**Address of the Duke of Argyll, F.R.S.**

BRITISH ASSOCIATION

FOR

THE ADVANCEMENT OF SCIENCE.

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GENTLEMEN OF THE BRITISH ASSOCIATION,

KNOW, Gentlemen, that the duty of presiding over this Meeting of the ttish Association for the Advancement of Science, has been assigned to mainly in consequence of my local connexion with the district and City in iich we are now assembled. It cannot therefore be departing from the ccial duty of that position, if I address you in the first place as one of those o are receiving the honour of your visit. I am sure I cannot express in ms too warm the feelings of this great community. It would be strange eed if Glasgow did not hold out to you a cordial reception. Here, if rwhere, we have reason to honour Science, and to welcome the men whose es are devoted to its pursuit. The West of Scotland has itself contributed a few illustrious names to the number of those who have enlarged the ndaries of knowledge, or have given fruitful application to principles eady known. I need not dwell on the fact that it was in this valley of the yde that the patient genius of Watt perfected the mechanism which first ve complete control over the powers of steam; and that it was on these ters too that those powers were first applied in a manner which has given v wings to commerce, and is now affecting not less decisively the terrible erations of war. These are but single examples, more striking and palpable n others, of the dependence of the Arts upon the advance of Science. is, however, is a dependence which I am sure the citizens of Glasgow uld be the first to acknowledge, and which no doubt, with them as with men, must be an important element in the value which they set upon sical research. But I am sure I should deeply wrong the intelligence of people of Glasgow, if I were to represent them as measuring the value of nce by no other standard than its immediate applicability to commercial poses. They seek to honour science for its own sake, and to encourage desire of knowledge as in itself one of the noblest instincts of our nature. t is my duty also, Gentlemen, to speak on behalf of a special body—one of ich Glasgow has so much reason to be proud—I mean its ancient and vene- le University. If the mechanical arts owe to this district of Scotland, the

greatest impulse they have ever yet received, it is not less true that our knowledge of the laws which regulate the pursuits of industry, and determine the distribution of the "Wealth of Nations," has been almost founded on the researches of one whose name is indissolubly associated with this seat of learning. Here again we have an illustrious example of the mutual relations between science and politics in its best and highest definition. But indeed our convictions are independent of such examples. It is impossible to appreciate too highly the influence which science is evidently destined to have on the prospects of education, and we look for the time when its methods, as well as its results, will form the subject of teaching, not only as partially it has long done in our Colleges, but also in the humblest of our schools. I feel it to be no small privilege arising out of the Academical Office which this year I have the honour of holding, to be able to assure you on behalf of the University of Glasgow of the deep interest with which we regard your visit, and of our high appreciation of the ends which it is your object to promote.

It is now fifteen years since the last Meeting of the British Association here. There are probably few even annual meetings of any considerable body of men, which are not marked by some melancholy recollections. Still more must this be the case after the lapse of so long an interval,—one which measures, as is usually reckoned, full half a generation in the life of man. Among the many vacancies in your ranks which that period has occasioned there are some which, from local association or from other causes, are naturally impressed more deeply on the mind than others. I am sure that one venerable name will rise to the memory of all who took any interest in the proceedings of 1840;—of one whose early tastes for natural science had only yielded before his devotion to a yet higher service; but whose powerful mind still sought to found all his efforts in the cause of religion and humanity on obedience to the eternal laws, which are as sure and steady in their operation over the minds of men, and over the progress of society, as are other laws over the subjects of material change. Who can forget the zeal and more than youthful eagerness with which Dr. Chalmers entered into the discussions of the Statistical section; and how he saw in those discussions the means of spreading the knowledge of principles which are of vital interest to the welfare of the State?

But that name, though the lapse of years has not carried it beyond the region of regret, is one with which we have at least become familiar as belonging to the number of the departed great. Such is not the case with other vacancies, and especially with one which is still affecting us with almost bewildered sorrow, and an abiding sense of irreparable loss. Who shall take up the torch which has fallen from the hand of Edward Forbes? Who shall hold it as he held it to those dark places in the History of Life which Science is striving, perhaps in vain, to penetrate, but which seemed already opening their treasures to his fine and advancing genius?

