the most practical consideration of this matter. These two great classes of organized beings (the vegetable and animal) renovate the air for each other, and everlastingly maintain it in a state of purity and richness."

But it is not only where inevitable aggregates of mankind are found, that sanitary science is needed. The results of ignorance on subjects connected with the laws of life and the preservation of health, are seen in the retired village equally with the crowded manufactory and workshop, or the ill-ventilated room of the artizan.

Dr. Acland, the Regius Professor of Medicine at Oxford, has published a Report of great and painful interest, with relation to the ravages of fever in an agricultural district. He sums up, by ascribing the continuance of the disease during the last nine months in various degrees to contagion, over crowded dwellings, putrescent matter, and an insufficient supply of fresh air. "We cannot get our landlord to give us more air," said one poor woman, "or make the windows we have to open." "Women," he said, "are best shut up." "I often awake stifled," said another, "and me and my husband go and sit at the window." Another evil from which these

poor people were suffering, was from accumulations of filth and piggeries close to human dwellings; thus in this and in their close ill-ventilated rooms, may be seen the type of fever and its cause in agricultural districts.

We rejoice to know that the subject of suitable dwellings for agricultural labourers has been brought before the National Association for the Promotion of Social Science, and will, doubtless, lead to beneficial results. In this, no less than in every other particular of social economics, the advances in well-directed practical applications of sanitary science are advances in economy. It may be difficult to induce landlords, especially those of small means, to undertake the expense of cure of those sanitary works of combined drainage and water supply, which it is their province to provide, and nothing but a wide diffusion of the principles of sanitary science, will create an enlightened public feeling on this subject, sufficiently strong to put to shame the man who shall dare to make a profit of a dwelling unprovided with the requisites for healthy existence, viz., a good supply of air, water, and a proper drainage.

As a national consideration, the importance of this subject cannot be overrated, when we know that in one town, Croydon, the death-rate has been reduced from more than twenty-three in a thousand to less than sixteen in a thousand, or lower than in any town in the empire; that in model dwellings, where sanitary conditions have only been applied yet in a rudimentary manner, the death-rate has, in fact, been steadily kept down to thirteen in a thousand. When it is proved that it is practicable to make human life, under favourable conditions, last full ten years, or probably one-third longer, surely we do not demand too much for the science which is so eminently the benefactor of the human race, and the ameliorator of its woes, that it should be

treated with respect, and take its place in the Council Chamber of the nation.

In the mean time, much may be done to popularize sound information on sanitary subjects. The indifference to them has arisen from defective knowledge among all classes of society.* "It is impossible to avoid the conclusion that much more might still be accomplished could we be induced to profit by a gradually-extending knowledge, so as to found upon it a more wisely-directed practice. When man shall be brought to acknowledge (as truth must finally constrain him to acknowledge) that it is by his own hand, through his neglect of a few obvious rules, that the seeds of disease are most lavishly sown within his frame, and diffused over communities; when he shall have required of medical science to occupy itself rather with the prevention of maladies than with their cure; when Government shall be induced to consider the preservation of a nation's health an object as important as the promotion of its commerce, or the maintenance of its conquests,—we may hope then to see the approach of those times when, after a life spent almost without sickness, we shall close the term of an unharrassed existence by a peaceful euthanasia." †

Dr. Simon has judiciously observed :—"I can have little doubt that as much might be done by individuals, under the influence of improved education, to lessen the mortality from chronic disease, as by sanitary legislation to stay the sources of epidemic death. And, regarding both classes of disease together, those on the one hand which are of endemic origin (arising in imperfect drainage, in defective water-

* For a sketch of the Rise and Progress of Sanitary Reform in England, we refer our readers to the *Handbook of the National Association of Social Science.*

† Dr. Willis, of Kelso.

supply, in ill-devised arrangement of buildings, in offensive and injurious trades, in the putrefaction of burial-grounds, and the like), with those classes on the other, which arise in the circumstances of individual life, I can have no hesitation in estimating their joint operation at *a moiety of our total death-rate*, or in renewing an assertion of my last year's Report, 'If the deliberate promises of science be not an empty delusion, it is practicable to reduce human mortality within your jurisdiction to *the half* of its present average prevalence.'"

But, perhaps, in no department of science have the deficiences in existing education been more productive of serious results than that of Pharmacy, in connexion with the drug trade. In a paper, read by Mr. John Mackay, of Edinburgh, last year, before a meeting of Pharmaceutists, he thus speaks of the education of the ordinary chemist of Great Britain :—*

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* "It is a strange omission," remarks a writer in a public paper, "both in the 'Sale of Poison's Bill,' and in the 'Medical Bill,' that no steps were taken towards compelling those who vend medicines to understand their exact nature. This, possibly, arises from the circumstance of the chemist and druggist selling the articles of his trade retail, thus entering into competition with the regular apothecary. Now, a regular apothecary must be an educated man, and receive a diploma from the Hall, before he becomes a regular practitioner. Not so the chemist and druggist, who hires a shop, and instantly begins compounding medicines without any previous knowledge of the Pharmacopœia. But even in the first case there is a great omission. It is this—an apothecary may employ any one he likes to make up the prescriptions sent to him, and make every mixture, sell every drug he thinks proper. Now, the master may be a clever man, a qualified man, but not so the shop-boy. He may be the greatest ignoramus in the parish, yet he is allowed, in the absence of his employer, to weigh life and death in the balance of stupidity, held by ignorance, and meted out by guess-work. If the master be from home, the patient runs the risk of his life : if the master be at home, the dispenser turns messenger."

"It is really sad to think of the want of knowledge displayed within the last quarter of a century by many connected with the drug trade; and I am only stating what has come under my own observation, when I say, that young men have applied for situations as assistants, who could not tell the chemical composition of Epsom salts, or the constitution of water, and to whom the atomic theory was a mere name without any reality; while again the construction of the galvanic arrangement was a perfect mystery, and of whom you might as well inquire the meaning of ancient Hebrew characters, as ask an explanation of the terms negative and positive in their relations to electricity."

Far different have the acquirements of the dispensing chemist or pharmacien been on the Continent. When, in France, a young man intends to become one, he must first take the degree of Bachelor of Letters, and then study *materia medica* for one year, chemistry and botany a second year, and toxiology, with chemical and pharmaceutical manipulations, a third year, after which he has to pass a regular examination before he dare open his shop.

In Sweden, where the apprentice must be fifteen years of age, he must have gone through a course of modern languages, Latin and geography, while at the end of the fourth year, he passes through his first examination in German and Latin, chemistry, pharmacy, and botany. Before becoming an assistant, he undergoes a further examination; while, ere he can open a shop for himself, he must go to Stockholm to be examined by two Professors of the Royal Caroline Institution.

The consequence of such a high standard of education on the Continent has been a corresponding elevation in the status of the profession; thus Professor Christison informs us, that, when, thirty-four years ago, he repaired to Paris to

study practically the higher branches of chemistry, he found, to his surprise and amazement, that his adviser there, the late eminent physiologist, Dr. Edwards, recommended him to place himself under the tuition of a chemist and druggist. Under this designation, Professor Christison found he was to have for his teacher the scientific and learned M. Robinquet. The dwelling of this gentleman joined his *boutigue* or shop, where he superintended an extensive dispensing establishment, and where, with an adjoining laboratory, he enthusiastically carried on, in immediate contact with the ordinary routine of business, those scientific researches by which his name will ever be distinguished in France. Professor Christison states, that M. Robinquet was the type of a class of eminent chemists in France, to whom the world has since assigned the most elevated rank as chemical discoverers, in a field equally rich in scientific and practical results.

Some of these pharmaciens or dispensing chemists of France attain to the rarest and highest of all purely scientific honours in Europe,—viz., that of being Members of the French Institute. M. Dumas, the late Minister of Commerce and Agriculture in France, began life as an apothecary at Geneva, and continued as a chemist and druggist until he gradually attained the high position we have named. Baron Thenard, of the University of Paris, Pelletier, and Persoz, with many other celebrated men, were all pharmaceutists, and their names will show how different, as a class, they are from their representatives in this country.

The great Liebig commenced his career as a pharmaceutist, and there are other distinguished names to be found among German chemists, who have now attained a world-wide reputation.

In evidence given before the House of Commons in 1851,

with relation to the Pharmacy Bill, a question was put by Mr. Bouverie to Dr. Arthur Wilson in reference to ignorant persons compounding prescriptions, and the doctor, having replied, that he and every physician must feel humiliated at the chance of the prescription finding its way to some of the present chemists, was asked, "Is that in respect of the quality of the medicines, or in respect of the competency of the persons who make up the prescriptions to measure out the quantities of the medicine, and compound them together properly?" Answer.—"With respect to both points, I may be allowed to say, that, in the course of my censorial official inspection of the medicines in the City of London, I have come upon such incidents as these. I and my colleagues have found in a shop in the City a widow-woman, with a baby in her arms, dispensing medicines, her husband having died two or three months back, and the woman depending for her sustenance, and that of her child, upon a little miserable shop. Again, with respect to one material, of which we all know something,—extract of colocynth,—I found in every shop but one, in the course of one of my visits, that extract very hard and very black. In the only shop where it was not so, it was very soft and mouldy. That is a combination which is in daily and hourly use by prescription. The extract was pronounced bad in every way."

It will give the English reader an idea of the vast superiority of French chemists, if we mention, that, when the celebrated Canning was ill, he was ordered quinine, and the best in the world being procurable in Paris, an urgent message was sent there to an English dealer to procure it, and forward it without delay. At the French Institute the dealer found three of the best pharmaceutical chemists of the day, from one of whom he obtained the quinine.

Great efforts have been made by superior members of the profession to improve chemical education, and the Pharmaceutical Society, established in 1841 (of which the excellent William Allen was first President), has done much to effect this object. Examinations have been instituted, which are gradually becoming more stringent, in accordance with the requirements of scientific progress. A deputation of the Society, in 1847, had an interview with Sir George Grey, regarding the deficient state of pharmaceutical education, which the Secretary of State at once admitted, and, in 1851, the Pharmacy Bill was brought in, through the unremitting exertions of the late Jacob Bell, Esq., M.P., and other eminent practical men, who had long felt the importance of increased knowledge, and extended education, as applied to the study of pharmacy by the chemist and druggist.

In the remarks we have now made on the past deficiencies in scientific education for all classes, throughout our universities, and public and private schools, we have endeavoured to show the heavy losses entailed upon our country by such a deficient state of education. We might have enlarged greatly on every part of our subject, had space allowed us to do so. It will, we think, be seen by the most unscientific reader, that the extension of scientific and technical education is one of the great wants of the present age. Dr. Lyon Playfair well observes, in allusion to the system of classical instruction that so long prevailed in our universities and schools, to the exclusion of modern science, "I can rejoice as much in a good thought from Plato, or a happy allusion from Aristophanes, as I can in hearing a discussion on the philological affinities of the Indo-Germanic tongues; but I cannot understand why our sons of industry, destined to reap its harvest, should be placed in its fields of corn having only been taught how to cut the poppies."

But let it not be thought that while we seek so anxiously to point out the evils that exist in our educational system, and those that have arisen in consequence of its long continuance, we are ignorant of the progress that has been made.

Believing that knowledge is a part of the heritage of man, we rejoice to find the attention that is now paid to the subject of education for all classes. The political economist has at last become aware, that the education of the people is the only preparation that can fit a nation to take and maintain its position aright, and "that the better educated the mass of the people are, the greater producers are they of national wealth."

Thus, while our legislators have found that an intelligent population is the most important element of national prosperity and security, they also find, to use the words of the writer from whom we have quoted above, "that the capacity of a nation for liberty depends on the degree of its intellectual culture, ignorance and slavery being correlative terms, the one invariably suggesting the other;" while the faculty of self-government developes simultaneously with an enlightened mind.

The recognition of these important truths is now made by the highest civil authorities of our country; and we find the subject of education for the lower classes occupying the attention of Her Majesty's Privy Council, while, throughout our land, the noble and the man of science are alike uniting their efforts to give the working classes every opportunity, by public lectures and other means, of mental culture. No longer is the moral dignity of the labourer unappreciated, but he is looked upon as one of a class gradually approaching his proper position, where the development of his intellectual and moral faculties shall place him on a level with his fellow man. "The grand idea of humanity, of the import-

ance of man as man, is spreading silently, but surely. The grand doctrine that every human being should have the means of self-culture, of progress in knowledge and virtue, of health, comfort, and happiness, of exercising the powers and affections of a man, this is slowly taking its place as the highest social truth. That society is to care for all, that no human being shall perish but through his own fault, that the great end of Government is to cast a shield over the rights of all, these propositions are growing into axioms, and the spirit of them is coming forth in all the departments of life."*

It has been happy for our country that the acknowledgment of these truths has been made before too late by the upper and middle classes of society. Had the case been otherwise, and had the great mass of the working division of our population realized the conviction, that they, the producers of wealth, the grand physical agency of the community, had not their right position allotted to them in the scale of society, their importance acknowledged, and suitable remuneration given to them for their services, the consequences might have been disastrous in the extreme to England's prosperity. Well has it been for our country that this feeling has been neutralized, by the manner in which the upper classes have lately united for the moral and material improvement of the wage people;† not, as Montalembert observes, by the humiliating tutelage of uncontrolled power, but by the generous combination of every free agency, and of every spontaneous sacrifice. In the sketch we now proceed to give of the Rise and Progress of the British Association, will be seen the mighty power

* Channing.

† The term adopted by Professor Owen for what have been called the lower or working classes.

of that principle of free association, and we are assured our readers will not fail to appreciate the devotedness of the scientific men to whom they owe many of the improvements and luxurious applications of that science, which, while it offers to the rich man every variety of enjoyment, places within the reach of the poor many of those comforts which would be otherwise inaccessible.

CHAPTER III.

Origin of the British Association—Previous Congress of Scientific Men in Germany—Sir David Brewster's Letter—First Meeting in York—Arrangements for its Organization—First President, Viscount Milton—Adjournment to Oxford—Second Meeting—Beneficial Influence of the Association—Reports on the Existing State of Science—Degrees conferred by the University—Meeting at Cambridge—Progress of the Association—Use of the British Association—Remonstrance addressed to the Duke of Newcastle on becoming President—The Meeting at Leeds in 1858—Leading Article in the "Leeds Mercury"—Population and Trade of Leeds — Town Hall — Programme of the Meeting—Inaugural Address of President—A Visit to the Sections—Conversazione—Section F.—Woollen Manufactures of Leeds—Iron Trade—Lecture of Professor Phillips—Sections G. and C.—Horticultural Fête at Kirkstall Abbey—Sections G. and F.—President's Lecture—Sections C. and E.—Paper on Penny Colonial Postage—Conversazione—Final Meeting.

"The chief advantage of learned societies is the philosophical *spirit* to which they may be expected to give birth, and which they cannot fail to diffuse over all the various pursuits of the nations among whom they are established. The insulated scholar may, without dread, abandon himself to the spirit of system: he hears the voice of contradiction only from afar. But, in a learned society, the collision of systematic opinions soon terminates in their common destruction; while the desire of mutual conviction creates among the members a tacit compact, to admit nothing but the results of observation, or the conclusions of mathematical reasoning. Accordingly, experience has shown how much these establishments have contributed since their origin to the spread of true philosophy. They have constantly opposed to empiricism a mass of knowledge, against which the errors adopted by the vulgar, with an enthusiasm which, in former times, would have perpetuated their empire, have spent their force in vain. In a word, it has been in their bosoms that those grand theories have been conceived, which, although far exalted by their generality above the reach of the multitude, are, for this very reason, entitled to special encouragement from their innumerable application to the phenomena of nature, and to the practice of the arts."—*La Place.*

THE British Association, in its different sections, has done much to give all classes of society a just appreciation of those branches of science, which have too often been considered of secondary interest and value.

This noble institution owed its commencement to a discussion which arose, between the years 1826 and 1831, on the low state of science in England, and the neglect of scientific men. Sir Humphrey Davy, Sir John Herschel, Sir David Brewster, Professor Playfair, and many others, had all expressed their deliberate opinion of the superiority of foreign to British scientific institutions, and their strong feeling, with regard to the national discouragement given to scientific men in England. These opinions were held by persons engaged in the pursuit of different branches of science, who had no connexion with each other.

It is said that Sir Humphrey Davy wrote a work on the decline of English science which has not been published, but his views are given in another of his works. "In looking back," he writes, "to the history of the last five reigns in England, we find Boyles, Cavendishes, and Howards, who rendered their great names more illustrious by their scientific renown, but we may in vain search the aristocracy now for philosophers, and there are very few persons who pursue science with true dignity; it is followed more as connected with objects of profit than those of fame, and there are fifty persons who take out patents for supposed inventions, for one who makes a real discovery."

Among other works published on this subject, was one by Mr. Babbage, entitled, "Reflections on the Decline of Science, and some of its Causes." The author asserted "that in England, particularly with respect to the more difficult and abstract sciences, we are much below other nations, not merely of equal rank, but below several even of inferior power," and that "mathematics, and with it the highest departments of physical science, have gradually declined since the days of Newton." Mr. Babbage proceeded to expose "the abuses then existing in the management of

our scientific institutions,—the imperfect system of instruction which is given in our public schools and universities,—the ignorance of public men,—and the culpable indifference of successive Governments to the intellectual glory of their country." This work was the subject of much criticism, and attracted the attention of Sir David Brewster, who, in a highly favourable and elaborate notice of it, in the *Quarterly Review*, gave a sketch of the existing state of science on the Continent and Great Britain, regarding the fact of its decline in the latter country as undoubted.

The reviewer mentioned certain measures of high importance, calculated to revive and extend science in the British Islands, and thus concluded this important article :—"An association of our nobility, clergy, gentry, and philosophers, can alone draw the attention of the Sovereign and the nation to this blot upon its fame. Our aristocracy will not decline to resume their proud station as the patrons of genius, and our Boyles, Cavendishes, Montagues, and Howards, will not renounce their place in the scientific annals of England. The prelates of our National Church will not refuse to promote that knowledge which is the foundation of pure religion, and those noble inquiries which elevate the mind, and prepare it for its immortal destination. If this effort fail, we must wait for the revival of better feelings, and deplore our national misfortune in the language of the wise man : 'I returned, and saw under the sun that there is neither yet bread to the wise, not yet riches to men of understandings, nor yet favour to men of skill.'"

In 1831, when reform in the public institutions of England was obtained, the state of science and its cultivators was brought before Lord Grey's Government, and, through the instrumentality of Lord Brougham, some

important objects relative to such an association as had been suggested by Sir David Brewster were secured.

The British Association thus unquestionably owes its origin to this distinguished man of science, who has been described by the present Astronomer Royal as a philosopher whose investigations have been extended through almost every branch of physical science, while his formation of the Association has been designated his boldest and most successful experiment. The idea appears to have been suggested to Sir David Brewster by the meetings of scientific men, which had taken place for some years in Germany. It will, perhaps, interest our readers, if, for one moment, we glance at the rise and progress of these important Continental *réunions*, distinguished as they have been by circumstances not unlike those which have attended the rise of the British Association, and showing that similar misapprehensions and difficulties attended the progress of the German Association, until its objects were fully understood and appreciated.

In Germany, an annual congress of scientific men had been originated, in 1822, by Dr. Oken, of Munich. The first Meeting was held at Leipsig, and its principal object was to make the cultivators of natural science and medicine personally acquainted with each other. The commencement was on so small a scale, that it might have discouraged Dr. Oken, and the other scientific men, who had formed the plan of such a *réunion* of savants. Twelve strangers and twenty citizens of Leipsig were all who attended it. In the course of the six following years, the Meetings gradually increased in importance; that of 1827, being held in Munich, and being warmly patronized by the King of Bavaria. Halle, Wurtzburg, Frankfort-on-the-Maine, Dresden, and Berlin, successively received the illustrious strangers. In

1828, on the 18th of September, this Scientific Congress assembled at Berlin, under the patronage of the King, and under the presidency of the illustrious Baron Von Humboldt, now, alas! no more. Our countryman, Mr. Babbage, who was the only Englishman present, has recorded his impressions, in an interesting account, communicated by him to the *Edinburgh Journal of Science.* We refer our readers to this article, for the address delivered by the President on the opening of the Congress. Several branches of the royal family, and the foreign ambassadors, were present. At a soirée given in the evening by the President, 1,200 persons were present, among whom was the King himself, beside many persons of high rank and distinguished talent. So well was this Meeting of Continental philosophers attended, that, at the table d'hôte, provided for the accommodation of visitors, 850 persons sat down to dinner on one occasion.

In 1830, on the 18th of September, the Congress was held at Hamburgh; 285 strangers attended, among whom were Professor Johnstone, Dr. Traill, Mr. Babbage, and Professor Pillans. Professor Johnstone communicated to the *Edinburgh Journal of Science* for 1831 a very full and humourous account of the transactions of this Meeting, from which we extract the following:—"The worthy community of Hamburgh could not well understand the meaning of all this gathering together from the four corners of the land, from either shore of the Baltic, and from where, with its broad belts, it girds and embraces the isles of Denmark. The notes of preparation had been sounded for months before, and notices in the journals of the day told of a coming of medical men and *naturforsher;* but as it did not relate to corn, sugar, or currency, they turned to something else, and thought no more about it. But when the time arrived, and there was a talk of public attention to be paid

to these strangers,—of the stadhouse being set apart for the place of enrolment and rencontre,—of the Boursen Halle for the great mid-day assemblies,—of the Apollo Saal for the mittags essen and the soirées, and various other apartments, public and private, for certain minor sectional Meetings, as they were called; above all, when it was whispered, that there was likely to be some good eating and drinking, some dancing, too, and music, and a chance that the citizens of Hamburgh might be called upon to pay for all this, then, to be sure, it became a matter of every-day business. The stomach and the purse were equally concerned, and inquiries were neither few nor far between, about the objects and intentions of these strangers, and the expense they might cost them. You might hear the matter discussed over a shipping-list, or a newspaper, on the Boursen Halle, over a sample of coffee, or a beefsteak. 'So many men come together to see one another! Nonsense!' 'And then,' said another, 'they say, we are to feed them; but, if the senate spend our money in that way, the town will be about their ears; the people will not stand it in these revolutionary times.'"

Soon after his review of Mr. Babbage's work, Sir David Brewster determined to make the necessary exertions in order to carry out the idea of a British Association for the Advancement of Science. A central town—York—was selected by him as a suitable locality for such a Meeting as he contemplated, the strong scientific tastes of the inhabitants of York being a secondary inducement. A Philosophical Society had been in existence in that city for eight or nine years, and Sir David Brewster, in pursuance of his plan, addressed the following letter to Mr. Phillips, the distinguished Secretary of that Society:—

"*Allerby, by Melrose, Feb. 23rd*, 1831.

"Dear Sir,—I have taken the liberty of writing to you on a subject of considerable importance. It is proposed to establish a *British Association of Men of Science* similar to that which has existed for eight years in Germany, and which is now patronized by the most powerful Sovereigns in that part of Europe. The arrangements for the first Meeting are in progress, and it is contemplated that it shall be held in York, as the most central city of the three kingdoms. My object in writing to you at present is to beg that you would ascertain if York will furnish the accommodation necessary for so large a Meeting, which might, perhaps, consist of 100 individuals,—if the Philosophical Society would enter zealously into the plan, and if the Mayor and influential persons in the town, and in the vicinity, would be likely to promote its objects. The principal objects of the Society would be to make the cultivators of science acquainted with each other,—to stimulate one another to new exertions,—to bring the objects of science before the public eye,—and to take measures for advancing its interests, and accelerating its progress. The Society would possess no fund, make no collections, and hold no property, the expense of each Anniversary Meeting being defrayed by the members who are present.

"As these few observations will enable you to form a general opinion of the object in view, I shall only add, that the time of meeting which is likely to be most convenient would be about the 18th or 25th of July. "I am, dear Sir,

"Ever most truly yours,

"J. PHILLIPS, Esq. "D. BREWSTER."

This letter, having been submitted to the Council of the Philosophical Society and the Mayor and Magistrates of York, was most favourably received, and the month of September was at last fixed upon as the most favourable time for this British Congress of savans to commence its Meetings. We should mention that, from the first, Sir Roderic Murchison, in London, Mr. Robison, Forbes, and Johnstone, in Edinburgh, gave zealous and effective support to this great undertaking. The learned and venerable Archbishop of York entered also with zeal into the proposed plan, and offered hospitality to the leading members of the Association, receiving them at the palace.

Circular letters had been addressed to the friends of science in Great Britain, and, all arrangements having been completed, the Association held its first convocation at York, 1831, commencing its sittings on Monday, the 26th of September.

At a subsequent Meeting, when the British Association had taken its high position as the recognised Parliament of Science, Professor Phillips described his own feelings, when, on the Sunday afternoon before the Monday on which the Meeting was to commence, he walked after service in the Museum Garden, for the purpose of meeting and welcoming any strangers, and found for some time no one had arrived. At last he discovered four persons, all friends of his own, who had come from a considerable distance to lay the foundation of the Association. These four persons, eminent as they were, would not be sufficient to make a Meeting; and Professor Phillips had anticipated seeing many more illustrious strangers, when he commenced his walk.

Nevertheless, in spite of any discouragement, the inaugural Meeting was held, and numbered no less than 353 persons. On Monday evening the first *réunion* took place in the Museum of the Yorkshire Philosophical Society, the design being to afford an opportunity to the distinguished men ofscience and visitors present, to become mutually acquainted before engaging in more important scientific labours. After an interchange of welcome and recognition among the assembly, an eloquent extemporaneous account of the most remarkable geological phenomena of Yorkshire was delivered by Professor Phillips, illustrated by organic remains and drawings selected from the Museum, and contributed by the visitors.

The following day, the first Meeting was held for the pur-

pose of organizing the Society, Lord Milton, as President of the York Philosophical Society, being called to the Chair on the motion of Sir D. Brewster. The assemblage consisted of many distinguished members of scientific bodies from different places in Great Britain. The number of tickets issued was 359, so that the theatre of the York Society, in which the Meeting was held, was full.

In his opening speech, Lord Milton spoke of the similar Meetings that had taken place on the Continent, the beneficial effects that had resulted from them, and remarked that in our insular and insulated country, as we have few opportunities of communicating with the cultivators of science in other parts of the world, it is the more necessary to adopt means for opening new channels of intercourse with them, and at the same time of promoting a greater degree of scientific intercourse among ourselves. His lordship pointed out the great advantages that must accrue to science from the establishment of the Association, expressing his hope that Government would see the necessity of affording to science due encouragement, and of giving every stimulus to its advancement, adding, "that the fiscal laws of the country offered numerous obstacles to scientific improvement," and mentioning the science of optics as one instance of this fact. "With regard to the more direct advantages which we have a right to anticipate from these Meetings," said his lordship, "I have no doubt that, if they shall be extended to different parts of the country, and held in well-selected places, this result will be obtained: the men of science, now scattered over the empire, will be enabled to meet each other, and mutually communicate their ideas; they will state the advances which have been made in their own respective spheres of action, and also what the deficiencies may be. Thus not only will an extraordinary impulse be

given, but the individuals and the Societies taking part in the Meetings will learn what parts of science they can cultivate with the greatest utility, and will give their researches the most advantageous direction."

The Rev. Wm. Vernon Harcourt, Vice-president of the Yorkshire Philosophical Society, and Chairman of the Committee of Management, then addressed the Meeting, being commissioned, by the Council of the Philosophical Society, to submit for its consideration a plan for the establishment of a system on which similar Meetings should be afterwards conducted.

Mr. Harcourt, having stated the fact, that the Meeting owed its origin to some distinguished cultivators of science then present, who were of opinion that great advantage might be expected from an association for scientific intercourse in these kingdoms, formed upon the model of that which had subsisted in Germany for several years, proceeded to say, "Fully concurring in the utility of such objects, our Society cordially embraced the proposal which was made to us, that the first Meeting should be held in these apartments. Happy if the accommodation which we have to offer could be made serviceable to a purpose of so much public interest, and not insensible, gentlemen, to the honour and advantage which the presence of so distinguished an assembly would confer upon our own institution, in conformity, also, with the express desire of the promoters of the Meeting, we undertook to make all the arrangements for it, and to prepare the plan of a permanent Association. I will request the Secretary of the Committee of Management to state, in the first place, what arrangements were made, and will afterwards proceed to give an account of the plan which I have to offer to your consideration."

Professor Phillips, Secretary of the Society and of the Com-

mittee of Management, then made the following statement, which to us possesses great interest, as illustrating the care with which the foundations of this great Association were laid by those who originated the plan, and the enlarged views and principles upon which they acted :—

"The Committee, being of opinion that the invitations to this preliminary Meeting should be co-extensive with whatever desire there might be in the country to promote the objects of science, drew up, in the first instance, a circular letter, inviting the attendance of all persons interested in scientific pursuits, which, in case any one who is here present should not have received it, may be proper for me to read :—

'*Sir*,

'*The Council of the Yorkshire Philosophical Society having received intimation from men of scientific eminence in various parts of the kingdom, of a general wish that a Meeting of the friends of science should be held at York during the last week in September next, we are directed to announce that the Society has offered the use of its apartments for the accommodation of the Meeting, and that arrangements will be made for the personal convenience of those who may attend it. It will greatly facilitate these arrangements, if all who intend to come to the Meeting would signify their intention as early as possible to the Secretaries.*

'*The apartments which the Yorkshire Philosophical Society has to offer for the use of the Meeting consist of a theatre, which affords seats for about* 300 *persons, five rooms, containing the Museum of Natural History, a Library, Laboratory, and Council Room.*

'*All persons interested in scientific pursuits are admissible to the Meeting.*

'Wm. Vernon Harcourt, *Vice-President.*
'John Phillips, *Secretary.*

'*Yorkshire Museum, York,*
'*July* 12*th*, 1831.'

"Copies of this circular letter were sent to the Presidents and Secretaries of all the scientific institutions in England,

metropolitan and provincial, which were known to the Committee, with a request that the invitation might be communicated to any members of those institutions who might be disposed to accept it. The number of Societies in London thus addressed was thirteen; the number in other parts of England was twenty-six, nine of these being in the county of York.

"The letter was sent individually to the more distant members of our own Society, and to persons, whether belonging to any Society or not, who were known to be active cultivators and promoters of science. One hundred copies were also transmitted for distribution to societies and individuals, by the correspondents of the Committee in Scotland and Ireland; and two or three eminent foreigners were in like manner individually invited, though the Committee did not deem it prudent to extend invitations abroad, till it should be seen what reception the plan of the Association might meet with at home. Lastly, to ensure more general publicity, advertisements of the Meeting were inserted in the *Philosophical Magazine* for the months of August and September, an announcement having before appeared in the *Edinburgh Journal of Science.*

"When the time appointed for the Meeting drew nearer, the Committee of Management put into circulation another notice, specifying more particularly the nature of the regulations which they proposed to adopt. The second circular notice was as follows :—

'*General Scientific Meeting at York.*—It is requested that persons proposing to attend the Meeting will give notice of their intention to the Secretaries of the Yorkshire Philosophical Society.

'Models of inventions, specimens of natural and artificial products, to be exhibited at the Meeting, instruments or drawings to illustrate any communications, and materials for experiments, will be received

by the Secretaries, and may be transmitted to them previous to the Meeting.

'It is also desirable that memoirs intended to be read, or a short statement of their contents, should be sent beforehand, in order to their being registered; and that any memoir which may be too detailed to admit of being read at length, should be accompanied by an abstract of its principal contents.

'On Monday, the 26th instant, the Managing Committee will receive at the Museum the names of persons intending to be present, and will deliver tickets for the morning and evening Meetings, and dinners, and references to lodgings. The Committee will think it right to pay regard to economy as well as convenience in these arrangements.

'The apartments of the Society will be opened on Monday evening; and the first morning Meeting for scientific purposes will be on Tuesday, the 27th instant, at Twelve o'Clock.

'Yorkshire Museum,
'Sept. 7, 1831.'"

Professor Phillips having concluded his statement, Mr. Harcourt again rose, and read extracts from letters which had been addressed to him by Dr. Buckland, Professor Faraday, and Sir Francis Chantry, (then Mr. Chantry,) who had been reluctantly prevented from attending the Meeting by pressing engagements. Sir Francis had given the Yorkshire Philosophical Society another proof of his desire to promote science, by presenting to its museum, on this occasion, a cast of the celebrated Plesiosaurus, in the Duke of Buckingham's collection. Mr. Harcourt then read a letter which he had received from the Duke of Sussex, who had been invited to honour the Meeting with his presence. The letter stated that nothing would have afforded his Royal Highness greater pleasure than to have complied with the invitation, if he had not been, unfortunately, pre-engaged. "You will, therefore," his Royal Highness added, "be so

kind as to express my regret on the occasion, accompanied with my best wishes for the success of so praiseworthy an object, and an assurance on my part of my warm co-operation in promoting any measure which may be suggested, and sanctioned by such a respectable Meeting." Mr. Harcourt then explained, in an admirable speech, the objects of the new Association, and the plan upon which it was intended to be established. He proposed that "A British Association for the Advancement of Science should be founded, having for its objects to give a stronger impulse and more systematic direction to scientific inquiry, to obtain a greater degree of national attention to the objects of science, and a removal of those disadvantages which impede its progress, and to promote the intercourse of the cultivators of science with one another, and with foreign philosophers."

A correspondent had alluded to the circumstance, that "what Bacon foresaw, in distant perspective, it had been for our day to realize; and as his prophetic spirit pointed out the splendid consequences that would result generally from institutions of this kind, so might we hope that the new visions which were opening before us might be productive of still greater effects than have yet been beheld, and that the bringing together the cultivators of science from the North and the South, the East and the West, might fulfil all the anticipations of one of the greatest minds that ever threw glory on our intellectual nature."

It was proposed by Mr. Harcourt, "That all members of philosophical societies in the British Empire should be entitled to become members of the Association on enrolling their names, and engaging to pay such subscription as should be fixed; that the members should meet for one week in each year at different places in rotation. The General Committee to consist of all members present at a Meeting

who have contributed a paper to any philosophical society, which paper has been printed by its order, or with its concurrence. Sub-Committees should select the points in each science which most call for inquiry, and endeavour to obtain competent persons to investigate them where the subject admits of co-operation, calling in the aid of scientific bodies, attending especially to the important object of obtaining reports, in which confidence may be placed, on the recent progress and actual state and deficiencies of every department of science."

The speaker quoted, with relation to the last point, the opinion expressed by Professor Whewell, of Cambridge, with regard to its importance :—"A collection of Reports, concerning the present state of science, drawn up by competent persons, is on all accounts much wanted, in order that scientific students may know where to begin their labours; and in order that those who pursue one branch of knowledge, may know how to communicate with the inquirer in another. For want of this knowledge, we perpetually find speculations published which show the greatest ignorance of what has been done and written on the subjects to which they refer."

Mr. Harcourt concluded this explanation of the objects of the Association by the remark :—"It has never yet been seen in this country, that twenty chemists, for instance, or twenty mineralogists, have met together for the purpose of settling the nomenclature of their respective sciences, or attempting to fix, with one consent, the foundations on which they rest. It has never yet been seen that the chemical, mineralogical, and optical inquirers have assembled for the purpose of mutually explaining and learning what light the sciences of chemistry, mineralogy, and optics are capable of reflecting reciprocally upon each other."

Resolutions, embodying the objects and rules of the Asso-

ciation, were then moved by Mr. Harcourt, and seconded by Sir D. Brewster, Sir Roderic Murchison, &c.* The following days were occupied in completing the arrangements for the formation of this important Society, Viscount Milton being chosen President for this, the first sitting of the "Parliament of Science," and Dr. Buckland President Elect.

Local Committees were appointed to act in London, Edinburgh, Dublin, and also in Calcutta. When these arrangements were completed, the Meeting commenced its scientific sitting by lectures, oral discussion, and the exhibition of interesting scientific objects. Among those who were thus active in promoting the objects of the Association at this first assembly, we find the names of Dr. Dalton, Dr. Henry, Sir D. Brewster, Rev. W. Harcourt, Sir R. Murchison, Dr. Scoresby, Professor Forbes, Dr. Daubeny, Professor Johnstone, Sir John Robison, and many other eminent scientific men.

On Saturday, the scientific discussions and communications having been terminated by some remarks of Sir D. Brewster, in which, adverting to a method of rendering visible the legends of ancient coins, he stated that he had never been more struck than by observing on an old coin, which he had placed on hot iron, an inscription make its appearance, which he could read in a dark room, bearing the words, "*Benedictum sit nomen Dei*," Viscount Morpeth addressed the Meeting; speaking of the high honour bestowed upon York, in being selected as the birthplace of an Association he trusted "was destined to confer fresh

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* A subscription of one pound constitutes membership, and entitles the subscriber to be present at the lectures and Meetings of the Association at its annual sittings. We refer our readers for further particulars to the Annual Reports, volumes of great interest, which can be obtained of Messrs. Taylor and Francis, Red Lion Court, Fleet Street, London.

lustre on British Science, to give a new motive and a new guarantee to the friendly intercourse and continued concord of nations, to make further inroads into the untravelled realm of discovery, and to glean fresh harvests from the unexhausted field of Nature, to promote the comforts and augment the resources of civilized man, and to exalt above and over all the wonder-working hand of Heaven. For it will always come out from the pursuit of knowledge, as surely as from the rusty medal of which we have this moment heard, "*Benedictum sit nomen Dei.*" "Observe well," continued the noble Viscount, "if you wish to appreciate rightly the true value and nobility of science, that while it proposes to itself distinct courses and definite spheres of its own, its general tendencies conduce to peace, and minister to piety. With these views and these hopes, it is natural, and it is becoming, that there should be mixed feelings of gratitude to those whose efforts have contributed so largely to our future progress." Viscount Milton concluded by moving that the thanks of this Meeting be given to Sir David Brewster, and the other authors who had favoured it with their communications.

Sir Roderic Murchison then rose, and, "on the part of Sir David Brewster and his other scientific friends, begged leave to return thanks for the high honour done to the contributors of scientific memoirs, and for the valuable aid which had been received from the residents of York and its neighbourhood." He explained the motives which induced the original promoters of it to select the city of York for their first assembly. "To this city," said he, "as the cradle of the Association, we shall ever look back with gratitude; and whether we meet hereafter on the banks of the Isis, the Cam, or the Forth, to this spot, to this beautiful building, we shall still fondly revert, and hail with delight

the period at which, in our periodical revolution, we shall return to the point of our first attraction." A vote of thanks was then moved by Sir Roderic to His Grace the Archbishop of York, and the other members of the Yorkshire Philosophical Society, for the different efforts by which they had so essentially contributed to the success and prosperity of this Meeting; which vote was seconded by Sir D. Brewster and Mr. Dalton.

The Meeting was adjourned to Oxford for the following year by Mr. Harcourt, who declared that, in the long period of its existence, the ancient city of York had never greater reason to be proud than of the genius and talent it contained within its walls at that moment, and of the honour it had acquired in being the birth-place of an Association destined, he firmly believed, "greatly to enlarge the boundaries of science; and, in so doing, to advance the many interests of human nature, which depend upon the improvement of knowledge."

We must not forget that two important subjects were prominently before the minds of the originators of the British Association,—viz., a repeal, or reform, of the law of patents, which has been so great an obstacle in the progress of science, and direct national encouragement for science and its cultivators. The fact that, in 1830, there was not a single instance of a philosopher, however eminent his services, enjoying any favour from Government, either by pension or title, will show our national insensibility at that time to intellectual greatness, and the unhealthy condition of a Government that was thus indifferent to science, as an element of national progress.

The following were the subjects upon which Reports for the next Meeting were requested by the Sub-Committees :—

1st. On the Progress of Astronomy during the Present Cen-

tury, from Professor Airy. 2nd. On the Tides, from J. W. Lubbock, Esq. 3rd. On Meteorology, from J. Forbes, Esq. 4th. On Radiant Heat, from Professor Powell. 5th. On Thermo-Electricity, from Professor Cumming. 6th. On the Recent Progress of Optics, from Sir David Brewster. 7th. On Mineralogy, from Professor Whewell. 8th. On Geology, from the Rev. W. D. Conybeare. 9th. On Chemical Science, from Professor Johnstone. 10th. On the History of the Human Species, from Dr. Pritchard.

So great was the interest excited among learned and scientific men by the results of the Meeting at York, that an invitation was given immediately, by one of its most zealous friends, Dr. Daubeny, to choose Oxford for the next annual session.*

The second Meeting was held at Oxford, beginning on the 18th of June, 1832, in the rooms of the Clarendon Buildings.

On Tuesday, at one o'Clock p.m., the Chair was taken by Viscount Milton, as President for the last year. The Chancellor, Lord Grenville, was a member of the Association, but was too infirm to be present at the Meetings. The theatre and numerous rooms in the Clarendon Buildings were placed by the Vice-Chancellor and other Governors at the disposal of the Association; and one of the highest distinctions the University had it in its power to bestow, viz., the degree of

* Our readers will be interested to see the gradual rise in the numbers attending the Meetings of the Association. At York, 353 tickets were issued; Oxford, in the following year, had 564 taken; Cambridge, in 1833, had 856 members present; while the Edinburgh Meeting rose to 1,139; and Dublin, the following year, to 1,203. The largest Meeting has been held at Newcastle, where 2,076 persons were present. The number of ladies attending the Meeting reached, at the Birmingham session, to 323, out of 1,189 persons present. Cheltenham, in 1856, had 1,109 tickets taken, of which 347 were ladies; Dublin, in 1857, 2,005, of which 569 were ladies; Leeds, in 1858, reached 1,693, 508 being ladies.

Doctor of Civil Law, was, during the week, conferred upon Dr. Dalton, Sir David Brewster, Mr. Robert Brown, and Mr. Faraday (not one of whom was a member of the Church of England).

The noble Viscount, having opened the business of the Meeting in an appropriate speech, thus concluded: after expressing the gratitude which every member of the Association felt to the constituted authorities of the University, for the kind reception given by them, he said,—"Confident I am that they will never have reason to repent of the favour which they have shown us, in permitting the Meeting to assemble within these walls, but will reflect, with well-grounded satisfaction, on the encouragement now afforded to an institution, the object and tendency of which is to promote the highest and most important interests of man,—I say, Gentlemen, his highest and most important interests; for were I to be asked, what is the chief use of any new inference which may be deduced from those facts of which we are already in possession, I should answer, that the principal use of such knowledge and such reasoning is, to lead man to lift up his mind and his heart to his Maker; and, in comparing his own inability, (of which the greater his knowledge, the deeper must his conviction be,) in comparing the inability of the creature with the stupendous works of creation, to imbibe a deeper feeling of religious awe, and acquire a stronger sense of the reverence and duty which he owes to the power, the wisdom, and the beneficence of the Creator. It is on this ground especially that every reflecting mind will rejoice in the advancement of science, and it is, I doubt not, to similar views of the value of every improvement in the knowledge of nature, that we are to ascribe the reception with which our Association is honoured in this ancient seat of learning and religion."

After stating the arrangements made for the reception of the Association, Dr. Buckland called upon Professor Airy to read his Report on the Recent Progress of Astronomy (practical and physical).*

The beneficial influence of the Association was now manifested, for the Professor of Astronomy at Cambridge declared that no inducement but that of such solicitations as he had received could have impelled him to undertake the task which in the following pages he had fulfilled. The Report, which is contained in the first published volume of the Association, is of peculiar interest and value, but we can only pause to extract one fact illustrative of the remarkable difference between the spirit with which scientific observations are made in England and the Continent. "In England, an observer conceives that he has done everything, when he has made an observation. In foreign observatories, on the contrary, an observation is considered as a lump of ore requiring for its production, when the proper machinery is provided, nothing more than the commonest labour, and without value till it has been smelted.

"With them, the exhibition of results and the comparison of results with theory are considered as deserving much more of an astronomer's attention, and demanding greater exercise of his intellect, than the mere observation of a body on the wire of a telescope. This contributes powerfully to produce that strong connexion between physical theory and

* "The ability and industry which have thus been enlisted in rendering a laborious and responsible service to science, prove the efficacy of a system of public invitation, in giving incitement and direction to the energies of individuals, and show the existence of a public spirit, entirely in accordance with the designs of the Institution." We may here mention that all the eminent services rendered by the members of the British Association have been entirely gratuitous.

practical observation, which is general on the Continent, but which does not exist in England. These foreign astronomers have first obtained distinction, while in the lower departments of the observatories. In all the important branches of science we are behind our neighbours." "When I remark," continued Professor Airy, "the growing intermixture of physical with observing science, I indulge in the hope that the character as well as extent of our Astronomy is improving, and that the time is approaching when a person will not in England be considered a great astronomer because he can observe a transit or measure a zenith distance correctly."

The Report on Tides, by Mr. Lubbock, was another valuable result of the impulse given by the Association; and, in the absence of the author, was delivered by Dr. Whewell, and illustrated by a map of the world, on which had been drawn the co-tidal lines, passing through the points where it is high water at the same time.

"There is no branch of Physical Astronomy," Mr. Lubbock declares, "in which so much remains to be accomplished, and no branch, we may add, of more importance to a maritime nation." La Place calls the theory of tides "la plus epineuse de L'Astronomie Physique," * but adds that the difficulties and irregularities disappear by constant and repeated observations.

On Wednesday, at one o'Clock, the members of the Association having re-assembled in the theatre, the Chairman of the four Sub-Committees read the minutes of the transactions of the Sectional Meetings.

At the conclusion of those of the Geological Section, the President requested the Meeting to allow the Wollaston

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* The most thorny of problems.

Medal, which had been awarded by the Geological Society to Mr. William Smith, to be delivered to him in the presence of the members of the Association. The President of the Geological Society, Sir Roderic Murchison, having in consequence presented the medal to him in the name of that Institution as a testimony of respect to the acknowledged "Father of English Geology," Mr. Smith expressed his gratitude for the high honour which had been conferred upon him.

Professor Cumming was then called upon to read his Report on Thermo-Electricity, which was followed by a Report on the Recent Progress and Present State of Meteorology, by Professor Forbes, which was partly read by the author, who mentioned the mistake made in the idea that "Meteorology, as a science, has no other object than an experimental acquaintance with the condition of those variable elements which, from day to day, constitute the general vague result of the state of weather at any given spot, not considering that while such hetorogeneous elements can be of little avail, when viewed simply as a group of facts, towards forwarding any one end of the science, or giving us any precise knowledge regarding it, yet that the careful stuty of the individual points, when grouped together with others of the same character, may afford the most valuable aid to scientific generalization. The most interesting views which have been given in this science, and the most important general laws at which it has yet arrived, have for the most part been contributed by philosophers, who, in pursuit of other objects, have stepped aside for a moment from their systematic studies, and bestowed upon the Science of Meteorology some permanent mark of their casual notice of a subject which they never intended to prosecute. Mr. Dalton descends for a moment from his

chemistry in the abstract, to illustrate the constitution of the atmosphere, and the theory of vapour. La Place, viewing nature with the eye of a master, introduced into his Mechanique-celeste an investigation of the mechanical structure and laws of equilibrium of the gaseous envelope of our planet. He applies Meteorology to one of its great objects, the laws of atmospherical refraction, and gives to the scientific world a new formula for the measurement of heights, which greatly exceeds in accuracy those which had previously been proposed. The true basis of this science rests upon several branches of physics, only at the present moment rising to their true level of importance in the scale of human knowledge; and there are few of the sciences which are not more or less directly connected with the progress of Meteorology."

We have given this extract because we think it will assist our readers to form an idea of the importance of Meteorology as a branch of science.

The Reports on Optics, Radiant Heat, Mineralogy, Geological and Chemical Science, were of equal interest and value, and we again refer our readers for their perusal to the annual volume.

Thursday, the day on which the degrees were conferred, after a convocation held in the theatre for that purpose by the University, a numerous assemblage accompanied Dr. Buckland on an excursion to hear his lecture on the Geology of the Neighbourhood of Oxford. Another party accompanied Professor Henslow on a botanical expedition. Dr. Buckland's lecture was eminently practical, and contained many valuable hints for the agriculturist.

In the course of the lecture, the President took occasion to enforce the importance of Geological Science, as connected with agricultural improvement, and suggested that there

might be great utility in an appointment, by the Geological Committee, of a Sub-Committee to devote its attention to this object. He pointed out many defects in the ordinary system of drainage, and explained in what manner large tracts of land might in many cases be permanently drained at a small expense, by methods depending entirely on a knowledge of the strata. He adverted to the possibility of reclaiming the peat bogs in Ireland, distinguishing those which are capable of being reclaimed from those where the outlay of capital must exceed any profitable return; and, in speaking of Artesian Wells, suggested the advantage which might be derived from a more general application of them in the neighbourhood of London.

On Friday the Reports were resumed, and on Saturday the Association assembled for the last time, Professor Sedgwick being chosen President for the next Meeting at Cambridge. In the evening, the President delivered a lecture on the Fossil Megatherium, lately imported from America. Dr. Buckland paid a touching and eloquent tribute to Cuvier in the course of his observations, remarking, that "to this great and good man not only are the sciences of Natural History profoundly indebted, but the higher science of morals also owes to him a debt of deep and everlasting obligation, for that he has proved to demonstration the high and solemn truth—the variety and universal goodness of the great Creator." Before the Meeting separated, Professor Babbage rose, and said he wished to express a feeling, general among the members of the Association, that in the selection of the places at which the Annual Meetings were to be held, attention should be paid to the object of bringing theoretical science in contact with that practical knowledge on which the wealth of the country depends. "I was myself," said Mr. Babbage, "particularly anxious for this, owing, as I do,

a debt of gratitude for the valuable information which I have received in many of the manufacturing districts, where I have learned to appreciate, still more highly than before, the value of those speculative pursuits which we follow in our academical labours. I was one of those who thought, at first, we ought to adjourn for our next Meeting to some large manufacturing town ; but I am now satisfied that the arrangement which has been made will be best adapted to the present state of the Association. When, however, it shall be completely consolidated, I trust we may be enabled to cultivate, with the commercial interests of the country, that close acquaintance which I am confident will be highly advantageous to our more abstract pursuits."

Sir Roderic Murchison then called the attention of the Meeting to the peculiar obligation under which it lay to one of its members. "At our first Meeting, Gentlemen, in York, when the Institution was in its infancy, and every difficulty hung aroung us, a Professor of this University came forward and undertook, on his own responsibility, that Oxford would open its gates to receive us. Delighted as we have been with the reception which we have experienced, and sensible how much the Association has been consolidated by this Meeting, we owe our acknowledgment of gratitude to Dr. Daubeny as the primary cause of our having assembled here."

Dr. Daubeny said, that from the situation which he occupied in the University, it was naturally to be expected that he should regard, with peculiar interest, the Meeting in that place of an Association which he considered calculated to form an important epoch in the history of British science.

"The attachment," said the Professor, "which I entertain for the cause of science implies in my case no extraordinary merit, placed as I am in a situation of com-

parative independence, by my connexion with one of the great ecclesiastical establishments of the country. It is to those only who have pursued such studies without partaking of the advantages derived from academical institutions, or that patronage of Government, which in other countries supplies their place, to whom the praise is due of a high degree of disinterestedness in preferring the attractions of philosophy to those of emolument."

The Meeting at Oxford was most successful, and not less so was the ensuing one held at Cambridge in the following year, under the presidency of Professor Sedgwick, which was attended by more than 900 members, among whom was the late Dr. Chalmers, of Edinburgh. The heads of colleges vied with each other in their hospitality and kindness; and on one occasion, when the members of the Association were invited by the members of the University to a collation in Trinity College, the President, who was in the Chair, having given as a toast the Universities of Scotland, Dr. Chalmers, in rising to return thanks, after mentioning the invitation that had been given to the Association to meet at Edinburgh the following year, proceeded, in his own eloquent manner, to say that there were no class of men who looked upon the progress of philosophy and the prosperity of this Society with greater kindness than the enlightened Christians of Edinburgh. In the spirit of that sentiment which the President had expressed in an early part of the day with a power and beauty he had never heard surpassed—"that Christianity would follow the advance of Science"—"he would say that Christianity had everything to hope and nothing to fear from its advancement. It was true, very true, that Christianity had been traduced by men who called themselves philosophers, but who were the disciples of a second-rate philosophy. There

was a humility of mind, the offspring of true philosophy, which manifested itself in well-constituted minds; and more, chief of all, in that of the great Sir Isaac Newton, the glory of Cambridge, and more especially the glory of Trinity College, who was regarded by universal consent as the parent of all philosophy, and who was, notwithstanding, the most engaging specimen both of religion and humanity the world ever saw. He should then beg leave to give as the next toast, 'Trinity College, Cambridge,' accompanied by a wish that the science of Newton, consecrated by the Christianity of Newton, may be for ever enshrined within her walls."