But whilst sad recollections are thus forced upon us as regards the life of individual men, we have every reason to be satisfied with the inheritance they have left. Many labourers are gone, but the cause in which they

coured has been steadily gaining ground. Long as fifteen years may be a period in human life, it is generally but a fraction in the history of ntal progress. Yet since the last Meeting of the British Association here, m greatly mistaken if we cannot mark great strides in the advance of ence. I wish, Gentlemen, you had a President more competent than I am chronicle that advance, and direct the retrospect to a practical and useful l. There are, however, some features so remarkable that I cannot omit erring to them, as well calculated to raise our hopes and stimulate our rtions. In that science which is the oldest and most venerable of all, I an Astronomy, if there had been nothing else to mark the progress of covery, the construction and application of Lord Rosse's Great Reflector uld have been enough to constitute an important epoch. Its systematic rrations may be said to be still only in the first stages of their progress; already how often do we see reference had to the mysterious revelations it made in discussions on the principles of that science, and in not a few of the culations to which they are giving birth! My distinguished friend Sir D. wster, in his recent Life of Newton, has designated that telescope as "one he most wonderful combinations of art and science which the world has seen." All who are interested in the devotion of abilities, of means and eisure to the noblest pursuits, must earnestly wish to see Lord Rosse arded by that which he will value most, the steady progress of discovery. ust always be remembered, however, that Astronomy is a science of which erto at least it might almost be said that one great genius had left us no e worlds to conquer; that is to say, he carried our knowledge at a bound one grand, and apparently universal law, to which all worlds were subject, of which every new discovery had been but an additional illustration. reign of that law, whether universal or not, was at least so wide, that we never pierced beyond the boundary of its vast domain. For the first time e the days of Newton a suspicion has arisen in the minds of astronomers we have passed into the reign of other laws, and that the nebular phæno- a revealed to us by Lord Rosse's telescope must be governed by forces erent from those of which we have any knowledge. Whether this opinion or be not well founded—whether it be or be not probable that our ted command over time and space can ever yield to our research other law of interest or importance comparable with that which has ady been determined—still, inside that vast horizon there are fillings-in fillings-up which will ever furnish infinite reward to labour. Of these a few have been secured since our last meeting here. Besides the patient k of our professed Astronomers, and the good service rendered by such as Mr. Lassell and Mr. Nasmyth, who have so well relieved the business ommercial industry by their devotion to the pursuits of science, we have one event so remarkable that in the whole history of Astronomy it stands e. If in looking at the wonderful objects revealed to us in Lord Rosse's scope, we turn instinctively sometimes from the thing shown to the thing h shows—from the Spiral Nebulæ to the knowledge and resources which collected their feeble light, and brought their mysterious forms under

the cognizance of the human eye, how much more curiously do we turn from the single planet Neptune, to that other instrument which has *felt*, as it were, and found its obscure and distant orbit! So long as our species remains, that body will be associated with one of the most glorious proofs ever given of the reach of the human intellect;—of the sweep and certainty of that noble science which now honours with enduring memory the twin names of Adams and Leverrier.

In Geology, the youngest, but not the least vigorous of the sciences, every year has been adding to the breadth of its foundation—to the depth and meaning of its results. Probably no science has ever advanced with more rapid steps. In 1840 the then recent publication of the "Silurian System" had just established those landmarks of the Palæozoic world which all subsequent discovery has only tended to confirm. The great horizons which were first defined by the labours of Murchison and Sedgwick have since disclosed the same phænomena which they so accurately described, in every quarter of the globe; and the generalizations founded thereupon have been definitely established. The same period has sufficed, partly by the labours of the same distinguished men, to clear up the relative position of the strata which represent the closing epochs of ancient life, and those which form the base of the secondary age. But above all, the last few years have seen immense progress made in our knowledge of that vast series of deposits which usher in the dawn of existing forms, and carry us on to those changes, which, though the most recent, are not the least obscure of any which have affected the surface of the globe. The investigations of Edward Forbes on the laws which determine the conditions of Marine Zoology, have supplied us with data altogether new on some of the highest conclusions of the science; whilst his profound speculations on the centres of creation and areas of distribution have pointed out paths of inquiry which are themselves of inexhaustible interest, and hold out the promise of great results. Another branch of investigation, which, if not entirely new, is at least pursued on a new system, and with new resources, has been opened up in Dynamical Geology by the learning and ingenuity of Mr. Hopkins; whilst the thorough elucidation of the conditions of Glacier Motion, which we owe to Professor James Forbes of Edinburgh, has given us clear and definite ideas on one, and that not the least important of the agents in Geological change. The observations accumulated during the recent Arctic voyages have materially added to our knowledge of the operation of the same agency under different conditions—conditions which we know must once have extended widely over the firths and estuaries near where we are now assembled—leaving behind them those enduring records of the Glacial epoch which were first explored by my friend Mr. Smith of Jordan-hill. We owe many important observations on the same phænomena, and on the various changes of sea-level, to Mr. Robert Chambers. And if the thanks of Science are due to those who advance her interests, both directly by adding to her store of facts, or of her discovered laws; and also indirectly by investing them with popular interest, and thus enlarging the circle of observers, we must mention with special gratitude the classical works of Mr. Hugh Miller; and those writings of Sir Charles Lyell, which his indefatigable industry is

er bringing up abreast with the progress of discovery—a progress stimu-
ted in no small degree by his own exertions,—and which are alike remark-
le for completeness of knowledge, for fertility of suggestion, and for sound
ilosophical reasoning. I think we cannot mistake the general tendency of
eological research, whether Stratigraphical or Zoological. It has been to
olong periods which had been considered short; to divide others which
ere classed together; to fill up spaces which were imagined blank, and to
nnect more and more in one unbroken chain the course of physical change
d the progress of organic life.

We pass from geology by a natural transition to another science which
nds to it in close alliance. If all our most sure conclusions respecting the
perficial covering of the globe have been founded on the classification of
animal remains, it is not less true that our knowledge and understanding
organic structure have been infinitely extended by the means which geo-
y has afforded of studying that structure in relation to its history in past
ne. In the hands of our great countryman, Professor Owen, Physiology
s assumed a new rank in science, leading us up to the very threshold of
e deepest mysteries of Nature. If the last few years had been marked by
other event in the advancement of science, there would have been enough
signalise them in the publication of his treatise on the "Homologies of
e Vertebrate Skeleton:" and we may recollect with pride the fact of that
gh argument having been first opened at a Meeting of the British Asso-
tion.

A sad interest, indeed, attaches, in one direction at least, to the progress
our knowledge in Geography. All serious doubt seems to have closed now
er the grave of Franklin. Even in a year during which war has been
iming the noblest victims by thousands and tens of thousands, it would ill
come this Association not to mark with an expression of our sorrow and
miration the self-sacrifice of that gallant band which has perished in the
use of science. But their devotion has been emulated, under a still higher
mulus, in the more successful career of others: and at last in the discovery
the North-West Passage (still so-called in spite of its having been found
passable), the courage and endurance of Captain M^c^Clure and his asso-
tes have ascertained with certainty a most remarkable fact in the physical
formation of the globe. Results of still larger, and certainly of more im-
diate interest are being arrived at by the rapid march of African explo-
ion,—not, surely, before the time. Every part of the *circumference* of
t vast continent has been either known or accessible to us for centuries.
its soil have flourished some of the most ancient and famous monarchies;
one of its great valleys is the fatherland of science. Yet up to com-
atively recent times our horizon there has been bounded by the same
ds or mountains which bounded the knowledge of antiquity, and we had
ost as little acquaintance with its interior as had the Tyrian mer-
nt when his eye rested of old on the Peaks of Atlas. Nothing but fami-
ity with the fact could have reconciled us to the ignorance in which we
e so long remained of one of the largest and most interesting regions of
world. That ignorance is at last being cleared away; and the exertions