Scientific men from the Continent took a share in this Meeting, and in 1834, when the Association met in Edinburgh, Arago, Agassiz, and other men of the greatest eminence, came to the Scottish metropolis to partake in the proceedings, and to be welcomed with true hospitality by the inhabitants of Edinburgh.

We shall not attempt to describe in detail the progress of the British Association during the next twenty years. The Universities, Dublin, Edinburgh, York, Birmingham, Liverpool, and Glasgow, have each twice had the honour of entertaining this Congress of Savans; while Bristol, Newcastle, Manchester, Cork, Ipswich, Hull, Plymouth, Southampton, Swansea, Belfast, Cheltenham, and Leeds, have also in their turn been favoured with its presence.

The following is the order in which the Meetings have taken place:—

Place of Meeting.	*President.*
1831 York	Earl Fitzwilliam, D.C.L., F.R.S., &c.
1832 Oxford	Rev. W. Buckland, D.D., F.R.S., &c.
1833 Cambridge ...	Rev. Adam Sedgwick, M.A., V.P.R.S., &c.
1834 Edinburgh ...	Sir T. M. Brisbane, K.C.B., D.C.L., &c.
1835 Dublin	Rev. Provost Lloyd, LL.D.
1836 Bristol	Marquis of Lansdowne, D.C.L., F.R.S., &c.

Place of Meeting.	*President.*
1837 Liverpool ...	Earl of Burlington, F.R.S., F.G.S., &c.
1838 Newcastle-on-Tyne .	Duke of Northumberland, F.R S., F.G.S., &c.
1839 Birmingham .	Rev. W. V. Harcourt, M.A., F.R.S., &c.
1840 Glasgow ...	Marquis of Breadalbane, F.R.S.
1841 Plymouth ...	Rev. Professor Whewell, F.R.S., &c.
1842 Manchester ..	Lord Francis Egerton, F.G.S., &c.
1843 Cork	Earl of Rosse, F.R.S., &c.
1844 York	Rev. G. Peacock, D.D., F.R.S.
1845 Cambridge ...	Sir John F. W. Herschel, F.R.S., &c.
1846 Southampton.	Sir Roderic Murchison, G.C.St.S., F.R.S., &c.
1847 Oxford... ...	Sir R. H. Inglis, D.C.L., F.R.S., &c.
1848 Swansea ...	Marquis of Northampton, F.R.S., &c.
1849 Birmingham .	Rev. T. R. Robinson, D.D., M.R.T.A., F.R.A.S.
1850 Edinburgh .	Sir David Brewster, K.H., LL.D., F.R.S.
1851 Ipswich	Geo. R. Airy, Esq., D.C.L., F.R.S.
1852 Belfast... ...	General Sabine, Royal Artillery, &c.
1853 Hull	William Hopkins, Esq., M.A., V.P.R.A., &c.
1854 Liverpool ...	Earl of Harrowby, F.R.S.
1855 Glasgow ...	Duke of Argyle, F.R.S., F.G.S.
1856 Cheltenham .	Charles G. B. Daubeny, M.D., D.C.L., F.R.S.
1857 Dublin	Rev. Humphrey Lloyd, D.D., D.C.L., F.R.S.
1858 Leeds	Richard Owen, M.D., D.C.L., F.L.S.

With regard to the present position of the British Association, Dr. Daubeny thus spoke in his eloquent presidential address at Cheltenham :—

"Twenty years ago, the invitations sent us proceeded either from places like the Universities, expressly dedicated to learning, and therefore peculiarly called upon to lend a helping hand to science, or else from cities in which the predominant occupations brought the mass of the population into immediate and constant connexion with scientific processes. Now, on the contrary, we have seen the two principal centres of fashionable resort—the favourite retreats of the wealthy and noble of the land—vieing with each other in their eagerness to receive us ; and an almost purely agricultural county greeting us with the same hearty welcome as that which we had heretofore received from the

commercial and manufacturing communities. Twenty years ago it was thought necessary to explain at our Meetings the character and objects of this Association, and to vindicate it from the denunciations fulminated against it by individuals, and even by parties of men, who held it up as dangerous to religion, and subversive of sound principles in theology. Now, so marked is the change in public feeling, that we are solicited by the clergy, no less than by the laity, to hold our Meetings within their precincts; and have never received a heartier welcome than in the town in which we are now assembled, which values itself so especially, and with such good reason, on the extent and excellence of its educational establishments."

When we call to mind the mighty changes that have taken place since the British Association commenced its labours, and the remarkable manner in which the discoveries of science facilitate the progress of Christian civilization, we must acknowledge an over-ruling Providence, which, though often mysterious, is, nevertheless, steadily pursuing its own designs.

But it must not be supposed that the British Association in its progress escaped the attacks of ridicule or expressions of hostility. At an early period the *Times* was a powerful opponent, and used every means in its power to affect the reputation of the newly-formed Association as a learned body; but at the Belfast Meeting it held out a flag of truce, and an admirable article, by Professor Wilson, of Cirencester College, occupying several columns, appeared in its pages. "Notwithstanding the important counties," said Professor Wilson, "in which the Association has met in successive years, the number of persons who have attended its Meetings, and the favour by which it has been regarded by the scientific world, it is evident that the public generally pos-

sess but a limited acquaintance with its objects, and that thousands are generally enjoying the benefits resulting from it, without ever knowing the existence of the source whence they are derived."

A fact, strikingly illustrative of the truth of the above observations, is related of a reverend Dean, who, on the eve of the Meeting of the Association being held at Newcastle in 1838, addressed a remonstrance to the Duke of Newcastle, who was to preside, "On the Dangers of Peripatetic Philosophy," thus evincing the writer's ignorance of the great advantages that must spring from the Meetings of the Association being held in different towns.

Professor Phillips well answered such objections, when at the Hull Meeting he thus replied to the question, "What is the use of a British Association, which is limited to no one place, and to no one set of men?" "My answer," said he, "is, that the very fact that it is not limited to one place and to no one set of men, forms one of the leading elements of its utility. If we were limited to one place, it must have been in London, where institutions for the promotion of every science and every department of knowledge already exist, and where we meet every day with those who are engaged in directing all those learned pursuits. Would another institution, located solely in London, confer upon the country an amount and variety of benefit equal to that dispensed by a Society visiting in succession the mines and fields of industry in all the leading ports and provinces? And if but one set of men composed the Association, they would have all the advantage of those who cultivate but one branch of knowledge, and are necessarily ignorant of much that others are doing and discovering in other branches, which, nevertheless, are perpetually showing, in the truths and phenomena which they elicit, an important bearing

one upon another. The object is not the personal gratification of those who come from a distance to make speeches. They have no such object; but they come for the purpose of forming a compact body to advance the interests of science,—an Association strong enough to appeal to the people, to the Government of this realm, and to the Governments of foreign countries."

Slowly, but surely, has an appreciation of the benefits conferred by this "Peripatetic" Association arisen in the minds of unscientific men. If its visits were considered merely in a pecuniary point of view, it would be allowed that a large influx of strangers into a town or city could not be unproductive of a considerable expenditure, the profits of which must be reaped by the inhabitants; but the advantages gained by those who are privileged to receive the Association are of a far higher character. To come into contact with the master-spirits of the age—the Herschels, the Brewsters, the Liebigs, and the Murchisons, who, in devoting all their energies and talents to the furtherance of science, become the benefactors of the whole human race—must have an influence upon those who, while they cannot equal such men in the discovery of scientific truth, may yet learn to appreciate their labours, and find their own intellectual faculties expand in so doing.

Nor let us forget that the visits of the Association have often been the means of bringing forward men whose native talent might have never emerged from humble obscurity, had not the fostering care of the Parliament of Science been extended to them. It is one of the distinctive marks of great men candidly and generously to acknowledge the capabilities of mind wherever it is to be found, viewing it as a common stock, to be turned by the industry of each individual to the common progress and happiness of all, and

hence the humble votary of science will have the assurance that he may bring his contribution of observation and thought or discovery before the consideration of the most eminent scientific men in the world, assured of receiving justice at their hands.

"In more than one instance, men working in obscurity, and unknown till the time for the assembling of the philosophers, have been brought out, and are now occupying conspicuous positions in the scientific world. The pursuit of the humble naturalist, laughed at by his townsmen, has been encouraged by the Association, and thousands have learned, by these annual gatherings, to appreciate the man of science." *

But it will perhaps enable our readers to judge better of the numerous advantages likely to arise, directly and indirectly, from the visits of the British Association, if we ask them to accompany us to one of the annual sessions. In 1856 we had attended the Meeting at Cheltenham, which had been a most successful one,† and that of Dublin, in the following year, had been equally so.

The first visit of the British Association to Leeds was under circumstances that rendered it of great interest. The Queen's visit, and the Musical Festival, had passed off with great eclât, and there were some of the sober inhabitants who were disposed to think they had had enough of excitement for a time. Others there were, and they were a numerous party, representing the influence, wealth, and intelligence of the town and neighbourhood, who hailed with delight the prospect of welcoming the most interesting

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* *Daily News.*

† *See* in the *Leisure Hour*, for 1856, two articles, by the author, the first on *Cheltenham*, and the second being a *Report of the Meeting of the British Association* in that town.

assemblage of scientific men that had ever taken place in the West Riding.

The *Leeds Mercury* (the principal journal) took a prominent part in enlisting all the sympathies of the inhabitants, in giving a cordial welcome to the illustrious strangers. In a leading article, the editor thus admirably placed the objects and aims of the Association before his fellow townsmen :—

"In this great industrial community of the West Riding, our material interests give us every motive for hailing the visit of the men whose lives are spent in advancing the progress of society. There is not in the world a district which has a closer interest in watching all discovery and invention in physical, chemical, and mechanical science. Committed to the arduous competition of manufacturing industry with other nations, among whom we find science, taste, art, invention, perseverance, and every appliance afforded by high civilization, it is at our peril that we indulge a careless and indolent spirit, or keep on at a mere jog-trot pace. We must, in self-defence, learn what others are doing, and try to do as well or better than they. At the Meetings of the British Association there are to be seen and heard, not merely the savans, who are engaged in the pursuit of abstract science, but also the foremost men in the application of science to practical purposes; and from the papers or remarks of these men, the most valuable information may be gathered or suggestions received. The very spirit that breathes amidst the Association is that of improvement, expansion, and progress. It is the spirit of scrutiny and of testing. Not that it unsettles truth; on the contrary, it confirms it: but it severely discriminates between truth and error, between reason and prejudice, between fact and fallacy. Of this spirit we may say that it is active yet calm, enterprising yet cautious. Nor is the

Association confined to subjects involving pecuniary profit: so far from it, it embraces the sciences which most elevate the mind, in the contemplation of the works of God, and the laws which He has given to the universe. It may be said to take in the whole range of nature, from the remotest orb in the starry heavens to the minutest flower that decks the field, or the smallest shell that is tossed up by the tide,—from the revolutions of the Pre-Adamite ages to the latest discovery of the adventurous traveller,—from the fossil bones of the megatherium or mammoth to the habits of the microscopic parasite,—from the strict principles of mathematical certainty to the less ascertained but more practically important truths of social economy and vital statistics. There is not, or there ought not to be, a man living who could not find salutary exercise for his thoughts and tastes within the wide scope of the British Association."

We will now give our readers a few facts relating to the past and present condition of Leeds, that they may fully realize how important it is that a town of such rapid growth should avail itself of every appliance for corresponding scientific progress.

The population of Leeds, in the reign of William the Conqueror, was estimated at 300. In 1775, it had increased to 17,119, and, since the commencement of the present century, (when, in 1801, it had 53,162 inhabitants,) it has more than trebled its numbers—the census of 1851 giving 172,270.

Leeds stands on the borders of a rich and vast coal-field, which is the source of its motive power, and, in a great degree, of its manufacturing importance, having its never-failing accompaniment of valuable beds of fireclay and iron-stone.

There are several blast-furnaces in the neighbourhood,

supplying material for the construction of all kinds of machinery. "Close to a navigable river, with canals communicating with the Mersey, the Ouse, and thence with the Humber,—with railways branching off in every direction, the number of trunk lines having their termini in Leeds being equal to Manchester, and larger than any other town in the kingdom, London only excepted,—Leeds has every possible facility for bringing raw material, and sending away manufactured goods, and for the access of men of business." With a vast manufacturing district on one side, and a rich agricultural district on the other, few towns possess so many advantages for commerce and manufacture. The principal manufactures are the woollen, flax, and silk; but, to form an adequate conception of the extent of the cloth trade in Leeds, we must travel down the valley of the Aire, where we shall find a dense mass of population, employed, for the most part, in the manufacture of woollen cloth, or cloth fabrics, "all of which, almost without exception, finds its way to Leeds, the greatest emporium for cloth in the civilized world." It is stated that goods to the amount of £6,000,000 to £7,000,000 are annually turned out of the warehouses. The flax manufactories, also, have a larger trade than any town in Great Britain, except Belfast.*

The silk spinning factories are of importance, but amongst the most interesting establishments to strangers, are those for making locomotive and stationary engines, which are of a wide-spread reputation. About thirty firms are engaged in chemical manufactures, which embrace a large variety of products. There are extensive glass works, and the leather manufacture is also of great value, Leeds ranking the second

* See a useful little work called an *Historical Guide to Leeds.*

town in the kingdom in this branch of trade. Tobacco is also manufactured to a large extent.

The proposed Meeting of the British Association excited the liveliest interest among all classes, and instead of £1,000, the minimum sum of expense to a town when receiving the Association, £2,400 was quickly raised.* The town had long been ambitious of the honour, but had not till 1858 obtained it, in consequence of there being no public building suitable, but the erection of the Town Hall obviated this objection.

Our first visit was to this noble building, to procure our tickets, and to make ourselves acquainted with the locale of the Association. This fine structure at once arrests the eye on entering the open space on which it stands. Its form is a parallelogram of 250 feet by 200, surrounded by Corinthian columns; and a flight of 19 steps leads up to the principal entrance. The tower or dome will, when completed, rise 225 feet above the ground, and in the vestibule leading to the great hall, stands the beautiful statue of her Majesty, in white marble, presented by Sir Peter Fairbairn, the Mayor of Leeds, at a cost, we believe, of 1,000 guineas.

Entering the great hall, the eye is struck by its immense size, grandeur, and beauty. This noble hall exceeds in size the Town Hall of Birmingham, or Exeter Hall. It is 162 feet by 72, and 8,000 persons, it is said, can be accommodated within its walls. At the north end is the great organ, one of the most wonderful wind instruments of the day. It is supplied with wind by five hydraulic engines; and some idea of its colossal size may be formed from the fact that fourteen persons have dined within the swell box. It is

* The expenses attendant upon the reception of the Association are defrayed by the town visited, the member's subscription being devoted to the advancement of science.

considered that, when completed, this instrument will stand unrivalled for brilliancy of tone and immensity of power.

On one side of the hall stands the statue of the late Edward Baines, Esq., M.P. This is an admirable likeness of one whose memory will long be revered in Leeds.

We must not forget to notice the richly-decorated ceiling and the painted windows, which shed a subdued but brilliant light upon the architectural decorations of this noble hall. As the eye dwells with pleasure upon these things, it is arrested by some significant sentences inscribed along its walls. At the north end are these words, "*Except the Lord build the house, they labour in vain that build it.*" On the south end, "*Except the Lord keep the city, the watchman waketh but in vain.*" Words of a similar tendency are inscribed along the sides of the hall.

The law courts, council and refreshment rooms, are grouped around this centre, and in the former the British Association was now to hold its twenty-eighth Annual Meeting.

In order to give our readers a clear idea of the week's proceedings, we transcribe to our pages one of the programmes of this Meeting, which will also give the conditions upon which persons are allowed to attend.

LEEDS.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE TWENTY-EIGHTH ANNUAL MEETING OF THIS ASSOCIATION WILL COMMENCE ON WEDNESDAY, SEPTEMBER 22, 1858,

Under the direction of the following officers:

President:

Richard Owen, M.D., D.C.L., V.P.R.S., F.L.S., F.G.S. &c.,
Superintendent of the Natural History Departments of the British Museum.

Vice-Presidents:

The Lord Monteagle, F.R.S.
The Lord Viscount Goderich, M.P., F.R.G.S.
The Right Hon. M. T. Baines, M.A., M.P.
Sir Philip De Malpas Grey Egerton, Bart., M.P., F.R.S., F.G.S.
The Rev. W. Whewell, D.D., F.R.S., Hon. Mem. R.S.A., F.G.S. F.R.A.S., Master of Trin. Coll. Camb.
James Garth Marshall, Esq., M.A., F.G.S.
Richard Monckton Milnes, Esq., D.C.L., M.P., F.R.G.S.

General Secretary:

Major-General Edward Sabine, R.A., V.P.R.S.

Assistant General Secretary:

John Phillips, Esq., M.A., LL.D., F.R.S.,
President of the Geological Society; Reader in Geology in the University of Oxford.

General Treasurer:

John Taylor, Esq., F.R.S.

Secretaries for the Meeting in Leeds:

The Rev. Thomas Hincks, B.A., 6, Woodsley Terrace, Leeds.
William Sykes Ward, Esq., F.C.S., Claypit House, Leeds.
Thomas Wilson, Esq., M.A., Crimbles House, Leeds.

Treasurers for the Meeting in Leeds:

Arthur Lupton, Esq., Leeds.
John Metcalfe Smith, Esq., Leeds.

Objects of the Meeting.—The objects of the British Association are, to give a stronger impulse and more systematic direction to scientific inquiry; to promote the intercourse of those who cultivate science in different parts of the British Empire with one another, and with Foreign Philosophers; to obtain more general attention for the objects of science, and the removal of any disadvantages of a public kind which impede its progress.

PROCEEDINGS OF THE MEETING.

Reception Room.—The Town Hall will be open, as the Reception Room, on Monday, 13th September, and afterwards during the Meeting, for supplying Lists and Prices of Lodgings, Lists and Addresses of Members, and for giving information regarding the proceedings of the Sections. Gentlemen desiring information on any subject connected with the Meeting, are requested to make application in this Room. There will be a Post Office in the Reception Room on and after Monday, the 20th September.

On and after Monday, September 20th, at Eight A.M., Members, and persons desirous of becoming Members or Associates, or of obtaining Ladies' Tickets, are requested to make application in this Room.

On Wednesday, September 22nd, at Eight A.M., there will be delivered to Members (gratis), on application, in the Reception Room, No. 1 of the "Journal" of the Proceedings of the Meeting. Nos. 2, 3, &c., will be delivered at the same hour, on Thursday, Friday, &c., containing Lists of the Papers appointed to be read on each of these days in the several Sections, and in the order specified. Lists of Members present will also be printed for gratuitous distribution, and delivered, on application, in the Reception Room. The Member's Card contains a Map of Leeds, and a plan of the Town Hall, in which the Sectional Meetings of the Association will be held.

ELECTION OF MEMBERS AND ASSOCIATES.—Gentlemen who desire to attend the Meeting are requested to make personal application at the Reception Room, on and after Monday, September 13th, for Tickets, which admit to all the Sectional and General Meetings.

The Terms of Admission are :—I. As Life Members, a composition of £10, which entitles them to receive gratuitously the Reports of the Association which may be published after the date of payment. II. As Annual Subscribers, a payment of £2 for the first year. These receive gratuitously the Reports for the year of their admission, and for every following year in which they continue to pay a subscription of £1, *without intermission*. III. As Associates for this Meeting only, a payment of £1. They are entitled to receive a Report of the Meeting at two-thirds of the Publication Price. Ladies may become Members on the same terms as Gentlemen, and Ladies' Tickets (*transferable to Ladies only*) may be obtained in the Reception Room, by Members, on payment of £1. Gentlemen who have in any former year been admitted Members of the Association may, on this occasion, renew their Membership, without being called upon for Arrears, on payment of £1. *Without a proper Ticket, no person is admitted to any of the Meetings.*

GENERAL COMMITTEE.—The General Committee will hold its first Meeting in the Town Hall, on Wednesday, 22nd September, at One P.M., for the Election of Sectional Officers, and the despatch of business usually brought before that body. The General Committee will meet again, in the same room, on Monday, the 27th of September, at Three P.M., for the purpose of deciding on the place of Meeting in 1859. The concluding Meeting of this Committee will be held in the same room, on Wednesday, the 29th of Sep-

tember, at One P.M., when the Report of the Committee of Recommendation will be received.

The General Committee consists of the following classes of Members :—

1. Presidents and Officers of the Association for the present and preceding years, with Authors of Reports in the Transactions of the Association.

2. Members who have communicated to a Philosophical Society any Paper which has been printed in its Transactions, and which relates to such subjects as are taken into consideration at the Sectional Meetings of the Association.

3. Office-bearers for the time being, or Delegates, altogether not exceeding three in number, from any Philosophical Society publishing Transactions.

4. Office-bearers for the time being, or Delegates, altogether not exceeding three, from Philosophical Institutions established in the place of Meeting, or in any place where the Association has formerly met.

5. Foreigners and other individuals whose assistance is desired, and who are specially nominated in writing, for the Meeting of the year, by the President and General Secretaries.

6. The President, Vice-Presidents, and Secretaries of Sections, are *ex-officio* Members of the General Committee for the time being.

First General Meeting.—The first General Meeting will be held in the Town Hall, on Wednesday, September 22nd, at Half-past Eight P.M., when the Rev. Humphrey Lloyd, D.D., F.R.S., &c., will resign the Chair, and Professor Owen, M.D., D.C.L., F.R.S., &c., will deliver an Address as President elect.

Sectional Meetings.—The different Sections will assemble in the Rooms appointed for them in the Town Hall, for the Reading and Discussion of Reports and other Communications, on Thursday, September 23rd ; Friday, September 24th ; Saturday, September 25th ; Monday, September 27th ; and Tuesday, September 28th, at Eleven A.M. precisely.

The Committees of Sections will meet in Rooms adjacent to the Section Rooms, at Ten A.M. precisely, on the same days.

Persons desirous of Reading Communications in any Section are requested to give early notice of their intention, by letter, addressed to the Assistant General Secretary, or to the Local Secretaries for the Leeds Meeting.

Reports on the Progress of Science, and of Researches entrusted

to Individuals and Committees, are expected to be forwarded in letters addressed to the *Assistant General Secretary, Leeds*, previously to the Meeting, accompanied by a statement whether the Author will be present, and on what day, so that the business of the Sections may be satisfactorily arranged.

The Reports complete, and concise abstracts of other communications, are to be delivered to the Secretaries of the Sections before which they are read, previously to the close of the Meeting, for publication in the Transactions.

THE SECTIONS ARE THE FOLLOWING :

A.—Mathematical and Physical Science. *President:* The Rev. W. Whewell, D.D., F.R.S., &c.

B.—Chemical Science. *President:* Sir John Herschel, Bart., D.C.L., F.R.S.

C.—Geology. *President :* William Hopkins, Esq., F.R.S.

D.—Zoology and Botany, including Physiology. *President :* Charles Darwin, Esq., F.R.S.

E.—Geography and Ethnology. *President :* Sir R. I. Murchison, D.C.L., F.R.S.

F.—Economic Science and Statistics. *President :* Edward Baines, Esq.

G.—Mechanical Science. *President :* W. Fairbairn, Esq., F.R.S.

The List of Sectional Officers will be completed by the General Committee on Wednesday, September 22nd.

EVENING MEETINGS.

On Thursday Evening, September 23rd, there will be a Conversazione in the Town Hall, commencing at Half-past Eight o'Clock.

On Friday Evening, September 24th, at Half-past Eight o'Clock, in the Town Hall, Professor Phillips will deliver a Discourse on the Ironstone of Cleveland.

On Saturday, at One P.M., there will be a Horticultural Show in the Grounds at Kirkstall Abbey ; and, on Thursday, Excursions to some of the largest Manufactories and Iron-works, and to places of interest in the neighbourhood.

On Monday Evening, September 27th, at Half-past Eight o'Clock, in the Town Hall, the President (Professor Owen) will deliver a Discourse on the Fossil Quadrupeds of Australia.

On Tuesday Evening, September 28th, at Half-past Eight o'Clock, there will be a Conversazione in the Town Hall.

CONCLUDING GENERAL MEETING.

The concluding General Meeting will take place in the Town Hall, on Wednesday, September 29th, at Three P.M. The Proceedings of the General Committee, and the Grants of Money sanctioned by it, will then be stated.

JOHN PHILLIPS,
Assistant General Secretary.

The General Committee of the Association met in the Civil Court at One o'Clock, on Wednesday, being presided over by Dr. Lloyd, F.R.S. The minutes of the General Council for the last year having been read by Professor Phillips, Major-General Sabine read the Report of the Council, which is always of a highly important character, and which is found in detail in the annual volume, to which we refer our readers.

The first General Meeting, at which the Rev. Humphrey Lloyd, D.D., resigned the Presidential Chair to Professor Owen, was held in the evening, in the large room of the Town Hall. There was a very numerous attendance, being larger than at any inaugural Meeting of the Association. Among the audience were a large number of ladies, whose presence gave the hall a gay and brilliant appearance. The Rev. Dr. Lloyd took the Chair at Half-past Eight o'Clock, and immediately around him, and in other parts of the room, were,—Professor Owen, Lord Enniskillen, Lord Monteagle, Lord Wrottesley, Lord Goderich, Sir J. V. B. Johnstone, Bart., M.P., Sir John Herschel, Sir D. Brewster, Sir Roderic I. Murchison, Sir B. Brodie, Sir John Richardson, Sir J. Rennie, Sir Peter Fairbairn, Sir J. P. Kaye Shuttleworth, J. W. Childers, Esq., High Sheriff of Yorkshire, Major-General Sabine, Professor Faraday, Professor Airy, Professor Stevelley, Professor Cairnes, Professor Phillips, Professor J. Nicol, Rev. Dr. Whewell, Rev. Canon Harcourt, Rev. Dr.