of many individuals, amongst whom the names of Mr. Galton, of Mr. Anderson, Dr. Livingston, Dr. Baikie and Dr. Barth, stand conspicuous, have contributed results of the deepest interest and importance. No man who values science can fail to appreciate the extension of our knowledge respecting geography even where, as in the Arctic regions, that knowledge is pursued simply for its own sake. But it becomes invested with tenfold interest when it brings with it the largest influence on the destinies of millions of the human race; and adds, as we may confidently hope it will ultimately do in the case of Africa, an inexhaustible field for manufacturing and commercial enterprise.

In connexion with the diffusion of geographical knowledge I cannot omit to mention the magnificent publications of Mr. Alexander Keith Johnston of Edinburgh, in his Atlas of Physical Geography. It is seldom that such a mass of information has been presented in a form so beautiful and attractive; or one which tends so much to place the study of geography on a truly scientific basis—that is to say, on the basis of its relation to the other natural sciences, and those grand cosmical views of terrestrial phænomena which have found their most distinguished interpreter in Baron Humboldt.

The kindred science of Ethnology has received of late years great development; not only by its increasing store of facts, but by the more scientific use which is being made of facts which have been long familiar. The investigation of the laws which regulate the growth of language, promise to cast the most important lights on the history of our race; but the conclusions to which that investigation may lead are still matters of keen and anxious controversy, and are exposed to all that suspicion which has been directed against almost every science at some stage or other of its growth; and which, we must allow, every science has, at some stage or other, justified by hasty generalization and premature deduction.

Of all the sciences Chemistry is that which least requires to have its triumphs recorded here. The immediate applicability of so many of its results to the useful arts has secured for it the watchful interest of the world; and every day is adding some new proof of its inexhaustible fertility. There is one department of inquiry, and that perhaps the most interesting of all, I mean Organic Chemistry, which has received an especial impulse during the last few years, an impulse mainly due to the genius of one distinguished man whom we have the honour of numbering among our guests upon this occasion. I think Baron Liebig will find in Scotland that kind of welcome which a man of science values most,—a readiness to profit by his instructions, and an enlightened appreciation among the farmers of the country of the practical value of studying in their husbandry the laws which have been revealed by his research. I am reminded, through the kindness of Dr. Lyon Playfair, of some facts which give yet a more special interest to this subject in connexion with our meeting here. It was to the British Association at Glasgow in 1840 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

e manures which are valuable for their ammonia and mineral ingredients; d especially to guano, of which in 1840 only a few specimens had ap- ared in this country. The consequence was that in the next year, 1841, less than 2881 tons were imported; and during the succeeding years the tal quantity imported into this country has exceeded the enormous amount 1,500,000 tons. Nor has this been all: Chemistry has come in with her d to do the work of Nature, and as the supply of guano becomes exhausted, nited as its production must be to a few rainless regions of the world, the portance of artificial mineral manures will increase. Already considerable pital is invested in the manufacture of superphosphates of lime, formed by e solution of bones in sulphuric acid, the use of which was first recom- ended at the last Glasgow Meeting. Of these artificial manures not less an 60,000 tons are annually sold in England alone; and it is a curious ample of the endless interchange of services between the various sciences at Geology has contributed her quota to the same important end; and the uviæ and bones of extinct animals, found in a fossil state, are now, to the tent of from 12,000 to 15,000 tons, used to supply annually the same ferti- zing materials to the soil. The exertions of Professor Daubeny of Oxford on e same important subject, and the continued attention which he has de- ted to it, have done much for the cause of agricultural chemistry in Eng- nd; whilst the thanks both of practical and of scientific men are due to r. Lyon Playfair, and Professor Gregory of Edinburgh, for those admirable anslations of Baron Liebig's works, which have rendered them accessible to ery English reader; and have thereby had no unimportant influence in ttending the knowledge of the laws affecting both vegetable and animal ysiology.

I am indebted to the same quarter for the mention of one remarkable in- ance of the manner in which—to use Dr. Playfair's words—"the over- wings of Abstract Science pass into and fertilize the field of Industry." ne of the newest and most obscure subjects of chemical research has been e discovery of certain conditions under which bodies, like in their com- osition, are nevertheless endowed with unlike properties, and thereby come convertible to new purposes. It is in the application of this rinciple that a gentleman of this city, Mr. James Young, has succeeded in btaining the illuminating principle of coal gas either in a solid or liquid ate; and it has proved to be a substance of immense value for the lubrica- on of machinery, vast quantities of it being now manufactured and sold for at purpose.

I hardly know whether it is strictly in connexion with the advance of emical knowledge that I ought to remind you of one great discovery made ng since we last assembled here;—I refer to the discovery of the effects of loroform on the animal system; one which claims for my friend Dr. Simp- n of Edinburgh a high place indeed among the benefactors of mankind. hloroform as a mere chemical composition had indeed been known before, d had been made the subject of elaborate research by the distinguished rench chemist, M. Dumas, whom we have here the honour of receiving as guest. But the discovery of its application is not the less a triumph of

science, and of the best and highest scientific faculties. Seldom indeed has that disposition of mind which is ever ready to receive a chance suggestion, and to pursue it believing what great things we have yet to learn, been crowned with a more brilliant and direct reward.

It marks the growing sense entertained of the value of Statistical research, that, during the late session of Parliament, a committee of the House of Lords sat for a considerable time on the best means of securing a complete system of Agricultural Returns. We owe much in this matter to the exertions of the Highland Society of Scotland, and, as has been specially recorded by the committee, to the zeal and activity of their able secretary, Mr. Hall Maxwell. We owe not less, also, to the high intelligence of the farmers of Scotland generally, who have rendered every assistance in their power, and that with a willingness which can only arise from an enlightened appreciation of the great objects to be gained by the inquiry.

No one has rendered more important service to Statistical science, in one of its most interesting departments, than the able Chamberlain of this city, Dr. Strang. His periodical Reports on the Growth and Progress of Glasgow are among the most curious and useful records of the kind which have been published in any part of the United Kingdom. I need hardly say that they supply materials for much reflection on many questions connected with the social welfare of the people. I believe Dr. Strang has lately visited Paris, with a view to communicate to this Meeting of the Association various facts connected with the great improvements which are in the course of progress in that city. Should his investigations cast any light on the best means of improving the dwellings of the labouring classes in the great centres of population, and on the possibility of doing so on a large scale, by public authority, he will have rendered no small service to his country in a matter of vital interest and of much difficulty.

Closely connected with the subject of Statistics, as applied to Agricultural returns, I am happy to say that, mainly owing to the exertions of Sir J. Forbes of Fettercairn, and of Mr. Milne Home, a Meteorological Society for Scotland has been established, warmly seconded by the Highland Society. The wonderful results on a great scale which have been obtained in this department of science by Lieut. Maury of the United States, give us ground to hope that even on the small areas of individual countries, where of course, from the crossing of local influences, the general result is infinitely complicated, some approach may be made towards ascertaining the laws which regulate the seasons.

The admirable agency which is now afforded by the Kew Committee of this Association, for the verification of instruments, and by the new meteorological department of the Board of Trade under Capt. Fitzroy, for the reduction of local observations, will, I trust, be taken advantage of by the new Scottish Society. I cannot help congratulating the Association on the position which has been secured by science in connexion with both of these establishments. The thanks of the commercial as well as of the scientific world are due to Colonel Sabine and the other members of the Kew Committee, whose assistance is now highly appreciated by practical men, and

agerly sought for by the best instrument-makers; whilst Capt. Fitzroy's ffice and duties are in themselves an acknowledgement of no small im- ortance of the public value of systematic observation.