Hook, Rev. Dr. Booth, the Right Hon. M. T. Baines, M.P., Col. Sykes, M.P., R. M. Milnes, Esq., M.P., G. S. Beecroft, Esq., M.P., E. Akroyd, Esq., M.P., Dr. Hopkins, Dr. Lankester, Edward Baines, Esq., W. Fairbairn, Esq., R. Chambers, Esq., and many other influential, scientific or literary persons.

The inaugural address, by the new President, was a comprehensive review of the progress of science, including the very latest discoveries. "We are here met," said Professor Owen, "to continue the aim of the Association, which is the Promotion of Science, or the knowledge of the Laws of Nature, whereby we acquire a dominion over nature, and are thereby able so to apply her powers as to advance the well-being of society, and exalt the condition of mankind. It is no light matter, therefore, the work that we are here assembled to do."

On Thursday morning the Sections commenced their sittings, and were numerously attended. In Section A, (Mathematical and Physical Science,) the President, Dr. Whewell, excited a smile by his observation, when opening the Section, that although the room was small, those ladies and gentlemen who meant to attend would find themselves comfortably accommodated, as the sublime nature of the subjects there pursued often thinned the room.

Dr. Whewell remarked, in the course of his opening address, that the sciences, the study of which they were met to promote, were among the oldest in existence—in fact, they existed ever since man's speculative power was called into action. They were subjects that required extraordinary cleverness of intellect, on account of the many complications with which they were involved. There was a subject upon the paper that morning — Luminous Meteors — which the Association had taken up. At present they did not know

much about these bodies, but they had taken the first step towards ascertaining accurately their nature. A paper would be read upon the formation of the cells of bees, in which the most accurate attention to the rules of geometry were shown. This had been a favourite subject to philosophers, from the time of Grecian greatness down to the present time, and had been a fruitful matter of speculation. This showed the abstruse nature of the subjects that would be brought before them. If they looked into the volume that had just been published by the Association, they would see that there were several reports therein contained respecting luminous meteors; and a paper by Professor Powell would now be read, giving the result of the investigations during the past year.

In Section F, (Economic Science and Statistics,) after an introduction by the President, to which we shall again have occasion to refer, and an important paper on the "Water Supply of Large Towns" had been read, a paper by Thomas Bazley, Esq., was brought before the Section by the author, on "Trade and Commerce, the Auxiliaries of Civilization and Comfort."

Mr. Bazley, after thanking Mr. Baines for the great services he had rendered to the cotton trade by his *History of the Cotton Manufacture*, proceeded to sketch the rise and progress of the cotton trade. In 1758 the imports of cotton and its consumption by domestic labour might be three millions of pounds weight; but in the present year, the quantity consumed would be one thousand millions of pounds. For the last year, the exports of cotton manufactures sent to every part of the world amounted to upwards of thirty-nine millions pounds sterling. In this year, the exports of cotton manufactures would, perhaps, amount to forty millions value, and the portion left for home consumption might be twenty

millions, or equal to 17s. per head for the population of this country; but as the cotton trade of Great Britain is not half its magnitude in the entire world, the manufacture of the world at large could not be less than the annual value of one hundred and forty millions. Mr. Bazley proceeded to discuss the question of increasing the supplies of the foreign raw material, and urged the importance of opening up new fields for its cultivation. Africa and Asia could grow more cotton than the most sanguine could contemplate the demand of the whole world would ever require, and to extend its production in those two quarters of the globe would be, at the same time, to extend civilization, and to diffuse the comforts of life. Workpeople, manufacturers, merchants, statesmen, and philanthropists, had all the deepest interest in this vital question, but which hitherto had been shrouded in almost fatal apathy. At home and abroad the wonder was that the British East and West Indies had not supplied the largest portion of the cotton needed in this country. For much of the unproductiveness of those portions of the British empire, misgovernment was responsible. Roused, however, by the salutary influences of public opinion, the Legislature of our country had given to the East Indies a new existence. No intermediate spoiler would hereafter prevent the Queen and a direct executive from developing the resources of India. An enlightened and just policy applied to every British colony would yield the benefits of an extended commerce, blessing, like Charity, those who gave and those who received.

During the course of the day we visited several of the other Sections, which each possessed its peculiar interest. In Section E, (Geography and Ethnology,) some letters from Dr. Livingston were read by the President, Sir R. Murchison.

The first conversazione in connexion with the Meeting of

the Association was held in the large hall, in the evening, and was one of the most brilliant assemblies which have of late graced this magnificent hall. The company began to arrive at about Eight o'Clock, and during the evening there were present—Professor Owen, the Rev. Mr. Lloyd, Lord Enniskillen, Lord Monteagle, Lord Wrottesley, Lord Goderich, Sir J. V. B. Johnstone, Bart., M.P., Sir John Herschel, Sir D. Brewster, Sir Roderic I. Murchison, Sir B. Brodie, Sir John Richardson, Sir J. Rennie, Sir J. P. Kaye Shuttleworth, J. W. Childers, Esq., High Sheriff, &c., &c., &c.

In the ante-rooms on each side of the east entrance, there was a beautiful collection of photographs by the Leeds Photographic Society, including several views of Lucknow. In the large hall there was a valuable assortment of mechanical instruments, rare and valuable books, holographs and autographs; a unique case of ancient and modern rings, and other objects of curiosity; an induction electric machine of great power, and a very ingenious machine for flashing railway signals a great distance, besides an interesting series of photographs of the Bombay waterworks, sent over bi-monthly to the contractors, to show the progress of the works; a beautiful assortment of chinaware and glass, and several vases of wax flowers. The Local Exhibition of Industry, the Philosophical Society, and other institutions, contributed several objects of interest. Mr. W. Spark presided at the organ, and performed an appropriate selection of music during the evening.

On Friday, in Section F, Colonel Sykes presided, while the President, Edward Baines, Esq., read a Report he had prepared on the "Woollen Manufacture of England, with special reference to the Leeds Clothing District;" and here we cannot but remark, that one striking feature in the benefits conferred by the British Association, is the manner in which it

concentrates all the talent of a neighbourhood, and leads to important research.

The Leeds Meeting has thus elicited reports of great value, bearing on the commerce and manufactures of Great Britain. We cannot attempt to give even a *résumé* of this interesting document, which will, doubtless, be found at full length in the published volume of the Association. Having glanced at the history of this ancient manufacture up to our own times, Mr. Baines remarked, "that the exports of English wool, both in the raw state, and in the first stage of manufacture, namely, yarn, were great and rapidly increasing. Thus the farmer was deriving benefit from the freedom of trade, and English wool was resuming its flow through channels which legislation had closed for five centuries. It was for our manufacturers to take care that no other country made a better use of their native raw material than themselves." Mr. Baines continued, "they ought not, in that Association and in that Section, to withhold the honour due to the high intelligence, manly spirit, and wonderful disinterestedness of Lord Milton, afterwards Earl Fitzwilliam, who, whilst representing the great seat of the woollen manufacture, Yorkshire, advocated the removal of protection from the manufacturers, and, although one of the largest landowners, contended for the removal of protection from agriculture. It was a matter of just pride for this Association and for Yorkshire, to remember that that enlightened and high-minded nobleman was the first President of the British Association. The woollen manufacture, in its various branches, was very extensively diffused. According to the last Factory Return, it prevailed in twenty-two counties of England, ten of Wales, twenty-four of Scotland, and six of Ireland."

The estimate of the annual value of the woollen manufacture formed by Mr. Baines was as follows :—

1. Raw Material—	
75,903,666 lbs. Foreign and Colonial Wool.....	£4,717,492
80,000,000 „ British Wool, at 1s. 3d. per lb.	5,000,000
45,000,000 „ Shoddy and Mungo—	
30,000,000 lbs. at 2½d.	609,370
15,000,000 „ 4¾d.	
Cotton Warps, 1-50th of the wool	206,537
2. Dye Wares, Oil, and Soap	1,500,000
3. Wages—	
150,000 Workpeople, at 12s. 6d. per week	4,875,000
4. Rent, wear and tear of machinery, coal, repairs, interest on capital and profit—20 per cent.....	3,381,680
Total.....	£20,290,079

Mr. Baines concluded by recommending the members of the British Association to inspect the Exhibition of Local Industry now open in the town, where they would be able, in some measure, to judge of the industry and skill of our manufacturers; and he would express a hope that those manufacturers will never rest satisfied with any position they may have attained, but, stimulated and warmed by what they have seen in the Great Exhibitions of London and Paris, will remember that they only hold their prosperity on the condition of increasing improvements.

Other papers of great interest were read in this Section, from which we select a few notes from one on the Iron Trade of Leeds, by Mr. James Kitson, jun., who, having referred to iron as the great civilizer of the world, pointed out that it was at once the most ancient and most modern of the manufactures of Leeds. The whole district abounds with iron, and there was ample evidence of its having been worked here in times now very remote. Coming to the statistics of the iron trade carried on in Leeds at present, he divided them into four parts:—1st, iron manufacturers; 2nd, cut nail manufacturers; 3rd, machine and tool makers; 4th, loco-

motive and stationary engine builders, railway waggon and general railway plant manufacturers. The year 1857 being a fair average year, he based his statistics on that period. The total value of the product in all the branches of the trade is estimated at £1,933,174. The annual value of goods actually sent from Leeds is about £1,800,000, as a portion of the iron manufactured is supplied to the local machine makers, engine builders, &c. By far the larger portion of the goods manufactured is exported to foreign countries. Leeds iron is sent to all quarters and all countries on the globe. With Leeds nails the emigrant fastens together his first rude habitation. Leeds machinery is spinning, and Leeds tools are working, in every seat of industry on the Continent; and Leeds locomotives are drawing their burdens, indifferent whether it be on the fertile plains of India, or on the sides of the snowy Andes. A branch of commerce which has extended so rapidly, and fixed so large a capital in the town, must contain within itself sound and permanent elements, and the fact that nearly one million sterling is actually invested, so as to be practically immovable, is a guarantee that it will be followed with continued energy.

A brief discussion followed the reading of Mr. Kitson's paper. The President, Mr. W. E. Forster, Mr. Pare, Sir P. Fairbairn, and Mr. Kitson, took part in the discussion.

In Section E, (where Sir R. Murchison presided,) the proceedings commenced by the reading of a communication on North Western Australia, written by Mr. James S. Wilson, geologist to the North-Western Australian Expedition, and entitled, "Notes on the Physical Geography of North-Western Australia." Dr. Norton Shaw, one of the Secretaries, read the paper. It described the climate of that part of Australia as being hot for six months in the year,

but not injurious to health. The country, it said, was fertile, and a large variety of luxurious grasses was found growing, one species of which was a kind of wild oats, from three to six feet high. The indigenous plants were more numerous and superior to those of Southern Australia. The characteristics of the natives were similar to those of the aborigines of the south of the country, and the writer was glad to say that, in Lower Victoria, at all events, there was no unfavourable impression upon the minds of the native population against the settlement of the English.

The President said, he was very strongly impressed with the importance of the Government making a permanent settlement on the northern coast of Australia. England had already possession of three sides of Australia, and it was scarcely necessary for him to point out that it was of great national importance that she should have on the northern coast a port of refuge for her ships in time of peace, and from which also her maritime forces might sally forth in case of war threatening her eastern possessions. The abundance of vegetation, and the capability for sustaining life which was afforded by the country, seemed to point it out as a favourable place for the establishment of a new colony, and he thought that, if some little expenditure were made by the Government, the country would soon become populated by Englishmen.

In the Geological Sections, papers of varied interest were read. One, on the "Deposits of the Aire Valley," gave an account of the discovery of bones of the Hippopotamus near Leeds, in the Valley of the Aire.

Another paper, on the Geology of the Lake District, led to some lively discussion.

In the evening, Professor Phillips delivered a lecture on the Ironstones of Cleveland, before a numerous audience, the

President being in the Chair. In his opening remarks, Professor Phillips alluded to the manner in which the ironstone was collected on the Yorkshire coast by hand-baskets thirty years ago, for shipment to Newcastle, and then traced the subsequent discovery of those vast bands of ironstone which pass through the whole of the vale of Cleveland, and which secure to that district an extent of mineral wealth almost unequalled in any other part of the country. Professor Phillips concluded, by pointing out the great importance of combining scientific knowledge with mercantile enterprise in pursuits of this nature, and resumed his seat amidst the hearty applause of the audience. A vote of thanks was then moved to the eminent lecturer by Professor Faraday, seconded by Lord Goderich, and carried with acclamation.

In Section G, (Mechanical Science,) considerable interest was excited on Saturday, by Mr. Cuthbert Brodrick, the architect of the new Town Hall, describing the principles on which he had constructed the roof of the Town Hall. This system of roofs has been adopted more frequently in France than in England, and is the invention of a French engineer.*

Mr. Scott Russell said the roof of the Town Hall appeared to open to us the English era of circular architecture. He hoped that the example of the Leeds people in selecting a good architect and a good plan, and letting the good architect carry out his own plan in his own way, would be generally followed in the country. As strangers, all the members of the Association must congratulate the architect on having

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* In giving a few notes of the proceedings in some of the Sections, we purposely refrain from giving lengthened accounts of valuable papers, whose contents enrich the annual volume; nor do we pretend, in our very limited space, to do more than indicate two or three of the subjects occupying daily the attention of the Sections.

employed the best principles known in our time, and at a moderate expense.

In Section C, (Geology,) in the absence of Mr. Hopkins, the Chair was taken by Professor Ramsay, and Professor Phillips, on the opening of the Section, delivered an interesting lecture on the Hematite Ores of North Lancashire, embodying in his remarks the substance of a communication from Mr. R. Baker, jun., on the Hematite Deposits of West Cumberland. The districts of North Lancashire and West Cumberland, to which reference was made, were, said Professor Phillips, exceedingly rich in valuable deposits of iron ore, and were now producing probably not less than one million tons per annum. Notwithstanding, however, their value and importance, they had not been carefully examined until a recent period.

In the after part of the day, a grand Horticultural Show took place in the ruins of Kirkstall Abbey, which agreeably diversified the proceedings of the Association.

"The place is admirably adapted for such a fête, the magnificent ruins of the old abbey giving an additional interest to one of the most beautiful landscapes to be found in the immediate neighbourhood; and we were not surprised, therefore, the weather being fine, to see gathered in the grounds, during the afternoon, a brilliant and fashionable assembly. Shortly after the adjournment for the day, of the Sectional Meetings of the Association, the roads leading to the Abbey grounds presented one continuous stream of carriages and pedestrians, whilst the grounds themselves were thronged with ladies and gentlemen, enjoying the variety of the exhibition, and whose presence, enlivened by the performances of two excellent bands of music, gave to the scene that animation which formed one of its chief attractions. During the afternoon the grounds were visited by nearly the whole

of the members of the Association, as well as by several thousands of the public. The exhibition itself was highly successful. It was spread over two commodious marquees, one being appropriated to the gardeners and seedsmen, and the other to the cottagers. The competition was open to all England, and, the prizes being liberal, there were exhibitors from various parts of the country. The plants and flowers were many of them rare and of great beauty." *

On Monday, at the usual hour, the business of the Sections was resumed.

In the Economic Section, Dr. Bateman read a paper "On the Degree of Education of Persons tried at the Middlesex Sessions." He noticed the fact that an opinion prevails to some extent that the imparting of the mere elements of education does not necessarily improve the morals of the people, and said, that on his way from London to Leeds, he heard a Dissenting Minister, of some celebrity, assert that our national morality has decreased in proportion as our head knowledge, as he called it, had increased. The record kept respecting the persons brought up for trial at the Middlesex sessions, in 1856, appeared, at first sight, to give a colour to that opinion, and was exultingly referred to in support of that allegation. He, however, laid figures before the Section, which showed that the criminals in the county of Middlesex were not taken from the entire community indiscriminately, but fully one-half of them from the class of extremely ignorant, consisting of one-sixth of the population, thus reducing the criminals among the educated classes to a very small proportion indeed.

Mr. J. I. Ikin said it had fallen to his lot to inspect above 8,000 recruits for Her Majesty's service, and the

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* *Leeds Mercury.*

proportion of totally uneducated men amongst them was between 60 and 70 per cent.

Mr. John Andrew mentioned the fact that the Rev. Mr. Clay, the late Chaplain of the Preston House of Correction, had found, from his inquiries, extending over several years, that strong drink was connected, either directly or indirectly, with the crimes committed by the prisoners confined in that gaol.

In Section G, (Mechanical Science,) W. Fairbairn, Esq., read a report on the "Collapse of Globes, Tubes, and Cylinders." The first experiments were upon glass globes, intended to be perfectly spherical, but in most instances somewhat flattened upon the side opposite to that from which they were blown. Notwithstanding, however, this ellipticity, some of the globes bore enormously high pressures, especially when the extreme tenuity of the glass is considered, amounting to only from one to two hundredths of an inch in thickness. The pressure ranged as high as 475 lbs. per square inch of surface, equivalent to a total pressure of 20 tons upon a $5\frac{1}{2}$-inch globe, 1-50th of an inch thick, before it was fractured. The next results are upon glass cylinders blown with hemi-spherical ends. In the experiments upon iron, the remarkable law had been deduced that the strength of cylindrical vessels, exposed to a uniform external pressure, varied inversely as the length. Thus, with vessels precisely similar in other respects, one twice the length of another bore only half the pressure, one three times the length bore only one-third, and so on. A similar law implies in the case of homogeneous glass cylinders.

Professor Rankin said that the law at which Mr. Fairbairn had arrived was a most remarkable one, and to some extent like that of the giving way of pillars. With respect to

boiler explosions, the wonder was not that so many flues had collapsed, but that so many had stood. For the future, *with these experiments, we should be in a great measure safe from these disasters.*

Mr. Scott Russell, on behalf of practical engineers generally, begged to express to Mr. Fairbairn the strong feeling of thankfulness they all entertained towards him; Professor Owen, Mr. Mallett, C.E., and Mr. Webster, C.E., also testified to the value of the memoir.

Dr. Whewell said, it could not be doubted that these results were of the greatest value to theoretical mechanics. It would be extremely interesting to attempt to conceive the elementary forces out of which these resisting forces arose. He wished to ask Mr. Fairbairn whether his mode of experimenting allowed him to see the manner in which the fractures took place.

Mr. Fairbairn, in reply, handed in his sketches. Some years ago, in consequence of an explosion on the London and North Western Railway, he made certain experiments, and he tested, amongst other things, flat surfaces, and he found them about four times the strength of cylindrical ones. Some further points of detail having been explained by Mr. Fairbairn, a vote of thanks was unanimously awarded him by the Section for his valuable paper.

In the evening the President of the Association delivered a lecture on the Extinct or Fossil Quadrupeds of Australia, which was listened to with deep interest.

On Tuesday, in Section C, (Geology,) Sir Roderic I. Murchison laid before the Section "The results of his Researches among the Older Rocks of the Scottish Highlands," in a very valuable paper. He commenced his observations by indicating the various steps which had been made in developing the geological structure of Scotland, from the

days of Hutton and Playfair through those of Jameson and McCulloch, to the state in which the subject was advanced a few years ago, by the proofs of the existence of considerable numbers of organic remains of Silurian age in the southern Scottish counties, which from the wild and hilly outline of most of them had been termed the "Southern Highlands." He then went on with a sketch of the knowledge progressively acquired respecting the structure of the North Highlands. In addition to the researches of Mr. Cunningham, the observations which the author made in the summer of 1855, when accompanied by Professor James Nicol, were communicated to the Geological Section at their last Meeting at Glasgow, and to the abstract of that memoir, as published in the volume of the Transactions, he referred as indicating the then state of knowledge. After describing the varied explorations he had made throughout the Highlands, and the fruit of his investigation, Sir Roderic said, in conclusion, that this communication must only be considered as a rehearsal of what was to be done with more effect next year at Aberdeen, when further observations would either confirm or induce him to modify some portion of his views, though the great fundamental reform of the North Scottish series, proving the ascent from the oldest rocks in Britain on the west coast of the north Highlands to the much younger "old red sandstone" of the east coast, is firmly established.

Some other papers having been read, discussion was then invited on the general subject of Scottish geology, and remarks were made by Sir Roderic Murchison, Professor Ramsay, Professor Nicol, Professor Phillips, and other gentlemen, the views of Sir Roderic Murchison being supported by Professor Ramsay.

In Section F, (Economic Science and Statistics,) after several valuable papers, the President read one by the

author of this little work, on the "Importance of a Colonial Penny Postage, Viewed in Relation to the Advancement of Science and Christian Civilization." The President remarked that no one could doubt the advantages which would be derived from a Colonial Penny Postage, provided it were financially possible; and it was right that the subject should be brought before the British Association as in the paper read.* So important does the subject appear to us, that we are led to give a lengthened extract from this paper, hoping it may meet the eyes of some persons whose influence we may be so happy as to enlist, in the promotion of a measure we believe would prove of incalculable benefit to the human race.

"If the history of the Penny Postage in this country were investigated, it would be found to have been a most important promoter of scientific progress, of education, commerce, religion, and the principles of civil government. It has done its part in awakening a desire for peace, and to the poorer classes its benefits have been incalculable in stimulating them to acquire the power of writing. When the Penny Postage was first given to this country, many were the fears expressed as to the result, none of which have been realized, and we now advocate its extension to the colonies on grounds which we consider of the highest importance.

"In a religious and moral point of view, the benefits of a Colonial Penny Postage would be great to our fellow countrymen in the colonies. It must be remembered that the tide of emigration is rolling on at a rate that far exceeds every ecclesiastical resource, and baffles every endeavour adequately to influence it by ordinary means of evangelization; so that a field of untold magnitude of spiritual destitution exists

* On various occasions the British Association has used its influence for the amelioration of rates of postage.

in our colonies, demanding all the aggressive agencies we can bring to bear upon it. Tens of thousands of emigrants are quite destitute of the ordinary means of religious growth : buried in the backwoods or the bush, congregated together in towns or on our gold fields, they are abandoned to the gross darkness of a practical heathenism.

"It has been remarked, that too often the emigrant leaves behind him all religious principle, and may we not, in a great measure, ascribe this painful fact to the utter cessation of those moral and religious influences that surrounded him in the parent country ?

"The important measure we now so earnestly advocate would, we are assured, prove one great means of remedy for the evils of which we have spoken. It would penetrate to the most remote districts of our colonies, entering the scattered dwellings of emigrants, too far removed, perhaps, from civilized life for any other outward medium of religious and intellectual progress.

"It must be remembered that the prosperity of a state is promoted by any measure that tends to elevate the individual members of families belonging to it ; and, viewed in this light, we think the value of a Colonial Penny Postage cannot be over-estimated ; and one peculiar feature of this measure, as applied to the poor man, is the beneficial action it must exercise upon his fireside and home comforts, both in the mother country and the colonies.

"So extensively has emigration prevailed of late years, that few families are to be found who have not some relative in a distant land ; and, were this boon conferred, it would be received with joy and thankfulness by emigrants with large families, and their relations at home.

"It must be a great mistake for England (a country in no small degree under the influence of good religious, commer-

cial, and political principles) to check the free and easy flow of those principles into her colonies by one of the most important channels through which they can be conveyed, viz., the Post Office.

"If it be advisable, on the part of an enlightened Government, to give every stimulus to education—to cement good feeling between the colonies and the mother country—to promote loyalty, and love of her institutions—to extend the influence of our language and our race, then loss of revenue ought not to weigh against the advantages of a frequent and lively correspondence between Great Britain and her colonies. We apprehend, however, that this need not form an objection, but that the number of letters to the working classes would quickly increase in such an enormous ratio, as soon to bring into the Post Office the same amount of revenue as at present.

"The Pen and the Press are the only means of conveying thought between distant emigrants and their mother country, but the pen is the sole substitute for friendly intercourse; and, as a whole, its tendency is to correct the errors of the press. While the latter has but an uncertain influence upon the English in the colonies, the former is ever working upon them for good.

"To emigrants of the present day, who have been accustomed to the penny rate of postage at home, the reduction we propose would be a greater boon, and effect its purpose more advantageously if made directly, before persons now gone or going have lost the habit of writing. It would also do away with what may be urged as unjust by emigrants, viz., that while part of Her Majesty's subjects enjoy the penny postage, those who are less able to pay are deprived of it.

"Another most important consideration in favour of a Colonial Penny Postage is the influence it would exert upon emigration. We are inclined to think it would do more

to promote this result than any measure that has hitherto been adopted, and in a more natural way than all the efforts of Government and Emigration Societies. From the increase of education in Great Britain, emigration has assumed a new feature within the last ten or twelve years, and a much larger proportion of the emigrants can read and write. We believe nothing more is needed for the full development of this important means of colonization than free interchange of thought between those who have emigrated, and friends at home.

"In this way would a penny postage be constantly pouring correct and unbiassed information into the mother country, preventing many mistakes, made by persons emigrating to the wrong place, and at the wrong time, thus avoiding much misery and suffering; and it would be found a most important agent in choosing the right man for the right place.

"We feel assured that the free correspondence for which we plead would form a cord binding the colonies to the mother country in ties scarcely possible to dissolve. The effect of distance would be practically annihilated, while the character of the colonists would continue to improve.

"We ask, also, for science, as the conciliator, the benefactor, and enlightener of the whole human race, that the great barrier now existing against her more rapid progress and development be withdrawn.

"In the prosecution of scientific research, unrestricted communication between men of science is an important condition of progress. Observers at meteorological, magnetic, or astronomical stations, will often have occasion to communicate with others similarly engaged, and it is much to be desired that all such intercourse should be promoted by every possible means.

"Nor should the claims of commerce be forgotten in the

enumeration of the considerations which lead us so anxiously to advocate a Colonial Penny Postage. Let it be remembered that the benefits of Free Trade can by no means be considered as fully enjoyed while there is anything like a heavy charge for postage.

"It would be difficult duly to estimate the bearing a penny postage to Canada would have upon our Anglo-Saxon brethren in America. Its action upon the United States would be immediate and powerful, and, most probably, would quickly induce them to arrange a similar rate of postage to England. Who can calculate the beneficial results to the human race of such an intercourse between the two great Protestant nations of the world, both sprung from one parent stock, and destined, we believe, to be again united in carrying out the designs of an overruling Providence for the Christian civilization of the world?