The increasing employment of iron in ship-building has brought into cor- esponding notice the uncertainty which attends the action of the compass n board vessels of that construction. This important and intricate subject as been treated of by Mr. Archibald Smith of Jordan Hill, with all the re- ources of his high mathematical and scientific attainments, in publications hich have appeared under the sanction and with the recommendation of e Admiralty. It will not fail to interest this great commercial city, whose eights are on every sea, that this question was taken up at the last Liver- ool Meeting by Dr. Scoresby, that it has continued to occupy his close ttention, and that he intends to communicate to this Meeting of the Asso- iation some of the valuable results of his investigations.

Feeling deeply, as I do, my own inability to give anything like an ade- uate sketch—even in outline—of the progress of science during the last w years, I remember at the same time with some satisfaction, that it is less e business of this Association to boast of the achievements which have ready been effected, than to devise means of facilitating those which are t to come. You have appointed a Parliamentary Committee for the con- deration of one important branch of this inquiry. We shall doubtless hear om my noble friend Lord Wrottesley those recommendations which have en the result of its recent labours, and which will be found to owe much his enlightened zeal, to his great knowledge and his sound judgment. In e meantime, I trust I may be allowed to make a few general observations what appear to me to be some of the best means of promoting in this untry the advancement of physical science.

It will readily be understood, that, in referring for a moment here to the l which may be afforded by the State to the advancement of science, I vest myself entirely of any official character other than that which belongs me as your President, and that I seek to give expression to my own inions only.

I am not one of those who are disposed to look to public authority as e primary or the best supporter of abstract science. In the main it must pend for its advancement on its own inexhaustible attractions,—on the light which it affords us to study the constitution of the world around , and to endeavour to understand, though it be but darkly, how the ins of its government are held. Nor am I disposed to indulge in any mplaint on a matter which has lately attracted some attention among ientific men. In a great manufacturing country like ours, the dispo- ion of whose people is eminently practical, it is perfectly natural that eater attention should be bestowed on the arts than on the abstract ences. This, indeed, is but adhering to what has been hitherto at least e natural and historical order of precedence; for it is a just observa- n of Professor Whewell, in his lecture on the results of the Great Exhi- ion of 1851, that practice has generally gone before theory—results have en arrived at, before the laws on which they depend had been defined or

understood. Art, in short, has preceded science. But it is equally important to observe, that in recent times this order has been in numberless instances reversed. Abstract science has gone ahead of the arts, and the conduct of the workshop is now perpetually receiving its direction from the experiments of the laboratory. Perhaps the most wonderful discovery of modern days—that of the Electric Telegraph—was thought out and perfected, so far as its principle was concerned, in the closet and the lecture-room, and flashed ready-made on the astonishment of the world. In chemistry, the lead taken by abstract science in reacting on the arts is manifest and constant; and in a greater or less degree the same result is appearing in connexion with every branch of physical research. The interest, therefore, of the State, even if it be considered merely in this economic point of view, in the encouragement of abstract science, is obvious and immediate. And there is this additional motive to be remembered: the moment any result of science becomes applicable to the arts, the unfailing enterprise of the commercial and manufacturing classes takes it up and exhausts every resource of capital and of skill in giving to that application the largest possible development. But so long as science is still purely abstract, it has often to be prosecuted with slender resources, and specially requires fostering care and a helping hand. But I rejoice to believe that the conviction of this truth is sensibly gaining ground. The foundation of the geological museums both in England and in Scotland, and the carrying out of a complete geological, concurrently with a geographical survey, by public authority and at the public expense, were great steps in the right direction. Another such step was the investment of £1000 annually in aiding experimental research, through the agency of the Royal Society, which undertook the trouble of its special allocation. It is the intention of my noble friend, Lord Palmerston, to bring the principle of some expenditure in this direction specially under the notice of Parliament for the future; and it is worthy of remark, as illustrating how far a small sum may go in aid of abstract science, and how cheaply the largest and most fruitful results may thereby be attained, that, as I have been informed on very high authority, this apparently trivial sum has been felt as a most important help in numberless instances, sometimes in the conduct of experiments, sometimes in the publication of their results, and sometimes in securing accurate artistic delineations.