"We cannot but think that this is not a case for merely a slight reduction of the existing rates of postage, but for a bold and noble act, worthy of the patriotic spirit of such a nation as England,—an act that will tend to elevate all her subjects, in every quarter of the globe, and will confer a lasting benefit, of the very highest order, on present and future generations.

"Viewing a Colonial Penny Postage as a measure of such importance, we earnestly hope it may be made the subject of a special recommendation to Government by the British Association, assured that it will thus meet with the attention it demands from Her Majesty's Government."

In the evening a conversazione took place in the Town Hall, which was again attended by a throng of fashionable and scientific persons.

Some of the articles shown were full of interest. The drawings by Mr. Waterhouse Hawkins, of "Some of the

Extinct Animals Restored," excited much attention. Folios of choice prints—a collection of Indian manuscripts—trophies of our recent triumphs, and, amidst other interesting objects, the exhibition of some articles from the new metal, aluminium, occasioned much remark. Among the photographs, some lighted interiors were attractive, from their peculiar and rich colour. The rooms dedicated to these objects of science and art were full of visitors.

The final General Meeting of the Association was held in the large hall at three o'Clock, on Wednesday, when there was a numerous attendance. The President took the Chair, being supported by other leading members of the Association.

General Sabine read the Resolutions of the General Committee, and named the grants which had been made, after which Professor Phillips briefly stated the results of what he said might then be considered as the Leeds Meeting of the Association. In the first place, they had had an unusually large attendance of the older Members of the Society, including several who were present at the first Meeting at York. There were in attendance, at this Meeting, 222 old Life Members, 43 new Life Members, 111 old annual Subscribers, paying £111, 90 new annual Subscribers, paying £180, 706 Associates, paying £706, 508 ladies, paying £509, and 13 foreigners, though at the commencement of the Meeting they only expected one. These gave a total of 1,693 Members at the Leeds Meeting, the receipts (including sale of publications) being £1,929.

The President then observed that this terminated the dry detail of the week's proceedings, but Lord Monteagle desired to say a few words before they separated.

Lord Monteagle said, it was to express their sense of obligation to the President, Officers, and Committee of the Association, for the selection of Leeds as their place of

Meeting, that he rose. He (Lord Monteagle) was one of the 208 original old members who inaugurated the Association at York, and he must take the liberty of saying that, in his own experience, and on behalf of his revered contemporaries around him, every additional Meeting had been an additional tie of interest, of gratitude, and association. He had said that these Meetings, above all, in the manufacturing districts, were Meetings between abstract science, and science applied, and in the great assemblages of intelligence and industry, they had an audience meet, because they had an audience capable of profiting by their instructions; and he believed he was justified in saying, not as an observation of his own, but as having heard it from various sources deserving of confidence, that one great peculiarity of the present Meeting had been the practical character of the papers, and of the observations made during their discussion. They had had collected together a great deal of local observation, a great many interesting local contributions relating to the district in which they were assembled, in aid of the more general researches and observations from other parts. This was, after all, the great reward to those distinguished men belonging to the Association for the benefits they conferred. He had no doubt that what they had heard, what they had listened to, and what they had seen, had fallen upon no ungrateful soil—that this gathering had not been considered merely as a social Meeting, but that it would become the practical means of inducing the young to persevere in their course of inquiry, of investigation, and of study; and would give to those who were no longer young the delight which they must always feel from superiority of intellect. Above all, when they knew that it was in the majority of cases only the badge of higher principles, of deeper feelings of attachments and aspirations,

that were bounded not by the space of that great hall, but extended from the universe itself up to the great Creator of the universe, they must indeed feel the highest pleasure and thankfulness. That characteristic of their Meetings could not be too much appreciated or too strongly recommended. Whenever the opportunity arose,—when, without the appearance of affectation, a high, a lofty, a holy thought could be united with a great scientific suggestion, it was always uttered, and it was at such times that the minds and the feelings of the audience were most deeply excited. Apologising for the length at which he had addressed them in the fulness of his heart, the Noble Lord concluded by moving—

That the earnest and grateful thanks of this Meeting be returned to the President and the officers of the British Association for their attendance here, and for the successful and triumphant manner in which the business of the Association had been conducted.

Lord Monteagle then put the motion, which was carried by acclamation.

The President then rose, and said it now only remained for him to perform the pleasing duty of expressing to the Meeting, in the name and on the behalf of the Association over which he had the honour to preside, their sense of gratitude for the reception with which they had met, and for the arrangements of every kind that had been effected for the efficient performance of their duties and for their comfort in every way. And if he felt some embarrassment in the endeavour to perform this duty, or any difficulty, that difficulty lay fairly at their own doors, for there had been such an unanimity amongst all the public bodies in Leeds, amongst all the office-bearers, and every individual, he believed, in this town, that the difficulty lay in giving expression to the acknowledgments of the British Association without a sense of some involuntary and most unwilling omission. First, and above all, they were led to express their thanks to

the Mayor and Corporation of Leeds, for this most magnificent hall, and for those appended apartments, affording most ample convenience for the business which they met here to perform. No part of that glorious building had been withheld in any shape, but the whole most liberally, most instantly, and entirely placed at the service of the British Association.

Professor Owen then enumerated the various persons, Societies, &c., to whom the Association was indebted for their hospitable reception, and concluded by saying, that "It now only remained for him to adjourn their Meeting to Aberdeen, where he hoped they might all meet in health and vigour, to pursue their investigations in that ancient seat of learning in Scotland. The Meeting then closed.

On Thursday, various excursions, which had been arranged for the members of the Association, took place—one to Harrogate, Ripon, and Studley, which comprehended about 100 persons; another to Skipton and Bolton Abbey; one to Malham and Godale Scar; a fourth party went to Ingleborough Cave, and a fifth to Low Moor and Saltaire, to inspect the Iron Works and Manufactory.

We had the pleasure before leaving Leeds of visiting the Exhibition of Local Industry, the Industrial Training School, with which we were much gratified, the Borough Gaol, &c. Did our space admit, we should gladly give some account of the Literary and Scientific Institutions, the Meeting of the Young Men's Christian Association, and the giving of prizes, connected with the Middle-class Examinations, all of which were deeply interesting to us. It was with regret that we terminated a week of unusual intellectual enjoyment; and when we parted from those who had been associated with us in so many pleasures, as Members of the British Association, it was with the hope that we might be permitted at a future time again to meet under similar circumstances.

CHAPTER IV.

Character of the Sections of the British Association—Section A, Mathematics and Physics—Results of the Labours of this Section—Importance of pure Mathematics—Astronomy—Discovery of new Planets—Neptune—Leverrier and Adams—Discoveries in Electricity and Magnetism—Electric Telegraph—Meteorology—The Tides—Section B, Chemistry and Mineralogy—Prevailing Ignorance of Chemistry—Agricultural Chemistry—Liebig and the British Association—Photography—Section C, Geology—Its economical Applications—Sir Roderic Murchison, and the Discovery of Gold in Australia—High Claims of Geology—Section D, Zoology and Botany—Cuvier—Progress of Zoology—Its Importance—Pisiculture—Botanial Science—Subsection Physiology—Section E, Geography and Ethnology—Dr. Livingston's Researches—Canada—Great Pacific Railway—Ethnology—Labours of Missionaries—Section F, Mechanical Science—Lord Rosse's Address—Investigations carried on by the British Association—Use of Steam Power in Agricultural Districts—The "Great Eastern"—Section F, Economic Science and Statistics—Value of Statistical Science—Change of Name—Numerous Subjects brought before the Association.

"If the laws of nature, on the one hand, are invincible opponents, on the other, they are irresistible auxiliaries; and it will not be amiss if we regard them in each of these characters, and consider the great importance of a knowledge of them to mankind,—

"I. In showing how to avoid attempting impossibilities.

"II. In securing us from important mistakes in attempting what is in itself possible, by means either inadequate or actually opposed to the end in view.

"III. In enabling us to accomplish our ends in the easiest, shortest, most economical, and most effectual manner.

"IV. In inducing us to attempt, and enabling us to accomplish, objects, which, but for such knowledge, we should never have thought of undertaking."—*Sir John Herschel.*

We have in a previous chapter given the arrangement of the Sections embraced in the British Association. So well matured was the original plan, that there have been but slight variations made in it, since the time when it was first sketched by the founders.

While the Reports on the existing state of science offer most important landmarks to all those who take an interest in forming clear ideas of its progress, and are regarded by scientific men as one of the most precious collection of documents ever given to the public, the personal intercourse and oral discussion afforded in the Sections are of very high value, and we are not surprised at the enthusiasm with which those who first conceived or took a part in the foundation of this great Association looked forward to the future, and realized the benefits that we now behold conferred through its instrumentality.

At the first Meeting at York, in the course of the eloquent speech made by the Rev. J. Harcourt, he said, "In a letter which I have lately received from Mr. Conybeare, and in which he expresses deep regret at finding himself unexpectedly prevented from attending this Meeting, the benefit which may be looked for from a general scientific combination, is described with the energy of his ardent and comprehensive genius. 'Your proposal,' he says, 'for ingrafting on the annual *réunion* of scientific men a system for effecting such a concentration of the talent of the country, as might tend more effectually to consolidate, and combine its scattered powers, and to direct its investigations to the points which an extensive survey, thus generalized, would indicate as the most important—benefited by all the aids which the union of powerful minds, the enlarged comparison of different views, and a general system of intellectual co-operation could not fail to afford—fills me with visions too extensive almost to allow me to write with sufficient calmness of approbation. The combined advantages, including at once the most powerful stimulus, and the most efficient guidance of scientific research, which might emanate from such a point of central union, seem to me to be far beyond calculation.'"

It must also be remembered, that, while there is much to be heard by listeners in the Sections that cannot fail to give an impulse to any intelligent mind, and convey scientific information, so far popularizing science, yet, that the object of these Meetings is not in any way to attain such an object "by stripping difficult subjects of all their difficulties, and enabling the highest regions of thought to be trodden without the exercise of thought. On the contrary, its mode of popularizing science is by stimulating those who attend its Meetings to rise to the level of the subjects it discusses. It will not sink science to the depth of popular ignorance, but encourages popular ignorance to rise to the height of modern science. It is in no way elementary. On the contrary, the results with which it deals are the very last discoveries made in the particular departments of science to which it is devoted. Its advantages are to gather the scientific men themselves together, and make each acquainted with the results achieved by his fellow-labourers; to give new and unknown men an opportunity of bringing their researches before the ablest judges, and of explaining them thoroughly by personal intercourse; to assemble the numbers whose interest in science would droop for want of a centre to which to attach itself, or a means of correcting their own knowledge by the more accurate and extensive research of the leading minds; to encourage and stimulate all who attend the Meetings, by showing the results that have already been attained, the points most urgently calling for investigation, and the infinite variety of ways in which science may be advanced. Perhaps its suggestiveness is one of its great and most important features, and a character of unity and system is given to the progress of science not unlike that magnificent scheme by which Lieutenant Maury has combined into one result all the maritime observations

made by the seamen of several nations in every part of the world."*

In the very cursory glance we now proceed to give our readers of some of the most important subjects that occupy the attention of the Sections, we shall not attempt to do more than indicate a few of the principal points of interest, referring those who wish for more information to the valuable yearly volumes of the Association.

Section A comprehends mathematics and physics; and the high importance of these subjects has, from the very first, enlisted the services of all those eminent scientific men whose names are identified with recent discoveries in astronomy, optics, electricity, magnetism, and meteorology. Beside the valuable Reports that have been elicited, we may mention the following as some of the results of the labours of this Section, thus given by Dr. Robinson :—

"1. There had been made, at Greenwich, during the preceding century, a vast series of solar, lunar, and planetary observations, matchless in the world, of the highest importance to perfect the planetary theory, but quite useless, because unreduced. How troublesome that work is, none know but they who have used it; and it would, perhaps, never have been performed, but that we obtained it from Government. That has been perfectly accomplished under the direction of Mr. Airy. 2. There existed a collection of star observations, the 'Histoire Céleste,' the proudest distinction of the two Lalandes, comprising 50,000 stars; all, however, unreduced, and nearly useless. These we have reduced, and, at a large pecuniary outlay, we have given to astronomers a catalogue not of less value than those of

* Edward Baines, Esq., M.P.

Bradley or Piazzi. 3. We originated those researches on the strength of iron, by which Hodgkinson and Fairbairn have added so much to the resources of constructive engineers. 4. We called for the investigation, and supplied funds for those discussions of tidal phenomena, by which Dr. Whewell has not only thrown light on a most difficult portion of hydrodynamics, but given precious aid to the practical navigator. 5. Two years before that Meeting, a great physicist had declared, that to improve by theory the form of ships was as hopeless as to get the equation of a breaker. At that Meeting, a young man, then unknown, produced the germ of those researches, which, extended under our auspices, and largely aided by our pecuniary grants, have given J. Scott Russell a world-wide fame, and made possible the construction of those noble ships, which, during the last month, have borne from your bay, at a speed twice what was once thought attainable, their freight of heroes,—to uphold our national power,—to avenge our slaughtered countrymen.* 6. Lastly, we set on foot that system of magnetic observation which has added so much to our knowledge of terrestrial magnetism; nay, which has gone beyond our globe, and opened a new range for inquiry, by showing us that this wondrous agent has power in other parts of the solar system."

To pure mathematics, as of incalculable importance, the first days of the Association week are always devoted in this Section; nor do we wonder at this, when we remember that this branch of science is the one that proves our "mightiest aid in exploring the wide fields of physical and mechanical science."

Professor Forbes has, in a few words, admirably placed

* Spoken at Dublin during the Crimean war.

before us the bearing of this department of science upon physics :—

"The analogy of the relation between mathematics and physics, and of the latter to civil engineering, is so close, that the three subjects might almost be represented as three terms of a continued proportion. What the second is to the first, may be affirmed of the third relatively to the second. Physics may exist, at least, to a limited extent, without a mathematical basis, as the art of construction long preceded a knowledge of the principles on which it is founded. But as knowledge advances, it extends, in both directions, towards speculation, and towards practical applications, but most towards the application. This Bacon well understood, and all the history of science since Bacon's day, has read this lesson more and more loudly in the ears of mankind."

Astronomy has always received a large measure of the attention of the Association, and upwards of £5,000 has been expended upon investigations and observations.

Modern discoveries show how much more numerous are the smaller planets of our system than was suspected. "The career of planetary discovery, which began in the first years of the present century, and was resumed in 1845, has since continued with unabated ardour. Since 1846, not a single year has passed without some one or more additions to the number of the planetoids, and, in one year alone (1852), no fewer than *eight* of these bodies were discovered." 1856 gave five, 1857 three, to the research of astronomers. So small are these planetoids, that, while the diameter of the largest is less than forty miles, that of Atalanta, the smallest, is not much more than four.

Forty of these planetoids are now known, all moving between Mars and Jupiter, their united mass being less than a quarter part of the weight of our own globe. It has

been suggested by Leverrier, that, probably, by the end of the present century, one hundred of these strangers may have been discovered.

One of the most deeply interesting, and at the same time most profound, branch of astronomical research, requiring all the aid of subtle mathematical analysis, is the question of the disturbances that take place among the *heavenly* bodies, in consequence of their mutual attraction. Perhaps one of the most striking examples of the wonderful accuracy of astronomical observation was shown in the discovery of the planet Neptune.

With regard to Mr. Adams's researches which anticipated the discovery of this planet, Sir John Herschel remarked, when addressing the Astronomical Society, "The names of M. Leverrier and Mr. Adams, which genius and destiny have joined, I shall by no means put asunder; nor will they ever be pronounced apart, so long as language shall celebrate the triumphs of science in her sublimest walks."

It has long been desired that the Nebulæ of the Southern Hemisphere should be examined with higher telescopic power than Sir John Herschel possessed when he was at the Cape; and it has been proposed to Government by the Association, that an instrument should be constructed under the direction of Lord Rosse and other scientific gentlemen for that purpose.*

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* Lord Rosse has devoted large means and untiring labour to the completion of the most wonderful telescope which science, art, and wealth have ever yet combined to perfect, and which is the rare combination of mechanical, chemical, and mathematical skill and knowledge. At Birr Castle, no one could fail to be impressed with the magnificent works in progress: whatever meets the eye is on the most gigantic scale,—telescopic tubes through which the tallest man could walk upright, structures of solid masonry for the support of

It has been beautifully said by an American author, "that the pathways of the ocean are marked out in the sky above, the eternal lights of the heavens being the only Pharos whose beams never fail, which no tempest can shake from its foundation. No one subject has received more of the attention of astronomers than those investigations of the lunar theory, on which the requisite tables of the navigator are founded."

The importance of astronomical observations in relation to geographical surveys, and boundaries of new countries, is well known; latitude and longitude being determined by observation. But even the daily business of life is affected and controlled by the celestial motions, for our artificial time-keepers are but transcripts of their movements; and it is from the observations of the heavenly bodies, made at an observatory, that we derive our only correct measures of time.

Subjects for interesting and profitable discussions have been often afforded to Section A, by the mathematical and physical theories of light, and, usually, one day in the six has been specially devoted to them.

In the sciences of electricity, electro-magnetism, and electro-chemistry, it has been well said, that the important researches of Professor Faraday have made the last thirty years almost an unbroken period of discovery.

It appears that upon the electrical condition of the atmosphere and the earth, the health of animal and vegetable life depends in a great measure, and the means of promoting a

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the telescope and its machinery, more lofty and massive than those of a Norman keep, while the same arrangements which secure the stability of masses which no ordinary crane could move, provide likewise for their obeying the most delicate impulse of the most delicate finger.

uniform state may yet be discovered. Every day some new light is thrown upon the relations between Chemistry and Electro-magnetism, Animal and Vegetable Physiology, Geology, and Electro-magnetic action. Sir John Herschel considers we are to look to "Electro dynamics for the *vera causa* of the Newtonian Philosophy."

The magnetic explorations of General Sabine have not only been carried on in England, but, in past years, in Brazil, on the Coast of Guinea, Spitzbergen, and Arctic America, throughout a great range of latitude; and to his indefatigable labours we owe a valuable Intensity Chart of the Globe, and a Magnetic Survey of the British Isles. We find "laws are coming out with beautiful precision from the reductions he is making of the numerous observations made at magnetic stations."

Professor Owen remarked at Leeds, that,—

"Magnetism has been studied with two aims, the one to note the numerical relations of its activity to time and space, both in respect of its direction and intensity; the other to penetrate the mystery of the nature of the magnetic force. It was in the committee rooms of the British Association that the first step was taken towards that great magnetic organization which has since borne so much fruit. Thereby it has been determined that there are periodical changes of the magnetic elements depending on the hour of the day, the season of the year, and on what seemed strange intervals of about eleven years. Also, that besides these regular changes, there were others of a more abrupt and seemingly irregular character—Humboldt's 'magnetic storms'—which occur simultaneously at distant parts of the earth's surface."

The expenditure of the British Association in these two branches, Meteorology and Magnetism, has been not less than

£2,000 ; but of far higher value than the money spent has been the result of their labours.

Most important investigations are at present making, relative to the deviation of the compass in iron ships. The melancholy loss of the *Tayleur*, a new vessel bound for Australia, in 1854, excited painful interest on this subject, and led to some communications from Dr. Scoresby, in which he mentions the circumstances under which the greatest magnetic changes might be expected, such as when ships, long running on one course, have their direction suddenly changed ; and he remarks that the north-east position in which the *Tayleur* had been built, and the violent straining and rolling she encountered, quite accounted to him for the variation in her compasses.

A paper was read at the Meeting of 1854, imploring attention to this important subject, in the name of the merchants and shipowners of Liverpool, and it is satisfactory to know, that Dr. Scoresby and other scientific men are of opinion that there is no reason, with careful application of certain known laws, why this danger should not be obviated. Another and striking proof of the great value of recent investigations relative to Magnetism.

We must not omit making a slight mention of the Electric Telegraph, which is now binding nations together in "the bands of electric intercourse."*

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* It was first carried out on a large scale in the United States, where its initiatory message deserves to be recorded. The enterprise was deemed so visionary, that the projector, Professor Morris, who had expended all the pecuniary means he possessed, while urging his claims for attention upon Congress, had little hope of success.

The evening of the last day of Congress had commenced, and the probability appeared so remote of the Bill being passed for the introduction of the Electric Telegraph, that the Professor returned to his lodgings in despair.

When sitting down to breakfast on the following morning, a young

In America, the system is in a course of development, so rapid, that "no schedule of telegraphic lines can now be relied on for a month in succession. It is scarcely doubtful that the whole of the populous parts of the United States will, within a few years, be covered with telegraphic network, like a spider's web, suspending its principal threads upon important points along the sea-board of the Atlantic on one side, and upon similar points along the lake frontier on the other. Even in 1847, when the *Hibernia* steamer arrived at Boston, with news of the scarcity in Great Britain and other parts of Europe, farmers from the interior States were thronging the streets of Albany with team-loads of grain almost as quickly after the arrival of the steamer, as the news of that arrival could ordinarily have reached them."

Professor Faraday remarks (in the course of an argument in favour of the full recognition of science as a branch of education) that "thoughts of an electric telegraph came over the minds of those who had been instructed in the nature of electricity, as soon as the conduction of that power with extreme swiftness through metals was known, and grew as the knowledge of that branch of science increased. The thought, as realized at the present day, includes a wonderful amount of study and development."

These were the preparatory steps by which the mind of

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lady was announced, the daughter of the Commissioner of Patents. She called, in the exuberance of her own joy, to communicate the passage of the Telegraph Bill at midnight, the moment before the adjournment of the senate. As an acknowledgment for the womanly sympathy thus given, Professor Morris promised that the first despatch should be indited by her. In about a year the line was completed, and the young lady was apprised of the fact; a note from her enclosed these words, which were the first that passed on electric wire in America: "What hath God wrought!" thus placing the honour and success where it was due.

man was led to conceive and execute the magnificent idea of uniting the old and new worlds, and when once it had been ascertained that there was no insurmountable difficulty in the way of telegraphing across the Atlantic, the Atlantic Telegraph Company was formed, and after due time the cable was laid, and messages were sent through the telegraphic wires.

But the success of this glorious triumph of theoretical and practical science will not end here. Already we hear of schemes to bring our Indian empire within speaking distance of us; and other countries will also soon share in the advantages of such communication.

Thus have the "abstract speculations which commenced many years ago on electricity, developed into the Electric Telegraph, which transmits our thoughts over continents and beneath seas with the rapidity of light."

The length, in miles, of land telegraph in operation in the different parts of the world, Jan. 1, 1858, is stated in round numbers as follows :—

	Miles.		Miles.
America, United States*.	35,000	India	5,000
America, British Provinces	5,000	Italy	2,500
America (other parts and islands)	5,000	Prussia	4,000
Australia	1,200	Russia	5,000
Austria and Germany ...	10,000	Switzerland	1,500
Belgium	550	Rest of Europe	1,400
England	10,000	Other parts of the world .	500
France	8,000	Total	94,650

The total length of lines of Submarine Telegraph, of which there are 27, besides river crossings, amounts to 2,904 miles.

It is not a little singular that agriculture and navigation, two of the most important industrial arts, have been the

* The number of messages passing over all the lines in the United States in a year is estimated at nearly 4,000,000.

employment of the most ignorant classes, the labourer and the sailor being alike uncultivated. Science is here effecting a wondrous change. The secrets of the deep, unveiled by scientific inquiry, cannot fail to interest seamen; and as observation becomes more extended, necessity will oblige the most ignorant to acquire the information needed.

The great work that has been achieved in the North by Lieutenant Maury, Dr. Scoresby, and others, will be followed out all over the globe; for science proclaims that "there is no reason why every part of the sea should not be as well known as the land." Is it possible, some will say, that the changeful wind and the treacherous wave can be subject to rule and law? That such is the case, is proved by the facts we have stated with regard to the ocean. As an important branch of science, Meteorology has been the subject of peculiar interest to the British Association, and, in connexion with Magnetism, has been greatly indebted to its general Secretary, General Sabine. Nations are now combining, under such influences as the Association brings to bear upon them, to study the atmospheric laws. Thus we find that the Emperor of Russia has been induced by Humboldt to establish a series of magnetic observations in Asia, and his example being followed by other "Governments, including the Chinese, we may ultimately hope to have a system of observation established throughout the world, in which the phenomena are registered at instants strictly simultaneous, and at intervals of two hours throughout both day and night." *

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* If the reader will refer to the Chart in the *Physical Atlas*, entitled the "Geographical Distribution of the Currents of Air, showing the Regions of Trade, variable Winds and Hurricanes, with their Effects in determining the different Tracks of Navigation," he will see the importance of these observations. "The oceans and

An important step with reference to the progress of Meteorology, was taken recently by the Board of Trade, in the formation of a Department for the Collection and Description of Meteorological Observations made at Sea. The United States Government invited other maritime nations to unite in a general system of marine meteorological observations, and, in consequence, a conference was held at Brussels in 1853, at which deputations from various States attended. The Report of this Congress was soon afterwards laid before Parliament, and a sum of money was voted for the estimated expense. The two leading Scientific Societies each took an important part in this great undertaking. The Royal Society, after consultation with the most eminent meteorologists of the old and new world, addressed a Report to the Board of Trade, setting clearly forth the objects to be attended to in the system of observation; while the British Association

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seas," writes a reviewer, in the *British and Foreign Evangelical Review*, "are, as it were, the streets of the great city of the world, connecting its different and distant parts, and binding its whole vast community into one. There the soft trade winds, blowing steadily in one direction, waft the voyager on,—there silent but irresistible currents, enormous ocean rivers, bear him onwards on their bosom. Here periodical winds, like great locomotives, wait at his service at certain seasons, as the monsoons of the Indian Ocean. All this is minutely laid down in our physical charts. Here along this gracefully sweeping red line is the track to the West Indies, and here again, on that blue tinted track, hundreds of miles to the north, is the way homeward. If you go to New York, early in the year, take this course, if later, that, and then come back again by another and nearer road, almost as the crow flies. How many tales of shipwreck and disaster, and how many thousand lives might have been spared, had this chart seen the light 300 years ago! Even the lurking places of the dread hurricanes—the jungles, as it were, where those fierce monsters lie—are marked for the warning of the mariner, and he can take heed and avoid the spot. He knows where to expect a trade wind and where a current—he knows where westerly winds are likely to prevail and where easterly, and he steers his course accordingly."

undertook, from its Observatory at Kew, to supply verified instruments. Thus, with the co-operation of the most eminent scientific men of the age, the Meteorological Department of the Board of Trade was fully organized, and placed under the direction of Admiral Fitzroy, coming into operation in 1855.