The relations now established between the Board of Trade and various branches of scientific investigation are such as lay the foundation for further progress in the same direction. I am happy to say that, in connexion with the new national museum which is being organized for Scotland, there is to be a special branch devoted to the industrial applications of science; and that a new Professorship—one which has long existed in almost all the continental universities—that of Technology—has just been instituted by the Government. I am not less happy in being able to announce that to that chair Dr. George Wilson has been appointed. The writings which we owe to the pen of Dr. Wilson, and especially his beautiful Memoirs of Cavendish, and of Dr. Reid, are among the happiest productions of the Literature of Science.

I trust also that the aid of the State may be secured in providing a house

d home for the scientific bodies in the metropolis. I am disposed to agree th those who attach no small importance to this consummation. When e Royal Society alone adequately represented all or nearly all who were gaged in physical science, that great body fulfilled all the necessary con- tions of a scientific council. But now, when almost every separate division science has a separate society of its own, it has become almost indispen- ble that some new arrangement should be come to, in order that abstract ience may have that degree of organization without which its interests will ver receive the public attention which they ought to have.

The influence, if not the authority of the State, may also, I think, be most neficially exerted on behalf of Science, through the educational rules and inciples of administration of the Privy Council. But the Committee of ouncil, in the adoption of those rules, is necessarily governed to a certain tent by the feelings and opinions of the various churches and bodies which e the primary supporters of our existing educational system. In the last eport of the Council of the Geographical Society, they announce a com- unication from the Committee of Privy Council, requesting the Society to ppoint an Examiner in Geography, to be associated with other examiners other branches of education. It may be well worthy of consideration, hether the same expedient might not be usefully adopted in reference to her branches of science, which have hitherto formed a less admitted part ordinary instruction.

And this, Gentlemen, brings me to say, that the Advancement of Science ppends, above all things, on securing for it a better and more ac- nowledged place in the education of the young. There are many signs at the time is coming when our wishes in this respect will be fulfilled. hey would be fulfilled, perhaps, still more rapidly, but for the operation obstructing causes, some of which we should do well to notice. How ten do we find it assumed, that those who urge the claims of Science e desirous of depreciating some one or more of the older and more sacred anches of education! In respect to elementary schools we are generally posed, as aiming at the displacement of religious teaching; whilst in spect to the higher schools and colleges, the cudgels are taken up in half of classical attainments. A remarkable example of the influence these feelings will be found in a speech delivered by Lord Lyndhurst uring the late session of Parliament. With all the power of his digni- ed and commanding eloquence he asserted the right of the elder studies their time-honoured pre-eminence; and in the keen pursuit of this gument even he was almost tempted to speak in a tone of some deprecia- on of those noble pursuits in which the University of which he is a distin- uished ornament has won no small portion of her fame. But surely no nlightened friend of the Natural Sciences would seek to challenge this naginary competition. Perhaps, indeed, like other zealous advocates, we ay have sometimes overstrained our language, and have thereby given such antage-ground to prejudice, that it has been enabled to assume the form of st objection. We cannot too earnestly disclaim the idea that the know- dge of physical laws can ever of itself form the groundwork of any active

influence in morals or religion. Any such idea would only betray our ignorance of some of the deepest principles of our nature. But this does not affect the estimate which we may justly put on an early training in the principles of physical research. That estimate may be not the less a high one, because it does not assign to science what belongs to other things.