More than 200 British ships are now furnished with instruments, books, and instructions, the officers of these vessels having undertaken to make and record the required observations, and transmit them to the Department. The logs thus received are now in process of tabulation. Other countries are doing the same thing, and Holland has already published several volumes of nautical information furnished by her vessels in the Atlantic and Indian Oceans.

"For the purposes of Meteorological Science," Dr. Lloyd observes, "this system cannot be considered as complete, until observations on land are included."

General Sabine has said of Sir John Herschel, that he is the father of all our modern researches in Meteorology ; to him we owe all our hourly observations, and to him we are indebted for those systematic arrangements by which Meteorology will take its due place among the sciences.

We have mentioned that, from the commencement of the Association, the subject of the Tides engaged its attention, and we believe its first grant of money was devoted to their investigation. The discussions that took place on this subject having attracted notice, our Government was led to take an interest in the subject, and continue the series of observations. The Government of the United States having made an application to our own, to adopt a general and systematic mode of observing phenomena of various kinds connected with the sea, such as winds, tides, currents, &c., observations have been recently made on a

most enlarged scale; £1,272 has been expended in the tidal investigations by the British Association, and some of the reports and papers on the currents of the ocean are of the deepest interest. The importance of a correct knowledge of the ocean currents is very great, and the art of navigation will be much advanced by the researches now being carried out. Already ocean routes are shortened by the observations that have been made. We are told that "a ship sailing from Shanghae, in China, to Panama, may, in ignorance, follow the apparently direct course, a distance of 8,982 miles, but her voyage would be extended by adverse winds and currents to not less than 1,800 or 2,000. But if our acquaintance were more correct, by taking a proper course of about 9,500 miles, she would be assisted 900 miles in her course by currents and fair winds, thus making the unknown voyage 11,000, and that on correct principles 8,600, a difference worthy of being appreciated." It is calculated that maps and sailing directions for the Eastern Seas, such as have been provided for the Northern Atlantic, would save the ports of Calcutta, Madras, and Bombay, from a quarter to half a million annually in freights.* Dr. Scoresby's papers on these subjects will be read with great interest. It appears that these ocean currents exercise a remarkable influence on the extreme temperature of certain parts of the globe.

It is a singular fact, that in this maritime country

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* No greater practical result can be shown than in the fact, that in consequence of Lieutenant Maury's charts and sailing directions prepared from a Map of Meteorological Observations, the voyages of American ships are shortened one-third; and it is stated that if the Indian voyages could be shortened one-tenth, the saving in freightage would be £250,000 annually. With a reduction of one-tenth in the time of transit throughout our whole commerce, it is calculated the saving would exceed £2,000,000.

the subject of the tides had been strangely neglected till the British Association took it up.

Dr. Whewell, by solicitation to the Admiralty, and personal application to the chief of the Coast Guard Service, procured the completion of continuous observations at upwards of 500 stations along the coasts of Great Britain and Ireland.

The Second Section, B (Chemistry and Mineralogy), includes their Applications to Agriculture and the Arts. The subjects comprehended in this Section have assumed a far higher importance since the rapid progress and development through which chemistry may be said to have become one of the main elements in the material progress of the present age.

Chemistry, in all its departments of research, connects itself with other natural sciences. Beside the natural subdivision into vegetable and animal chemistry, its applications to medicine occupy a large space in our pharmacopœias, while the general physiology of animals and plants, as a department of organic chemistry, is assuming a high importance. Sismondi said, "We have no curiosity about that of which we know nothing;" and a writer in the *Edinburgh Review* scruples not to say that "it is the almost total ignorance of chemistry on the part of our older university men, which has hitherto excluded this branch of knowledge from the list of subjects of instruction in nearly all the educational institutions, over which their influence extends. We can neither appreciate the claims nor the value of a science of which we have been taught nothing."

Did our space permit, it would be interesting to show in how many ways the science of chemistry lends itself to the advancement of all the arts of civilized life; and surely a science which is related in so many ways to our comforts

and necessaries should rank as high as any of the crowd of sciences that are contending for precedency.

"Only about seventy years ago," observes the great chemist Liebig, "was chemistry like a grain of seed from a ripe fruit, separated from the other physical sciences."

In his Letters on Modern Agriculture, Liebig designed to bring about an union of the natural sciences with agriculture, and to effect their beneficial co-operation.

Among the services rendered by the British Association to agriculturists, is one that we presume the latter will not be backward to acknowledge in connexion with agricultural chemistry, and which is thus recorded by the Duke of Argyle.

"It was to the British Association at Glasgow, in 1841, that Baron Liebig first communicated his work "On the Application of Chemistry to Vegetable Physiology." The philosophical explanation there given of the principles of manuring and cropping gave an immediate impulse to agriculture, and directed attention to the manures which are valuable for their ammonia and mineral ingredients, and especially to guano, of which, in 1840, only a few specimens had appeared in this country. The consequence was, that, in the next year, 1841, no less than 2,881 tons were imported; and during the succeeding years, the total quantity imported into this country has exceeded the enormous amount of 1,500,000 tons. Nor has this been all: chemistry has come in with her aid to do the work of nature, and as the supply of guano becomes exhausted, limited as its production must be to a few rainless regions of the world, the importance of artificial mineral manures will increase." *

The Chemical Section of the British Association has a wide range of subjects submitted to its consideration, and

* Duke of Argyle's speech, as President of the British Association in 1855.

questions of direct interest to the community have often here received their true solution.

We cannot omit all mention of Photography; every year some improvement has taken place in what Professor Owen calls, "this most subtle application and combination of discoveries in photicity, electricity, chemistry, and magnetism."

The value of photography is becoming duly appreciated. It is used for the reduction of maps, thus saving thousands of pounds to our country. Photographers connected with the royal engineers have been sent to many places on foreign and colonial service; and our great railway contractors, without leaving their own country, can receive, by successive mails, "the weekly progress, brick by brick, board by board, nail by nail, of the most complex works on the Indian and other remote railroads." Photography is also made the servant of science in numerous departments.

Section C (Geology).—Latterly, this science has so occupied the public attention in consequence of the important bearing it is found to have upon the various branches of our commerce, and progress as a nation, that this Section excites more than usual interest.

The economical applications of geology are so great, that even the unscientific begin to have a respect for it. To agriculture it is increasingly valuable for a knowledge of the qualities of the soil—the substrata, and the theory of the earth's internal drainage, are all highly important. "Every man of common sense," says Professor Phillips, "would be able to drain his land upon sure principles, or else to know precisely why it cannot be drained, if he were to become so much of a geologist as to learn what rocks existed under his land, at what depth, and in what positions."

To the engineer, a knowledge of the geological structure of

a country is invaluable, furnishing one of the grand data by which he fixes his line of road.

With regard to coal, and other mineral products, there are "two things which have been established by geological research, in opposition to the contracted 'experience' of colliers, and it is difficult to say which is most important. First, it is perfectly ascertained, that coal is limited, in Europe and America, almost absolutely to one portion of the series of strata. Secondly, it is demonstrated, that coal occurs in abundance, and of excellent quality, beneath large tracts of country where few or no indications of its existence appear at the surface. In the practical working of coal which has been discovered, geological principles may often be useful in determining its probable extent, but the main value is in the *discovery of coal in new situations, and the arresting of costly and fruitless trials for coal where it cannot be found.*" "Let it be added, that, because geology has, of late years, made itself heard, even from a distance, and because the principles of this science have been kept in view in the field, *gold* will in future be looked for in the places where it is likely to be found."*

It is a well-known fact, that Sir Roderic Murchison first pointed out the similarity of formation in the Blue Mountain Chain of Australia to the Ural,—an intimation that was then looked upon as one of the theoretical assumptions of science.

"After surveying the Ural, and publishing, in 1844, his Critical Observations on the Old Mines of that 'Hyperborean' District, he took several occasions publicly to declare the general views to which they had conducted him; made a special comparison of the Ural with the eastern chain of

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* Professor Phillips.

Australia 1844), invited the Cornish miners to emigrate to New South Wales, and dig for gold on the flanks of the Australian Cordillera, where gold had been found in small quantity, and in which, from its similarity to the Ural, he anticipated that it would certainly be found in abundance (1846), and presented a note on the subject to the British Colonial Minister" (1848).*

"Facts like these," continues Professor Phillips, "are unanswerable, but do they not teach us that it is of the utmost importance to connect more closely the theory and the practice—the intellect and the hand; to place the treasure of science within the grasp of experience; to bring together the Murchisons and the Hargraves—the men of thought, and the men of action, so that right ideas may become fruitful deeds, and patient labour be encouraged to undertake enterprises which science shows to be of good omen."

The report on the Distribution of Gold Ore on the Crust and on the Surface of the Earth, by Sir Roderick Murchison, is peculiarly interesting. It is proved to be a geological constant that the Azoic and Paleozoic Rocks, when metamorphosed, are the only great repositories of gold, small quantities detected in secondary and younger deposits, not interfering with this general rule. So ignorant were the modern Russians of the existence of gold in their Ural Mountains, or that they had in their hands the country which supplied so much gold to Greece and Rome, that experienced German miners had long worked the iron and copper mines before gold was discovered. Sir Roderick Murchison expressed it as his opinion, founded on the experience of other auriferous tracts, that, with the activity and number of the men now employed, these deposits may in no length of time be exhausted in the Californian Mines,

* Professor Phillips.

but other gold tracts may be discovered wherever the Geological and Lithological constants occur.

Sir David Brewster, in his Presidential Address in 1850, spoke thus of the high claims of geology :—"Geology is the first chapter of astronomy. It describes that portion of the Solar System which is nearest and dearest to us—the Cosmopolitan Observatory, so to speak, from which the astronomer is to survey the sidereal universe, where revolving worlds, and systems of worlds, summon him to investigate and adore. There, too, he obtains the great base line of the earth's radius to measure the distances and magnitudes of the starry host, and thus to penetrate by the force of reason into those infinitely distant regions where the imagination dare not venture to follow him. We find in the bosom of the earth, written on blocks of marble, the history of primæval times, of worlds of life created, and worlds of life destroyed."

The progress of geology has been of a remarkable character. It has now taken its place beside the exact sciences, and owes much of its present advance to the zealous efforts made by the members of the British Association. The Earl of Harrowby remarks that "practical men are beginning to have greater respect for a science which enables them to form a very sound conjecture where such minerals are likely to be found, and to come to something like an absolute certainty where they are not.

"When the question begins to be asked, Is there a square mile in all the coal fields of Britain untouched by the mines, of its 5,000 square miles of visible coal tract? it is time, indeed, to listen to that science which has taught us so successfully in the hands of a Murchison, and a Phillips, and others, where further resources for the supply of this, the life of Britain, is to be found."

One of the recommendations made by members of the British Association was, that a Committee should be appointed, consisting of the President of the British Association, the General Secretary, the President of the Geological Society, the Director of the Geological Survey of Great Britain, the Professors of Geology in Oxford and Cambridge, with others, for the purpose of preparing a map of the World, in which every region in which coal is known to exist should be marked down, with an explanatory report, showing the nearest seaport and other information necessary to the miner.

A most valuable addition to geological science has been recently made by Professor Sedgwick, in his "Communications on the Nomenclature and Classification of the Older Paleozoic Rocks," the result of many years' hard labour.

In the promotion of geology and natural history, nearly £3,000 has been spent by the British Association.

Section D (Zoology and Botany) includes a Sub-section for Physiological Science. Since the time of Cuvier, zoologists have been stimulated to a great increase of research. "To that great man appertains the merit of having systematically pursued and applied anatomical researches to the discovery of the true system of distribution of the animal kingdom. Rapid and right has been the progress of Zoology since that resumption. To the observation of outward characters is now added that of inward organization and developmental change, and Zootomy, Histology, and Embryology combine their results in forming an adequate and lasting basis for the higher axioms and generalizations of Zoology properly so called. Three principles, of the common ground of which we may ultimately obtain a clearer insight, are now recognised to have governed the construction of

animals :—unity of plan, vegetative repetition, and fitness for purpose."*

Zoology assumes a new importance when we know that it takes its share in meeting the requirements of the age ; thus, while Acts of Parliament relating to fisheries, which are such an important part of national wealth and commerce, must be based on correct zoological data, we find also, both here and on the Continent, Pisiculture has attained to a high degree of cultivation. The immense development also which the various artificial rearing, and fattening of animals will attain, in the course of time, are all subjects that demand nothing less than what our modern Cuvier calls a "Philosophical Zoology."

"Every organism is a character in which Divine wisdom is written, and which ought to be expounded ;"† and this applies with equal force to the vegetable as well as to the animal kingdoms.

Botanical science bears also an important relation to various abstract and applied sciences, which are either wholly or partly dependent upon it ; thus a knowledge of the general physiology of plants forms the only secure basis of scientific agriculture, and with the advance of such knowledge we may expect to see corresponding improvements in agricultural produce.

In 1835, when the British Association first met in Dublin, a Physiological or Medical Section had been formed, and had worked with great success. Since that time no distinct Physiological Section had existed ; but at the Dublin Meeting, in 1857, there were so many distinguished medical men assembled, representing not merely England and Scotland, but several of the Continental countries, that a Sub-section was organized.

Section E (Geography and Ethnology). This Section

* President's Speech at Leeds. † *Ibid.*

was first devoted to these important subjects at the Ipswich Meeting, by the suggestion of Sir Roderick Murchison.

In opening this Section at the Leeds Meeting, Sir R. Murchison (President of the Section) alluded to these circumstances, and appealed to the members of the Association whether it had not produced an eminently popular and satisfactory development of those sciences. It had produced papers which had a world-wide reputation; it had brought the most distinguished travellers from foreign parts to attend the Meetings of the Association; and he need only refer to the officers of the Section by whom he was surrounded, to show that the geographers at large appreciated the benefits of the Section, and attended its Meetings readily to exchange thoughts with each other, and to give their descriptions of foreign countries, and their opinions on geography in general.

We must confess that while we take deep interest in every department of scientific progress, we find, in this Section, peculiar claims to our attention, founded on the important relations its subjects bear, to the Christian civilization of the world.

Never did we realize this more than when, at the Cheltenham Meeting, we entered the Section, where letters from Dr. Livingston were being read by Sir Roderick Murchison, and heard the closing words: "*The end of the geographical feat is only the beginning of the Missionary enterprise.* Geographers labouring to make men better acquainted with one another, soldiers fighting against oppression, and sailors rescuing captives in deadly climates, are all, as well as Missionaries, aiding in hastening a glorious consummation of God's dealings towards man."

In Geography, the papers and reports of the Association are most comprehensive and important. "Great navigations," we are told, "are opening up the heart of the South

American Continent by the Paraguay, the Amazon, and the Orinoco, and traversing and uniting the colonies of Victoria and South Australia by the river Murray. The projected exploration of North Australia, the wonderful discoveries in South Africa by Dr. Livingston and Anderson, and the explorations of Central Africa by Barth and Vogel, the pictures given us by Captain Erskine and others of the condition of the islanders of the South Pacific, passing by every stage of transition, from the lowest barbarism to a fitness for the highest European and Christian culture—these and a hundred other topics awaken an ever new interest in the mind of the philosopher and statesman, in the feelings of the Christian, and the lover of his kind. What new fields for service! What an opportunity for wealth and power!"

Nor can we, in the present rapid development of Anglo-Saxon power and influence, doubt that one part of our duty, as members of that mightiest branch of the Teutonic stem, is to see to it, that we are prepared by every means in our power to meet the growing demands upon our energy and enterprise.

A young and rising statesman, Lord Bury, who has recently visited and inspected our Canadian colonies, declares that Canada must eventually become the great carrying power of the world; that in the present generation we shall see a railroad, a ship canal, and a telegraph between the Atlantic and Pacific Oceans, on British territory; and, as if to show the feasibility of such grand schemes, and the opening of a channel through which the Great Pacific Railroad should pass to the Western Ocean, at a Meeting of the Royal Geographical Society in London, Sir R. Murchison recently drew attention to the discoveries made by Captain Pallisser in the Far West of British North America. One of these is a practicable

pass through the Rocky Mountains, connecting the rich prairies of Saskatchewan with British Columbia. The facilities for crossing the mountains are so great as to leave little doubt in his mind of the practicability of constructing a railroad, connecting the plains of the Saskatchewan, with the opposite side of the main chain on the Rocky Mountains.

A wide field for scientific research is opened in Ethnology, which involves the arrangement and classification of the different members of the human family, and explains their common origin and casual juxtapositions. This must be regarded as the most important accession to systematic knowledge which has been made in our time. The field of research entered upon by Ethnologists is a most extensive one, calling to its aid anatomy, natural history, physical geography, philology, and many other branches of science capable of throwing light upon their researches. History and archæology contribute much, also, to their work.

The labours of Missionaries have been inestimable in this branch of science. Silently and unobtrusively have they pursued their labours for the spread of the Gospel, gathering materials for dictionaries and vocabularies of various dialects, preparatory to intercourse with native tribes, or for translating the Word of God. One of the papers of the Association mentions that the Church Missionary Society, in connexion with other Societies, engaged in vernacular translations of unwritten languages, has recently adopted a common system of orthography. This system closely agrees with one that has been employed by the great Missionary Institution at Basle, and likewise by others, for translating the Scriptures.

Grammars and elementary books, beside the principal parts of the Bible, have been printed in the Caffre language, through the Missionaries of the Wesleyan, London, and other Societies. The Dutch Missionaries did much for the

Hottentots in this respect; and the devoted Moffat has just completed the translation of the Bible into Sechuana.

Section F (Economic Science and Statistics). At the third Meeting of the British Association held at Cambridge, a Statistical Section was added to the five Sections into which the Association had been divided by the General Committee. The President (Professor Sedgwick) remarked, when announcing the formation of this Section, that some members might think the objects of Statistical Science ill suited to a Society formed only for the promotion of Natural Science. It might be asked, "Can statistical inquiries be made compatible with our objects, and taken into the bosom of our Society? I think they unquestionably may, so far as they have to do with matters of fact, with mere abstractions, and with numerical results. Considered in that light, they give what may be called the raw material to political economy and political philosophy; and, by their help, the lasting foundations of those sciences may be, perhaps, ultimately laid."

In the note on this subject in the annual volume, it is stated that the inquiries of this Section are restricted to facts relating to communities of men which are capable of being expressed by numbers, and which promise, when sufficiently multiplied, to indicate general laws.

A permanent Committee of this Section was appointed, of which Professor Babbage was requested to act as Chairman.*

The Statistical Section discusses all questions to which the science of probability can be applied. Thus, statistics are doing for the contingencies of human life, from materials

* It is an interesting fact, that to the impulse given by the British Association, is to be attributed the origin of the Statistical Society of London, which was formed in 1834, and which, in its turn, now gives what Professor Sedgwick has here aptly called the raw material, to the National Association for the Promotion of Social Science.

apparently as uncertain, like what Meteorology is doing for the winds and waves.

The statistics of crime, education, pauperism, the laws of population, mortality, and sickness, are brought under the notice of this Section, &c., and, would time and space permit, we could bring abundant proof of the valuable results.

From an early period, the important subjects that now occupy the attention of the National Association for the Promotion of Social Science, were brought under discussion and observation in the Statistical Section of the British Association, and the latter may fairly claim to have been the pioneer, and, indirectly, the originator, of many of those philanthropic labours bearing on social reformation, which now find their full development in the younger Association. Thus, among the early Reports of the British Association, we find papers on the Defective State of Education, Prison Discipline, Industrial Schools, and other subjects of like interest, while the Health of Towns is also brought prominently forward.*

Realizing more and more the importance of this Section, a slight adaptation of its name has been made to its increasing claims, and it is now known as that of Economic Science and Statistics.

This was in consequence of a proposal of R. M. Milnes,

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* For a sketch of the progress of Sanitary Reform, see "Handbook of the National Association for the Promotion of Social Science."

Among the most pleasing features in the progress of the age, is the foundation of a Ladies' Sanitary Association, which aims to diffuse correct information on sanitary subjects among the poor. When presiding at the first Annual Meeting, Lord Shaftesbury spoke of the high importance he ascribed to the commencement of a Ladies' Sanitary Association, and Dr. Southwood Smith expressed the same sentiments. We earnestly commend this Association to the attention of the women of England. Information respecting it can be obtained at the Office, 14 A, Princes Street, Cavendish Square.

Esq., M.P. "I am desirous this change should be effected," said Mr. Milnes, in a letter to the General Secretary, "because I think it will bring the objects of the Section more legitimately within the scope of the Association. Political Economy is now recognised as a science, not only by the establishment of Chairs in the chief Universities of Europe, but also by the confirmation which experience has given to its principles and deductions. At the same time, I do not wish to give up the name 'Statistics,' because its retention enables the Section usefully to entertain many subjects of general interest, which the wholesome abstinence of the Association from political and moral questions must otherwise exclude. I believe the public has derived great advantage from the materials of social and economical truths gathered together at the Meetings, and would see with regret any limitation of its objects."

Section G (Mechanical Science). The importance of this Section will be realized by all who are aware of the heavy national and private losses sustained from the want of adequate theoretical knowledge. Few unscientific persons are perhaps fully acquainted with the extent to which the interests of the State, both in peace and war, are bound up with the full development of engineering. "How often," said Lord Rosse, when President at the Dublin Meeting of this Section, "do we see the ingenious mechanic working on false principles, vainly, perhaps, attempting to accomplish something which a little elementary knowledge would have shown to be impossible! There are, perhaps, few gentlemen present who could not point out instances where individuals have sustained heavy losses from the want of adequate theoretical knowledge." Lord Rosse proceeded to say, that, in his limited experience, he had known several. Some years ago he was invited by a physician of eminence,

in London, to visit the works of an ingenious mechanic, who was endeavouring to employ air, heated by gas, as a prime mover. The physician had embarked £12,000 in the project; a lady of wealth had speculated in it to the extent of £30,000; and various individuals had advanced sums altogether to a large amount. At the entrance of the premises was the wreck of a gigantic machine, of unknown construction; other machines, in a dilapidated state, were lying about in all directions. It appeared, from the explanation of the mechanic, that these huge masses of ruined machinery had been constructed partly for the purpose of ascertaining facts to be found in every elementary treatise, and partly for the accomplishment of objects manifestly impossible. In the construction of the engine itself, there was a striking display of great ingenuity constantly engaged in a struggle with the laws of nature. It was perfectly evident that the whole was fated to end in disappointment; still the mechanic and his patrons, undismayed by repeated failures, and heedless of warnings, which, where there was no science, were without force, struggled on till the project came to an end from exhaustion. Some of the parties were ruined, while all lost the capital they had embarked.

To prevent such disasters, and to show the importance of engineering science in the service of our country, have been some of the objects of the Mechanical Section.

The investigations carried on under the auspices of the British Association, with regard to the strength of materials, have been of most signal service to the advancement of Mechanical Science. The iron tube over the Menai Strait could never have been suspended, had not Mr. R. Stephenson been acquainted with the results of the experiments carried on by the members of the Association. On these subjects £1,276 has been expended.*

* See annual volumes of the British Association.

We may mention that, in recent improvements in railways, "the best data for determining with accuracy the power to be provided for attaining the high velocities of fifty and sixty miles an hour, were those furnished by a Committee of the Association."

Mr. Fairbairn, whose reports of experimental researches to determine the strength of locomotive boilers and material are most valuable, observes, on the progress of mechanical science, that "to be convinced of the changes now in progress, it is only necessary to notice the splendid sight at Spithead, to witness ships, such as the *Duke of Wellington*, of nearly 4,000 tons burden, 1,100 men, and 131 large guns, moving in and out of position, regardless of wind and tide, with a facility that would have astonished the Rodneys, Howes, and Nelsons."

In the review Mr. Fairbairn took at Leeds of the progress of Mechanical Science, he stated, that in this country we have now 9,500 miles of railway; and taking at a rough calculation one locomotive engine with a force of 200 horses power to every three miles of railway, and assuming each to run 120 miles per day, we might thence calculate the distance travelled over by trains to be equal to 380,000 miles per day, or 138,000,000 miles per annum. To transport these trains required a force equivalent to 200,000 horses in constant operation throughout the year.

The gradual spread of steam power in agricultural districts is one feature in the present day, not the least remarkable among the many signs of progress. Many hard and laborious kinds of field labour are now effected by steam.

Among other papers and reports, those upon railroads through Asia Minor, or on the Euphrates line of communication with India, are of no ordinary interest. It appears that the Arabs have a kind of prophecy, that, when iron

should swim, their dominion is to end, and they came in consequence hundreds of miles, to ascertain the fact that it really did. We find, in these reports, remarks on the importance this line of route would assume, as the means of re-introducing Christianity and civilization to regions hallowed by the most sacred associations.

We look forward with deep interest to the time when this important aid to the civilization of a country shall traverse the extent of British India. The "Pathfinder" is there, for we rejoice to know that the geological survey of that country, now being carried out, will afford important aid to the future engineers who shall extend the line of railroad from one part of that vast country to another. Let it be remembered that the value of our brave soldiers will be doubled when they can thus be transported at once to the scene of action. Had it been possible to have called into existence the appliances of modern science during the late fearful rebellion in India, in two days the electric telegraph might have borne the intelligence of the mutiny to England, while back might have flashed the order to Calcutta to send steamers from that place to meet regiments going overland, instead of there being three or four months' delay by the Cape.

Changed indeed is the time since the *Quarterly Review* thus spoke of one of the noblest elements of civilization :— "As to those persons who speculate on making railways throughout the kingdom, and superseding all the canals, and, in short, every other mode of conveyance by land and by water, we deem them and their visionary schemes unworthy of them. The gross exaggerations of the powers of the locomotive steam-engine, or, to speak in plain English, the steam carriage, may delude for a time, but must end in the mortification of those concerned. We are not surprised that

people who probably never saw a steam-engine or a railway, should put their names to such pure nonsense as this, but we hardly expected that Mr. Telford, the engineer, should have lent it the sanction of his."

It is a singular fact, that, in 1802, the embryo power of steam was noticed in a lecture by Mr. Walker, who remarked that "the day would arrive when, instead of changing horses, we shall only have to light a coal."

Recently in India the railway rendered great service during a drought by transporting large tanks of water to the spot where it was wanted. We hear, with less pleasure, of its being made available, on the Sabbath, to carry the worshippers of Juggernuth to the scene of their idolatry.

It appears not unlikely that a new motive power may be shortly discovered. An investigation fraught with important consequences is being carried on at present, on the question of the conversion of heat into motive power. At Turin an hydraulic railway has been tried, which it was thought by the inventor might succeed for the passage of Mount Cenis.

At the Dublin Meeting of 1857, John Scott Russell, Esq., gave an account to this Section of the mechanical structure of the *Great Eastern* steam-ship. The ship, as a naval structure, as far as her lines were concerned, was a child of the British Association. It was twenty-two years since, in Dublin, he laid before the Mechanical Section a form of construction which had since become well known as the "wave line." The Section received the idea so well, that it appointed a Committee to examine into the matter, with the intention, if they found the wave principle to be the true principle, to proclaim it to the world. The Committee pursued its investigations, publishing the results in the account of their transactions; and from that time to the

present, he had continued to make large and small vessels on the wave principle; and the diffusion of the knowledge of this system through the transactions of the British Association had led to its almost universal adoption. Whenever they found a steam-vessel with a high reputation for speed, economy of fuel, and good qualities for sea, he would undertake to say they would find her built upon the wave principle.*

At the Leeds Meeting of the British Association, William Fairbairn, Esq., who was Chairman of this Section, said that "the *Leviathan*, with all her misfortunes, was a magnificent specimen of naval architecture, the cellular system, so judiciously introduced by Mr. Brunel, being her great source of strength. He was so persuaded of the security of the principle upon which she had been constructed, that he had no doubt she would stand the test of being suspended upon the two extreme points of stem and stern, with all her machinery on board, or she might be poised upon a point in the middle, like a scale beam, without fracture or injury to the material of which she is composed. He expressed the hope that the necessary funds would be forthcoming to complete her equipments, and we should then see her dashing aside the surge of the Atlantic at a speed of eighteen to twenty knots an hour."

We can scarcely realize as yet all the consequences to commerce, should this "Saurian Ship," as it has been called, succeed. But one month's voyage will separate us from some of our most distant colonies, and we may predict such a consolidation of the British empire as has never before been imagined, and, with it, the corresponding addition of strength that so much greater union can give. Perhaps those noble sons of science who fostered, with kindly care, the speculations of Mr. Scott Russell, scarcely realized all these gigantic results.

* For a full explanation of the wave principle, see Mr. Russell's Report in the annual volume for 1857.

It would be impossible for us even to glance at the numerous subjects that have been brought before the Association. They involve every branch of scientific inquiry, and all have but one object,—to benefit mankind either directly or indirectly.

To adopt the language of General Sabine, the President in 1852, "We recognise the gratifying picture of British science, in the full career of energetic action and advancement, pressing forward in every direction to fill the full measure of the sphere of its activity, in the domain of intellectual culture, regardful, on the one hand, of the minutest defects in the careful examination of natural facts, and, on the other hand, diligent in combining them into generalizations of the highest order, by the aid of those principles of inductive philosophy, which are the surest guide of the human intellect to the comprehension and order of the material universe." Humboldt recorded it as his opinion that the conquests already achieved by science constitute only a very inconsiderable portion of those to be obtained.

We must not omit to touch upon an error which has been exceedingly prevalent, and is intimately connected with our present subject. We hear, occasionally, various degrees of importance attributed to different branches of science, an arbitrary distinction being made between them, as if some (because at present immature, and therefore veiled in obscurity) were not of so much consequence to the human race as others. "An equal appreciation of all branches of the mathematical, physical, and natural sciences," writes the same great German philosopher, "is a special requirement of the present age, in which the material wealth and the growing prosperity of nations are principally based upon a more enlightened employment of the products and forces of nature."

In perusing the valuable reports and papers of the British

Association, we are struck with the intimate connexion existing between every branch of science, and the assistance reciprocally given. Thus "we find the practical value of the compass and chronometer due, in a great measure, to abstract observations on the magnetism of iron, on the elasticity of steel, and on the expansion of metals."

Professor Sedgwick has remarked that "there is no end to the practical application of mathematical analysis to the business of life;" and we may now name, as one of the distinguishing marks of the present age, that science has passed from the field of speculation into the active sphere of life.

The strenuous efforts now made by men of science to give concentration and unity to parts of physical phenomena, which had been before regarded as having no relation, is one of the most remarkable features of the present time. La Place has said, "*Les phenoménes de la nature ne sont qui les resultats mathematiques d'un petit nombre de lois immuables,*"* and the truth of these words of the great astronomer are being verified in every department of science.

What is now needed in scientific observations (carried out at wide distances) is felt by all scientific men to be—unity, which, while connecting them one with another, will, as the grand result, give to the finite mind of man the apprehension of those simple but wonderful laws impressed by the great Creator upon the work of His hands, and gradually lead to the accomplishment of what the great Bacon shadowed forth when he said, "Only let mankind regain their rights over nature, assigned to them by the gift of God,—that power obtained, its exercise will be governed by right reason and true religion."†

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* "The phenomena of nature are only the mathematical results of a small number of unchangeable laws."

† Bacon, *Novum Organum.*

CHAPTER V.

Present State of Scientific Education in England — Change in the Universities—Influence of His Royal Highness Prince Albert—The Oxford Museum—Scientific Instruction in our Public Schools—Middle Class Education—College of Preceptors—Mechanics' Institutes—Dr. Booth on "Examination the Province of the State"—Examination of Society of Arts—University Local Examinations—Science and Art Department—School of Mines — Geological Survey — Minute of Council — South Kensington Museum—Schools of Art — Benefits bestowed by British Association—Unity of Action desirable—Science the Handmaid of Christian Civilization—Infidelity—High Value of Christian Civilization.

"There is nothing so revolutionary, because there is nothing so unnatural and so convulsive to society, as the strain to keep things *fixed*, when all the world is, by the very law of its creation, in eternal *progress*; and the cause of all the evils in the world may be traced to that natural but most deadly error of human indolence and corruption—that our business is to *preserve*, and not to *improve*. This is the ruin of us all alike,—individuals, schools, and nations."—*Dr. Arnold.*

In a former part of this little work we have endeavoured to give some idea of the great extent to which deficiencies in the appliances for scientific instruction have prevailed throughout our Universities and schools. The question may now be well asked, and is a deeply interesting one, How far has a remedy for this state of things been provided by the increased intelligence of the age?

It has been stated as a remarkable fact, that the Universities of Europe were often in past ages the fortresses from which prejudice was latest in being expelled; and no person who is aware, on the one hand, of the present pressing requirements of the age, with regard to physical science, and, on the

other, of the difficulty with which its claims have found proper recognition in the ancient seats of learning, but must, however reluctantly, add his testimony to the accusation above mentioned.

Dr. Acland has well said of Oxford, "It does seem strange that it has taken some centuries from the epoch of Roger Bacon, followed here by Boyle, Harvey, Linacre, and Sydenham, besides nearly two hundred years of unbroken publication of the Royal Society's Transactions, to persuade this great University to engraft, as a substantive part of the education of her youth, any knowledge of the great material design, of which the supreme Master Worker has made us a constituent part."

That there is a great change, no one can deny who is acquainted with the present advantages enjoyed by the student at Oxford or Cambridge, as compared with those possessed by former generations. These two great Universities have, at least, recognised the right of physical science to take its part in a course of academical study; and we doubt not that a continuance of the same causes which have already led to important changes,—viz., the strong internal sympathetic force, arising from the residence in the Universities of some of our greatest scientific men, and the external pressure produced by the growing force of public opinion,—will ultimately effect an entire revolution in this respect.

In the Universities of Scotland and Ireland, and in our Metropolitan colleges, the sciences of observation have taken their place, and the Scotch School of Science can boast a Watt, a Ferguson, and last, but not least, a Livingston, whose attendance on the Natural History Sections in Glasgow were the means, in God's Providence, of rendering his explorations in Africa so important to mankind.

But till within a very recent period, it was on the Continent that the greatest advantages were afforded to the student of modern science; and we have often thought that England owes a heavy debt of gratitude to the German University, which, through its extended curiculum of study, fostered those enlarged views which fitted His Royal Highness Prince Albert to perform a most important part in the great educational reform of which we now speak.

It is no slight matter that a weighty influence, such as must be exercised by an enlightened Prince, occupying the exalted position of Royal Consort to our beloved Queen, should always be found on the side of progress. Were we to attempt to trace the origin of the present recognition of the natural sciences in our schools of learning, it would, perhaps, be difficult to say how much is due to that benignant influence which originated the Great Exhibition, and which, in so many ways, has operated in the same direction.

Let it not be thought that, while we express our satisfaction at the establishment of schools of chemistry, natural philosophy, and anatomy in our Universities, we place a low estimate upon classical studies. We are well aware of their relative value; and it is only to the exclusive direction of the mind to those studies, that we object, and to the consequent limit that has arisen to the usefulness of our Universities, which, ceasing to satisfy the demands of the age, would, ere long, have ceased to influence it, had they not taken steps to resume their true relation.

In the completion of the Scientific Museum at Oxford, and in the generous promptitude with which the Universities have, by their corporate action, seconded and given form to the Middle Class Examinations, we see a promise full of hope to us with regard to the educational future of our country. It was essential that the first step in advance

should be made by the Universities, for we could not expect our great public schools to assign their proper position to the natural sciences, till the example was set them by those ancient schools of learning whose future students are under their care.

"I cannot doubt," observed Dr. Daubeny, the President of the British Association in 1856, "but that, the signal once given, both masters and scholars will eagerly embrace a change so congenial to the tastes of youth, and so favourable to the development of their intellectual faculties. * * * In anticipation of which change, I look forward with confidence to the day when the demands for instruction in the physical sciences at Oxford will become so general and so pressing, that no institution which professes to prepare the youth it instructs for academical competition, will venture to risk its reputation by declining to admit these departments of study into its educational courses." *

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* With reference to the scheme for the extension and better management of the Universities, Dr. Daubeny published some time since a valuable work on the *Correlation of the Natural Sciences.*

"The natural sciences," Dr. Daubeny writes, "may be divided into two classes,—viz., into those which are general or primary, and those which are special or subordinate. The primary ones ought to be regarded as parts of every complete system of education; the special ones as not essential to it, however much they may deserve encouragement in a place dedicated to learning: the first class should be limited to those departments of knowledge which, besides being important in themselves, are requisite also for the prosecution of every other branch of physical inquiry. The primary sciences comprehend the knowledge of the general laws common to all matter whatsoever, the special properties and relations of those bodies which are either most familiar to us, most useful, or most generally diffused throughout nature, the general laws which govern life, both as it exists in the animal and vegetable creation. Of these the first-named branch of science is termed mechanical, or, more popularly, natural, philosophy; the second is included under chemistry; the third under general physiology. In declaring that these three sciences ought to form a part of every complete system of

We believe that the bold educational movement inaugurated by Oxford will ultimately lead to the most important results, with regard to the position, this ancient University will hold to the industrial towns of Old England.

Before the commencement of the present century, Oxford stood pre-eminent in those branches of human knowledge which then chiefly occupied the attention of learned men; but when new studies were ushered in with the sedulous

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education, I intend to maintain, with regard to natural philosophy, that the law of gravitation and its consequences, as illustrated on the grand scale in the movements of the celestial bodies, and on a smaller scale, as a mechanical agent, should be understood—not that optics, accoustics, electricity, &c., should be severally insisted upon, or even that the principles which are required to be taught should be treated mathematically. With regard to chemistry, that the general laws of combination between bodies, the properties and composition of the atmosphere of water, and of some of the more important elements, should be rendered familiar, but not that a knowledge of the entire catalogue of simple substances, or their primary combinations, should be of necessity required. With regard to general physiology, that the great distinctions between the two kingdoms of organic nature, the primary divisions of each, the leading properties which belong to living matter in general, the functions which their respective organs discharge in each class or division, should be fully understood, while neither the details of structure in man and the inferior animals are to be regarded as forming part of the information which the student is expected to possess. If it be conceived by any that the rudiments of all these three branches of science are too complicated or too difficult to be mastered by every Oxford student, I would beg them to recollect that the amount of knowledge supposed is not greater than that which every well-educated man at the present day is assumed to possess, or than what is at present generally enforced in many foreign Universities. In natural philosophy only those facts are to be deemed essential which can be acquired without the aid of mathematics; in chemistry, nothing more than some knowledge of bodies of everyday occurrence is required; and in physiology, such elementary results as are included in the text-book put into the hands of all the students in all the colleges for general education in France, and taught not to adults, but, generally speaking, to mere lads."

investigation of the material world, the ancient University had no adequate appliances for their culture.

The Oxford Museum consists of schools of natural philosophy, anatomy, and chemistry, provided with lecture-rooms, laboratories, library, and reading-room. Who can estimate the influence that these opportunities for scientific progress will have on the students of Oxford? and with regard to the future Clergymen who may here be trained, we have long felt that the best interests of religion demand, that her teachers should not be behind the progress of the age in relation to the truths of science.

The public schools of England have not yet universally recognised the due importance of physical science.

We have lying before us the tables of weekly study for several of our most eminent public schools. As far as classical knowledge is concerned, we do not suppose any improvement could be made. Attention is also given to mathematics, and to the modern languages; but we look in vain for that full recognition of the claims of science which we feel certain will one day be made in all our public and private educational institutions.

In consequence of this deficiency, in all our principal towns we find new colleges and schools rising up, to meet the wishes of what the *Edinburgh Review* very aptly has called "the less stationary part of our population."

Thus, in one Proprietary College, that of Brighton, we see in the prospectus that pupils not going to the Universities may be exempted, at the request of their parents, from learning Greek, and from such Latin compositions as, in the judgment of the Principal, appear unnecessary; while the time so gained can be devoted to subjects suited to their future professions. Lectures in Chemistry, and other branches of physical science, are given by a lecturer of the Govern-

ment School of Mines, who also prepares boys for that school, while complete practical instruction in chemistry and chemical manipulation may also be obtained.

This is but one example, out of many we could give, of the manner in which the old classical education is now modified, to meet the demands of the present age.

In an able address to the College of Preceptors, the Rev. J. Howson thus touches upon the very point to which our own observations have tended :—"Dr. Lyon Playfair, whose name I am glad to see among the recent accessions to the college, has forcibly pointed out the importance of scientific education in a country where machinery is taking the place of manipulative skill. How can physical science be taught in schools so as to be a real mental training? In what proportions ought the old studies to be combined with the new? What place ought to be assigned to drawing? Such are some of the questions which invite careful discussion."

We have no fear but that these questions will ultimately be solved, now that there has been found a body of educators sufficiently aware of their importance, to take them into consideration.*

Among those institutions which have had a powerful influence in stimulating the dormant intellect and scientific tastes of our population, must be named the Mechanics' Institute, which may be regarded as doing the same office for the working classes that the Universities do for the upper, —viz., carrying education on beyond the point at which the school leaves them.

"These valuable institutions," says an eminent scientific

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* We refer to the College of Preceptors, an institution which we believe will prove of the highest value in raising the standard of education, and the status of the educator, and which, by its examitions, has done much in this respect.

man, "have done excellent work, and I hesitate not to state my conviction, that one-half of the noble applications of science which so peculiarly distinguish the nineteenth century are to be traced to the Mechanics' and Literary Institutions. Many of the most eminent of our living philosophers—using that term in its original and widest sense—date the kindling of the first spark to those institutions; and I doubt not, but embryo Watts and future Daveys will be found to be now sitting on the benches of some humble country Institution, listening to some itinerating lecturer on science." *

In October, 1847, Dr. Booth published a pamphlet, called, *Examination the province of the State; or, the Outlines of a Practical System for the Extension of National Education,* in which he had clearly shown the manner in which national education, in its widest sense, might be most effectually promoted. In 1852, hearing that the Mechanics' Institutes of the kingdom were about to form a union with the Society of Arts, Dr. Booth joined that Society, being anxious to test the soundness of his principles with regard to the improvement of education for the mechanics.

In 1854, the Society of Arts and the Institutes had agreed that their students should be annually examined, but so little was the principle of such examinations understood by the public, that, even in 1855, only one candidate, an adventurous chimney-sweep, presented himself. In 1856, 52 students underwent examination according to the plan drawn up by Dr. Booth. In 1857, 220 candidates offered themselves; and, in 1858, when the examinations were first divided into previous examinations by the Local Boards, and final examinations by the Society's Board, and when a minimum of the age of candidates (sixteen) was first fixed, 1,107 candidates, at thirty-two different places, underwent

* Robert Hunt, Esq., F.R.S.

the previous examinations, and 288 the final examination. In the whole, 394 candidates have received 863 certificates this year, and henceforward the examinations will be held simultaneously, at all places throughout the union, in England, Scotland, Ireland, and Wales, wherever there are candidates and a Local Board.

For some time, the subject of middle-class education, and the best way of meeting its deficiencies, had much occupied the minds of superior men, and in April, 1857, Dr. Temple, at that time a member of the Board of Examiners of the Society of Arts, wrote a public letter to Dr. Jeune, of Pembroke College, Oxford, calling his attention to the success that had attended the Society of Art's scheme of examinations, and pointing out how desirable it was that the University of Oxford should occupy the ground which a private body like the Society of Arts could not cover.* The University of Oxford responded with energy and spirit to this proposal of Dr. Temple; and, while it was under consideration, the deep interest awakened in the country was shown by memorials from members of the medical profession, architects, &c., in London, and letters from well-known educationalists, expressing their conviction of the great benefit that would be conferred upon the country by the institution of such examinations.

Careful inquiry was made with regard to the wishes and opinions of schoolmasters, and a Meeting of some of the Head Masters in England took place in the Radcliffe Library, at Oxford.

Before the regulations were finally published, the Master

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* In 1857, a scheme for the examination of boys destined for arts, manufactures, commerce, or agriculture had been carried out with great success by Dr. Acland, in the West of England: above one hundred boys attended.

of Pembroke, the Master of Balliol, Professor Phillips, Professor Rice, Dr. Temple, and Dr. Acland, were requested to visit Cambridge, in order that they might communicate with the Syndicate appointed to consider the same subject, and this unreserved communication will, it is hoped, ultimately pave the way for the co-operation of the two Universities. The following is a brief summary of the schemes of the two Universities. We are indebted for it to the kindness of our valued friend and connexion, Robert Potts, Esq., of Trinity College, Cambridge :—

"The institution of local examinations for students who are not members of the Universities, is not the least important of the measures undertaken for extending the beneficial influence of the ancient Universities. This work has been taken up in a generous and liberal spirit. They admit students from all ranks of society, without distinction, to these examinations, just as all students are admitted as members of the Universities who desire to avail themselves of the advantage of an academical education. The fees required to be paid by the students are fixed at so small a sum as is considered will be simply sufficient to defray the necessary expenses, on the part of the Universities, of holding the examinations. These University examinations have been called middle-class examinations without any authority, as this designation has not been adopted either by Oxford or Cambridge. The expression is, besides, most inappropriate, and calculated to create both prejudice and misapprehension. It is, perhaps, difficult to define where the middle-class begins, and where it ends. It is generally applied to mean that part of the community which, in social rank, is above the lowest, but below the higher ranks of society.

"The Oxford statute for instituting these local examinations is entitled, *De Examinatione Candidatorum, qui non*

sunt de Corpore Universitatis; and the University of Cambridge has simply named their scheme, 'Examination of students who are not members of the University.' The expression, *University Local Examinations*, has been suggested, as fitly expressing the designs of the Universities, as they have declared their readiness to hold examinations in any locality in England from which they may receive an invitation. The examinations are comprehensive, including all the subjects of a sound English, classical, and mathematical education. They embrace the English, Latin, Greek, French, and German languages; the pure mathematics, arithmetic, algebra, geometry, &c.; the mixed mechanics, hydrostatics, &c.; drawing and perspective; history, geography, English law, &c.; and the following special subjects, botany, chemistry, geology, mineralogy, music, &c. Oxford also offers an examination on 'the rudiments of faith and religion;' and Cambridge, on 'religious knowledge.' The schemes of examinations issued by the two Universities exhibit some differences in the details. Oxford has fixed fifteen as the maximum age of the junior candidates. Cambridge has extended the maximum age to sixteen, but requiring a greater number of subjects of examination from each candidate. Both have fixed eighteen years as the maximum age of the senior candidate. Oxford requires a University-fee of ten shillings from a junior, and thirty from a senior candidate. Cambridge makes one uniform University-fee of twenty shillings for all candidates, without distinction. The classification of the candidates who pass the examination to the satisfaction of the examiners is different under the Oxford and Cambridge schemes. Under the Oxford scheme, the results of the examination are valued separately; in the Cambridge scheme, the aggregate results of the examination are valued together.

"The successful junior candidates at Oxford examinations are arranged in two honour divisions; the names in the first division being placed in order of merit, and those in the second, alphabetically. There is a third division, arranged alphabetically, of such candidates as have satisfied the examiners. Every successful candidate receives a certificate, which specifies the subjects in which he has passed a satisfactory examination. The names of the successful senior candidates are arranged in two honour divisions, under each of the six sections which embrace the different subjects of examination. The names of the first divisions are placed in order of merit, those of the second alphabetically, and the names of the other successful candidates are arranged together in one general alphabetical list. Each of the successful senior candidates receives the Vice-Chancellor's certificate, conferring the title (A.A.) Associate in Arts, and specifying the subjects in which he has satisfied the examiners.

"The names of the candidates who pass the Cambridge examinations are placed in two divisions, one division containing the names of the senior, and the other the names of the junior, candidates. The names of each division are arranged in three honour classes, and letters are attached to the names of the students, indicating the subjects in which they distinguish themselves. The names of those who pass to the satisfaction of the examiners, yet not so as to deserve honours, are placed alphabetically in a fourth class, after the senior and junior honour classes respectively. Every student who passes the examination receives a certificate, signed by the Vice-Chancellor, specifying the subjects in which he has passed with credit, or has only satisfied the examiners.

"In the Oxford scheme, 'the Rudiments of Faith and

Religion' are not considered essential either for the certificate or the honorary distinction of Associate in Arts. The examination in these subjects is purely optional, and no candidate's place in the examination is affected, whether he exhibit a sound and accurate knowledge of these subjects, or omit them altogether. Those candidates, however, who do satisfy the examiners in these subjects, have a mark attached to their names in the general list, as having passed that part of the examination.

"In the Cambridge scheme, 'Religious Knowledge' stands in the same rank as other knowledge, and the student's place is affected according to the manner in which he may acquit himself. The scheme, however, so far agrees with the Oxford scheme, as it makes the examination in Religious Knowledge voluntary; but it grants that a student may be admitted to an examination in the Scriptures alone, apart from the Liturgy of the Church of England. The Religious Knowledge in the Cambridge scheme includes the Scriptures, the Liturgy, and the Christian Evidences; and a student has the option of being examined in any two, or in all three of these subjects.

"The first Oxford examination was held at eleven different centres in June, 1858, and 1,151 candidates presented themselves for examination, of whom 429 were successful; 435 of the 1,151 declined to be examined in the Rudiments of Faith and Religion.

"The first Cambridge examination was held at eight different centres in December, 1858, and 886 candidates were examined, of whom 240 satisfied the examiners, and only 11 out of the 886 objected to be examined in Religious Knowledge according to the Cambridge scheme. These examinations, conducted under the authority of the Universities, afford all possible security for their impartiality,

and are calculated to be of especial service both to parents, scholars, and schoolmasters. The masters of those schools who shrink from having their work tested by independent examiners, are not likely to command confidence in the soundness and judiciousness of their teaching; whereas those who do, not only afford to parents an evidence that their system of education is good, but that they desire to have it declared so by an independent judgment. These examinations will also afford to parents some means of judging what schools are ably administered, and afford proofs of the judicious skill of the schoolmaster, combined with the careful attention of the pupil."*

We now proceed to say a few words on the help Government is giving to the people in scientific instruction. The Department of Science and Art has, since 1857, been transferred from the Board of Trade to the Educational Department of Government, it being determined that the latter should consist of two branches, one administering state assistance in aiding general or primary instruction, the other affording similar aid in promoting industrial or secondary instruction; each branch having its own separate office, Secretary, and establishment, but both under the orders of the Lord President. The primary branch still continues to conduct its business at Whitehall, whilst the offices of the secondary branch should be located at South Kensington.

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* It is pleasing to know that in order to assist members of Mechanics' Institutes in union with the Society of Arts to partake of the advantage of these examinations, the Council of that Society will grant to each youth not less than sixteen, or more than eighteen, years of age, who shall obtain three of the Society's Certificates of the First Class in the subjects contained in the Oxford and Cambridge Programmes, the sum of £5 towards his expenses, if he attend at the University, and undergo his examination there.

The duties of the Science and Art Department, as now organized, consist in,—

1. A general superintendence over several distinct metropolitan institutions for promoting science.

2. Aiding schools for the encouragement both of art and scientific knowledge bearing on industrial occupations; also, aiding mechanics' and local institutions to obtain examples, diagrams, apparatus, &c., at a reduced cost.

3. The direction of a training school for art masters at South Kensington.

4. The direction and management of a museum and circulating art library at South Kensington.

With regard to metropolitan institutions, the Government School of Mines is the first we shall mention.

The Government School of Mines and of Science applied to the Arts was founded in 1851, in consequence of numerous memorials addressed to Government by the mining districts of the United Kingdom. In these memorials it was urged that the mineral produce of this country far exceeds that of any other European State, that it is equal to four-ninths of the produce of the whole of Europe, and represents an annual value of £28,000,000. It was shown that states far lower in the scale of production had established schools for the instruction of persons engaged in mining pursuits, and the effect had been increased economy, efficiency, and safety in mining operations. The memorialists pointed out that the want of mining schools similar to those which exist in France, Belgium, Russia, Prussia, Saxony, Austria, Spain, and Sweden, had long been felt in the mining districts of this kingdom. The Government School, established in connexion with the Museum of Practical Geology, in consequence of these memorials, was opened in 1851.

The School of Mines and of Science applied to the Arts is conducted by the following officers :—

Sir Roderick Impey Murchison, D.C.L., M.A., F.R.S., &c.—*Director*.
A. W. Hofmann, LL.D., F.R.S., Lecturer on "Chemistry."
T. H. Huxley, F.R.S., Lecturer on "General Natural History."
George G. Stokes, M.A., F.R.S., Lecturer on "Physics."
Robert Willis, M.A., F.R.S., Lecturer on "Applied Mechanics."
John Percy, M.D., F.R.S., Lecturer on "Metallurgy."
A. C. Ramsay, F.R.S., Lecturer on "Geology."
Warington W. Smyth, M.A., F.R.S., Lecturer on "Mining and Mineralogy."
Trenham Reeks—*Registrar*.

The chief object and distinctive character of this Institution (to which everything else is made subsidiary) is to give a practical direction to the course of scientific study. Although the education provided in it will not of itself qualify the student to undertake the direction of mining and other technical operations, yet the knowledge which he may acquire of the principles of the sciences on which the arts are respectively based, will, in combination with future training, render him in the highest degree competent not only to engage in any special branch of industry, but to promote its further development.

The mode of instruction is by Lectures, by written and oral Examinations, by practical teaching in the Laboratories and Drawing Office, and also by Field Excursions, under certain conditions.

The great success that has attended the instruction given at this admirable Institution is shown in the fact that some of the first-class students have been appointed to posts on the Geological Survey of Great Britain. One has been appointed to the direct Geological Survey of Trinidad, one drafted from the English Survey to direct the Geological Survey of Tasmania, and three or four have been appointed to the Geological Survey of India under Professor Oldham;

while a considerable number have received posts in mining establishments and manufactories, and some have started the latter on their own account. If it be remembered that the salaries to these foreign posts are good, affording a liberal provision, we cannot but think that many parents, who have not been aware of the advantages offered by the School of Mines, will be glad to avail themselves of them.

The important and valuable Museum with which the School is in connexion offers great opportunities to the student in its extensive collections, which are all arranged in the most scientific manner. As it is open to the public every day in the week but Friday, we strongly recommend our readers to visit it, that they may realize all the advantages offered by this Institution.

The general Laboratory for instruction in chemical manipulation, in qualitative and quantitative analysis, and in the method of performing chemical researches, is under the direction of Dr. Hofmann. The Royal College of Chemistry having become the property of the Government, its spacious and well-furnished laboratories are used for the instruction of the pupils of the School of Science applied to Mining and the Arts.

Each laboratory student works independently; there are no classes. All operations are superintended by the Professor and his assistants. A table with drawers, cupboard, and shelves, is appropriated to every pupil. The Institution supplies gas, fuel, and re-agents. Larger and more expensive instruments, such as air-pumps, thermometers, barometers, condensers, large evaporating dishes, &c., may be had on loan from the laboratory. The student has to provide himself only with the apparatus specified in the laboratory regulations.

The Metallurgical Laboratory is under the direction of

Dr. Percy, and is devoted to practical instruction in Metallurgy. The nature of this instruction will be adapted to the special requirements of the student. It comprises,—

Assaying in all its branches, especially of the more important metals, such as iron, copper, lead, tin, alloys of silver and gold, &c., and the examination of ores and metallurgical products.

Courses of Lectures on Chemistry, Metallurgy, Geology, General Natural History, Mineralogy, Mining, Physics, applied Mechanics, illustrated by laboratory practice, by regular demonstration in the Museum, by the use of mechanical tools and instruments, and instruction in the mode of conducting Geological Surveys, all occupy their place in this course of study, while instruction in Mechanical Drawing is also given.

There are various Exhibitions attached to the School, some of them being general, open to all pupils ; the others being special, and connected with particular provincial schools.

A great advantage is derived by the students from the connexion of the Geological Survey with the School. This department of scientific research has not only an important bearing on the advancement of correct geological theory by the identification of strata, but is intimately connected, as we have endeavoured to show in a previous chapter, with our prosperity, both nationally and individually. The general diffusion of such authentic documents as are found in the Government maps and sections cannot but save capital and labour, that have hitherto been vainly wasted in fruitless researches for coal and other mineral substances.

The first geological map of England, or, indeed, of any country, was made by William Smith, the English Geologist, to whom "we owe the first clear enunciation of the law of

the stratigraphical succession of species—a law alike great in theoretical results, and in the strictly practical applications arising therefrom." *

The Geological Survey is conducted under the powers of an Act of Parliament. The first Director-General was Sir H. de la Beche, who was succeeded in 1855 by Sir R. Murchison. It is divided into two branches—that of Great Britain under Professor Ramsay, and that of Ireland under Mr. Jukes. Our readers could not fail to be interested in the geologically-coloured maps published by this Survey, which contain the result of an amount of labour that can be rightly appreciated only by the field geologist.

In the Mining Record Office is a large collection of plans and sections of mines, which has for its object the preservation of life and property by giving information to the miner of old and deserted mine workings.

The object of Government being to aid in the diffusion, among all classes of the community, of those principles of science and art, which are calculated to advance the industrial interests of the country, science schools have been formed for those, who cannot avail themselves of the one we have described. The number of these schools, at the close of the year, was nineteen, of which twelve were navigation schools ; and the total number of persons receiving scientific instruction in different degrees and ways is 9,172.

A Minute has been recently passed by the Committee of Council on Education, while former Minutes relating to science or trade schools' scientific class instruction, except those referring to navigation, public lectures, and the training of teachers, are cancelled, and the following regulations are substituted in their stead : The Science and Art Department will hereafter assist the industrial classes of this

* Professor Ramsay.

country in supplying themselves with instruction in the rudiments of Practical and Descriptive Geometry, with Mechanical and Machine Drawing and Building Construction, Physics, Chemistry, Geology, and Mineralogy (applied to mining), Natural History, by augmentation grants in aid of salary to competent teachers, and by payments and prizes on successful results, and grants for apparatus, &c. Any school or science class, either existing or about to be established, and duly approved by the Science and Art Department, may apply, through its managers, for a certificated teacher, or for the certification of any teacher, in any one or more of the above-named branches of science. Examinations for certificates, of three grades of competency, to teach any of the above-named sciences, will be held annually by the Department, in the last week of November, in the metropolis.

The establishment of art schools throughout the country, on self-supporting principles, is a most important step in our material progress as a nation, and the education in art of the whole people, as it has been the object of the new Department at Kensington, so it will gradually be achieved.

The special objects for which this Department of the Government has been organized are :—1. To train male and female teachers to give instruction in art, to certify them when qualified, and to make them annual fixed payments, varying according to their acquirements. 2. To aid and assist Committees in the provinces desirous of establishing Schools of Art. 3. To hold public inspections and examinations, and to award medals and prizes to the most deserving candidates. 4. To collect together works of art, pictures, &c., in the central Museum, and books and engravings in the central Library. 5. To circulate among the Schools of Art objects from the Museum, and books and engravings from the Library.

The new buildings at South Kensington embrace :— 1. The Offices of the Department. 2. The Male and Female Training School for Masters and Mistresses, and the Normal Central School of Art. 3. The Museum and Library.

The Training School has for its special object the education of Art-teachers, male and female, but it also aids in supplying certificated Art-masters or mistresses to teach drawing to schools in connexion with the Committee of Council on Education. The course of studies embraces, besides all the ordinary branches of Art-education, instruction in various direct applications of Art-power to mechanical and manufacturing industry.

In order to encourage students of Provincial Schools of Art, by opening to them opportunities of pursuing their studies under the most favourable auspices, and also to secure a wide field of choice from which to select students best qualified for training as future masters, a competition for free admission takes place twice in the year, at the commencement of each session.

The students have full access to the Museum and Library, either for consultation or copying, as well as to all the public lectures of the Department. Special classes are arranged in order to qualify schoolmasters and schoolmistresses of parochial and other schools, to teach elementary drawing as a part of general education.

The Museum devoted to the purposes of Education in its various branches.

This educational collection originated with the Society of Arts, which organized an Exhibition of Apparatus, Diagrams, and Books, in St. Martin's Hall, in 1854.

In the arrangement of the collections a system of classification has been strictly observed, with especial view to its utility for reference. The divisions are School Buildings and

Fittings, General Education, Drawing and the Fine Arts, Music, Household Economy, Geography and Astronomy, Natural History, Chemistry, Physics, Mechanics, Apparatus for Teaching the Deaf and Dumb and Idiots, &c., and Physical Training; the Art Library containing books and engravings illustrative of ornamental art.

The Provincial Schools of Art on a self-supporting basis at present number sixty-eight, and have been established in various parts of the country. These Schools are all placed under the management of Local Committees, who appoint the masters and conduct the schools; the only interference of the Department being to see that the instruction corresponds with the course sanctioned.

It is interesting to notice that we have now three branches of natural products represented in London,—the Mineral Kingdom in Jermyn Street, the Vegetable at Kew, and the products of the Animal Kingdom in a part of the South Kensington. We hope that, ere long, Professor Owen will obtain, at the British Museum, the scientific and descriptive arrangement he so strongly advocates.

Lectures on various subjects connected with science and art are delivered at this valuable institution, some of the courses being addressed especially to working men. As the museum is open in the evening, the working man comes, accompanied by his wife and children, to enjoy the wholesome and acceptable excitement afforded by an evening's entertainment among its treasures.

It will not be expected that, in our brief space, we can do more than mention one or two of those scientific educational institutions which we regard as indicating the rapid material progress of our country, and, consequently, we select those that stand out in bold relief to our mental vision. Nor have we opportunity to dwell on the prospective advantages of such

measures as the Free Libraries Act, which, we hope, will ultimately be carried out in every part of the kingdom; nor on many other appliances for scientific cultivation.

From its first foundation, the British Association has availed itself of every means for the creation of a public opinion, that should ultimately lead to such results as those we have named.

We find the questions constantly reiterated by Parliamentary Committees of the Association—"Whether any measures could be adopted by the Government or Parliament, that would improve the position of science or its cultivators in this country? 1st. How can the knowledge of scientific truths be most conveniently and effectually extended? 2nd. What inducements should be held out to students to acquire that knowledge, and, after the period of pupilage has expired, to extend it and turn it to useful account? 3rd. What arrangements can be made to give to the whole body of competent men of science a due influence over the determination of practical questions, dependent for their correct solution on the accurate knowledge of scientific principles? The proper determination of these three questions appears to us of vital importance to the welfare of the State."

In the yearly volume for 1855 will be found a most valuable Report on these subjects, embodying the opinions of eminent scientific men, drawn up by a Committee, with Lord Wrottesley as Chairman. After dwelling on the neglect of Physical Science, the Report suggests, that "provision should be made for effectually teaching all the various branches of Physical Science in our Universities; that Professors and local teachers shall be appointed to give lectures on science in our chief provincial towns; that the formation of museums and free libraries should be promoted; that, by

fellowships and increased salaries to Professors, due encouragement should be given to scientific studies; that scientific officers shall be placed more nearly on a level, in respect to salary, with such other civil appointments as are an object of ambition of highly educated men; and lastly, that a board of science shall be constituted, composed partly of persons holding offices under the Crown, and partly of men of the highest eminence in science, which shall have the control and expenditure, of the greater part at least, of the funds given for its advancement and encouragement."

The objects for which the Association was established have been carried out in three ways—"First by requesting and printing reports on the present state of different branches of science; secondly, by granting sums of money to small committees, or individuals, to enable them to carry on new researches;* thirdly, by recommending to Government to undertake expeditions of discovery, or to make grants of money for certain scientific and national purposes, which were beyond the means of the Association; nor ought we to forget the original communications made to the several sections, and the discussions to which they give rise."†

* Upwards of £16,000 has been expended by the Association since its foundation.

† The following important lists of objects, to be submitted to sub-committees, was drawn up by Sir David Brewster, and so well gives an idea of the enlarged views possessed by the founders of the British Association, that we are anxious our readers should be acquainted with it:—

1. On a Direct National Provision for Men of Science.
2. On the Revision or Repeal of the Patent Laws.
3. On the Advancement of Astronomy, Navigation, and General Geography, by fitting out ships of discovery.
4. On the Advancement of General Science by the Erection of Physical Observatories.
5. On the most Scientific and Economical Method of Lighting the Coasts and Harbours of Great Britain.
6. On the Improvement and Extension of the Lines of Communi-

Among other benefits bestowed by the British Association, we must mention the respect and interest that have been excited in the community for the pursuits of scientific men. One of its warmest friends has said that, some years ago, the Association could not have existed, for its ends and aims would not have been appreciated; nor are they yet, we must admit, to their proper extent.

Through the personal exertions and influence of its members, a great change has taken place in the views of Government with regard to science. We mentioned the fact, that, in 1830, no philosopher was in the enjoyment of title or pension from the State, but, since that time, we can present a long list of honours bestowed on scientific men; some having received the Guelphic Order, with knighthood, others knighthood, and some pensions. Other distinguished men have obtained high appointments on account of their scientific attainments.

Steps have also been taken to obtain that fostering care for science, as a subject of national importance, which has been hitherto confined to private institutions.

Scientific institutions are becoming national ones. "The Museum of Economic Geology, indeed, is itself a complete

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cation throughout the Kingdom, by Roads, Railways, and Steam Boats.

7. On the Formation of a Scientific Board, for Improving our Naval Architecture.

8. On the Improvement and Extension of the British Fisheries.

9. On the Mines and Minerals of the Kingdom.

10. On the Formation of a Statistical Board.

11. On the Propriety of having an Annual Exhibition of British Industry at the place of Meeting of the Association.

12. On the Propriety of Entrusting to each Metropolitan and Provincial Society certain Specific Objects of Inquiry, and furnishing the means, when necessary, to carry them into effect.

13. To arrange a System of Prizes for the Successful Prosecution of Particular Branches of Science.

section of a Royal Institute, giving a scientific position to six eminent philosophers, all of whom are distinguished Members of the British Association.

"Our private institutions have assumed the transition phase, and it requires only an electric spark from some sagacious and patriotic statesman to combine in one noble phalanx the scattered elements of our intellectual greatness, and guide to lofty achievements and glorious triumphs the talent and genius of the nation." *

Nor can we conceal the hope we entertain, that, to the illustrious Prince who has allowed himself to be nominated as President for the Meeting at Aberdeen, we may be indebted for further progress in a subject of such importance to the best interests of science.

We shall not attempt to enumerate all the benefits conferred by the British Association on the State; but, among these, it would be difficult to select a more important service than it has rendered to our country in its Observatory at Kew, where for several years the adjustment of barometers and thermometers has been carried on. In consequence of the great value of these verifications, the Board of Trade has directed apparatus similar to that employed at Liverpool, while at Plymouth and Portsmouth the Admiralty provide the same. Numbers of instruments are verified during the year for the United States Government, the Admiralty and Board of Trade, and for opticians. "Let not," it has been said, "the practical man think lightly of such labours as the testing accuracy of the instruments, when he remembers the great services of the barometer in forwarning of the coming storm, and that the ascertained

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* Sir David Brewster's Address as President of the British Association.

temperature of the sea which his ship is traversing will inform the master whether he is engaged in one current or another, and announce to him the approach of the dangerous iceberg, when it is not discoverable by any other means."

Another of the gifts of science to the nation, through the Kew Committee, is a standard thermometer, which can be bought for 4s. 6d.

Sets of magnetical instruments were prepared at Kew for Dr. Livingston, and for the Oregon Boundary Commission. So great a reputation has the establishment at Kew obtained for the accuracy of its instruments, that requests are received from various foreign States for help in the preparation and adjustment of philosophical instruments. While Government gives the use of the building at Kew, the British Association charges itself with the expenses of the establishment, amounting last year to £800.

An important measure, obtained through the strenuous exertions of some of the members of the Association, has been an amelioration of the Law of Patents, which had hitherto been a blot upon the legislation of Great Britain, and the Committee on Patent Laws continue their efforts for their amendment.

We have spoken, in a former page of this work, of the evils of centralization, and we shall not be suspected of wishing to exchange the free constitution we enjoy for a despotic form of Government. To create an enlightened public opinion is the indispensable condition of success with those who desire to see measures carried that they consider of vital importance to their country; and when once the conviction of the importance of such measures is widely diffused, the will of a free people will not fail to carry them into effect. It is thus that we expect to see ere long the full recognition of the value of science in all its bearing

upon our national prosperity—a recognition which, once made by a great people, cannot fail to demand that science shall take its place in the councils of the nation, and that its eminent men shall share in every honour a grateful country can bestow. Nor do we despair of our even seeing the scattered rays of light that emanate from science, literature, and art, combined in one great national institute, which shall, by its organization, remedy the evils thus described by Lord Wrottesley :—

"The blots in our system seem to be, first, that there is a great want of combined action between the various communities representing science,—an evil, which might possibly be remedied by some joint representation of the whole ; and secondly, that the Societies instituted for the promotion of the various branches of science, though containing among their members and governing bodies those men who have been impartially selected as pre-eminent in their various walks, are not officially recognised in any way as authorities, or appealed to except occasionally, and by accident, whenever some member of the administration may happen to perceive that their counsel might advance the object in view, and be profitable to the State. Moreover, it seems never to have occurred either to the Government or Parliament, that the materials exist out of which a Board may be formed which might be expected to give wholesome advice on scientific questions, take on themselves a share of the Government responsibility, and save the country from the bad consequences which now flow either from neglecting to take counsel, or from the careless and indeterminate way in which it is sometimes sought and obtained."*

* Address of the Honourable Lord Wrottesley, as President of the Royal Society, in November, 1858.

At the first Meeting of the British Association, its members recommended the organization from which the most important results of combination of scattered powers and co-operation might be expected. Burlington House has already located within its ample space the Royal Linnæan and Chemical Societies, and this is an important step towards the unity so desirable for a combination of scientific labour.

The testimony of our most eminent men of science shows us that there are certain existing elements in the present state of science which only need this unity to combine in most important results. Thus Sir John Herschel says, that "never was there a time when the mind of the country, as well as its resources of every kind, answered so fully and readily to any call, reasonable in itself, and properly urged upon it;" and he speaks of "the vast mass of magnetic and meteorological observations—the profusion of facts in every branch of scientific observation that are poured down upon us. It becomes our duty to forward, by every encouragement in our power, the due consideration and scientific discussion of results so procured, and to urge it upon the science of our own country, and of Europe."

In the preceding chapters of this little work we have endeavoured to show the high importance of scientific knowledge to our country in a material point of view.

But we must add, that a still further mission is committed to science. We find it bringing into one brotherhood all the nations of the earth, constructing a pathway for the Missionary, and placing in his hands every appliance for evangelizing the world. Literally may be applied to these mighty operations the prophecy of Scripture—"Every valley shall be exalted, and every mountain and hill shall be made low, and the crooked shall be made straight, and the rough places plain."

For what purpose, we would ask, has so vast an extent of influence and power been bestowed upon the Anglo-Saxon race, but that they may be the bearers of a pure civilization to all the ends of the earth, that, "like a moral beacon in the midst of the nations, England may shine for the light of the world, exhibiting, in her own aspect, the power of Christianity to make a nation great?"

As we have no faith in the existence of civilization that is not based upon Revelation, believing, with Archbishop Whately, that the mere fact that civilized men do exist is enough to prove, even to a person who has never heard of the Bible, that, at some time or other, men must have been taught something by a Superior Being, (in other words, that there must have been a Revelation,) so we earnestly deprecate the ideas of those who would exalt science above her proper position, as the handmaid of Christian civilization. While advocating the widest extension of scientific knowledge, we do so with the deep conviction, first, that there is a knowledge infinitely higher in importance to every human soul, the attainment of which should be made the first object in education for all classes; and, secondly, that the end and aim of every scientific man—of every humble votary of science—should be to do his part towards the accomplishment of the designs of Providence. Little may the sceptic, in the pride of his boasted reason, think, that, in pursuing his philosophical researches, he is furthering God's gracious designs to a fallen race; or the merchant prince, that, in carrying out the enterprizes of a world-wide commerce, he is assisting to fulfil the sure word of prophecy. But so it is; and the Christian philosopher may claim it as his most exalted privilege, to be a humble, but conscious, instrument of working out the Divine will.

We would ask, Shall the Christian man, who has a far

higher motive to energetic action than worldly honour or wealth, suffer himself to feel indifferent to the progress of science, that mighty medium of benediction to all the nations of the earth? Will he not rather see to it, lest, in neglecting its weighty interests, he should fail in an important part of Christian duty?

The great Societies which form so remarkable a feature in the present day are but the aggregate action of each individual; and whether it be the achievements of science or Missionary and philanthropic labour that we contemplate, we reverently recognise in them the instruments for the accomplishment of the Divine will. It is one of the favourable characteristics of the age in which we live, that we find in all classes a growing spirit of anxiety to fulfil the mission devolving, by Divine Providence, upon each and every member of society; and we believe the time is coming, through the rapid extension of science and a superior education, when the Christian legislator, the philosopher, and the capitalist shall see unfolded before them, in all its length and breadth, the full meaning of those emphatic words of their Great Master—"Occupy till I come."

In its bearings upon the truth of the Christian Revelation, science manifests itself as "the witness to religion; a mighty apostle that vindicates his ministry by signs and wonders, and is ever leading us to look from Nature up to Nature's God." Time would fail to bring forward the testimony to the truth of Holy Scripture, rendered by modern science and discovery. "Science," writes Dr. Pye Smith, "is Truth. All its tendencies are heavenward; every new fact which it reveals is a ray from the Origin of Light, which leads us to its source." Dr. Abercrombie, at the Meeting of the British Association in 1854, observed that "Infidelity and irreligion

were the offspring of ignorance, united to presumption; and the boldest researches of Physical Science, if conducted in the spirit of true philosophy, must lead us but to new discoveries of the power, and wisdom, and harmony, and beauty, which pervade the works of Him who is eternal."

Let it not be thought that we have any fear of true and sound philosophy, or that we look upon her other than as a fellow worker in the cause of truth. "We hold," writes a master mind, "that the science which does not content itself with looking on the surface of natural things, but desires to penetrate into their substance or their essence, and to explore the secret causes of visible effects, is a noble science—a science fitted to bring glory to God by discovering more of His works—more of the exquisite secrets of the mechanism of infinite wisdom and skill which abound all above, and beneath, and around, and within us."

Christianity has nothing to fear from the progress of science, and the characters in the books of nature and grace only need clearer light to demonstrate their perfect harmony, and their common origin from one Divine Source. It has been well said, "They are never out of unison with each other; superficial men create a seeming discord, and then find fault with God's work instead of their own."

A Bacon, a Newton, and a Locke have bowed with the deepest veneration at the footstool of Revelation, looking upon faith as at once the perfection and highest exercise of their reason, and the crown of science.

But there is a modern *infidel* philosophy, identical with what St. Paul styles "science falsely so called," which seeks to supersede the glorious sun of Revelation, representing the Bible as only one link in the chain of truth—one stage in the development of human knowledge and philosophy, which

would entirely ignore the fact that science has derived almost all the light she possesses from Revelation.*

This infidel philosophy dares to rank Christianity with the effete paganism of Greece and Rome, and would have it take its place among those things which have answered a certain purpose, and assisted in the progress of society, but are now gone by.

It endeavours to divest Revelation of all mystery, pretending to explain away, on natural principles, the miracles which attested the Divinity, and scruples not, in another of its phases, to resolve the sublime truths of Revelation into a series of myths.†

This infidelity ignores (being incapable of justly estimating) the high value of the Christian element in the civilization we enjoy. Truly has it been said, that "the Bible is the seed plot of all real progress." And, when we remember the characteristics of pagan civilization, as manifested in the slavery and oppression of the masses, the per-

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* "Shall we be told of the unaided science of Rome, of Athens, of Babylon, and of Egypt? But who can tell how large a measure of straggling rays from Revelation mingled in their philosophy? How little could the blinded reason of man have discovered, had it been left altogether to its own resources! Could we take away from Great Britain all that she owes to the Bible, we should throw her back into the darkness and barbarism of her pagan days."—*Rev. Hugh Stowell, M.A., Honorary Canon of Chester Cathedral.*

† Archbishop Whately remarks, "that it is important to lay down the PRINCIPLE on which either the Bible, or any other writing or speech, ought to be studied and understood, viz., with a reference to *the object proposed* by the writer or speaker. Now," he continues, "the object of the Scripture Revelation is to teach men, not astronomy or geology, or any other physical science, but RELIGION. Its design was to inform men, not *in what manner* the world was made, but WHO made it; and to lead them to worship Him, the Creator of the heavens and the earth, instead of worshipping His creatures, the heavens and earth themselves, as gods, which is what the ancient heathen did."

mitted indulgence of vice, the total absence of all those noble charities which, from the very foundation of the Christian religion, have existed in order to show its spirit of love to all men, we may well rejoice that we live in the days of a Christian civilization.

It is the mission of Great Britain to bear this civilization to all lands, and we believe that her scientific progress, and her increasing commerce, will be made subservient to the same glorious purpose.

The Bishop of Ripon has justly said, "The efficacy of Christianity has been abundantly tried. We can point to results which it hath already produced, as sustaining all that we have affirmed of what it is adapted to effect. We can speak of its well-attested power to civilize the barbarous, to humanize the brutish, to enlighten the ignorant, to disenthral the superstitious, to scatter blessings without number wheresoever she finds a home: hopes, which philosophy could never kindle, have been awakened by her voice; vices, which philosophy could never curb, have been effectually repressed; sorrows, which philosophy could never soothe, have been abated and staunched. Science and commerce have never so flourished as when cultivated beneath the influence of this religion. Christianity has been tried of old in the schools of philosophers, and the lamp of human philosophy flickered and grew dim before the light which she gave. Once let Christianity pervade the whole earth, and this would be coincident with the moral amelioration of all the disorders and calamities of the world. The globe, in being everywhere Christianized, would be everywhere civilized, and everywhere morally elevated and blest."

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