There is one aspect in which we do not require to plead the cause of science as an element in education, and on that, therefore, I shall not dwell. I mean that in which certain applied sciences are recognized as the essential bases of professional training: as, for example, when the engineer is trained in the principles of mechanics and hydrostatics, or the physician in those of chemistry. Of course, with every new application of the sciences to the arts of life this direct influence will extend. But what we desire, and ought to aim at, is something more. It is, that abstract science, without special reference to its departmental application, should be more recognized as an essential element in every liberal education. We desire this on two grounds mainly; first, that it will contribute more than anything else to the further advancement of science itself; and, secondly, because we believe that it would be an instrument of vital benefit in the culture and strengthening of the mental powers.

But, as regards both these great objects, we must remember that much will depend on the manner in which elementary instruction in science is conducted; on the conception, in fact, which we entertain of what science really is. Nothing can be easier than so to teach science as to feed every mental vice or weakness which obstructs the progress of knowledge, or blinds men to every evidence of new truths, in self-satisfied contemplation of the few they have already ascertained. May we not illustrate this by the effect which has not seldom been produced by the scientific education of professions? It is true, indeed, that professional men have often enlarged the field of science by the discovery of new and important truths. Some of the strongest-armed pioneers of science have been of this class. But how have their discoveries been too often received by their professional brethren? How many of them have been assailed by every weapon in the extensive armoury of prejudice and bigotry! How many of them have had their name recognized only after it had been written on the grave! and over whom we might well repeat the noble lines—

> . . . . . Now thy brows are cold
> We see thee, what thou art, and know
> Thy likeness to the wise below,
> Thy kindred with the great of old.

What we want in the teaching of the young, is, not so much the mere results, as the *methods*, and, above all, the *history* of science. How, and by what steps it has advanced; with what large admixture of error every new truth has been at first surrounded; by what patient watchings and careful reasonings; by what chance suggestions and happy thoughts; by what docility of mind, and faith in the fullness of Nature's meanings; in short, by what kinds of power and virtue, the great men, aye, and the lesser men of science have each contributed their quota to her progress; this is what we

ght to teach, if we desire to see education well conducted to the great ends view. It is not merely for the sake of investing the abstractions of science h something of a living and human interest, that we should recall and re- e these passages in her history: nor is it merely to impress her results ter on the memory, as we fill up from biographies and other sources of ormation, the meagre page of the general historian. It is for something re than this. It is both that they may be more encouraged to observe ure, and that they may better understand how to do so with effect. It hat they may cultivate that temper of mind to which she most loves to eal her secrets. And as regards those whose own opportunities of obser- ion may be small, it is that they may better appreciate the labours of ers; and may be enabled to recognize, in the midst, perhaps, of much ex- vagance, the tokens of real genius, and in the midst of much error the den sands of truth.

It is one of the many observations of Sir C. Lyell which have a much der application than that to which they were specially directed, that the stake of looking too exclusively to the grand results of geological change, l of referring them too readily to sudden agencies of tremendous activity l power, tended to check the advance of that science, by discouraging bits of watchfulness over those operations which are contemporary with selves, and the secret of whose power is to be found in the lapse of time. effect precisely analogous is produced on the progress of science as a cole by a similar method of regarding it. And even when the history of t progress is attended to at all, there is a natural disposition to look back a few great names among the number of its chief promoters, as Beings co, by dint only of some unapproachable superiority of intellect, have ght us all we know. It is true, indeed, there have been a few such men; t as there have been periods of sudden geological operations, which have heaved at once stupendous and enduring monuments. But even in re- ect to those great men, it will often be found that at least one great secret their power has lain in virtues which might be more common than unfortu- tely they are found to be. That openness and simplicity of mind which ever ready to entertain a new idea, and not the less willing that it may be ggested by some common and familiar thing, is one of the surest accom- niments of genius. But it is clearly separable from extraordinary intellec- l power, although, where both are found together, the great results pro- ced are too often attributed to the more brilliant faculty alone. Professor hewell, in his most interesting History of the Inductive Sciences, whilst precating the degree of attention which has been paid to the well-known ory respecting the origin of Newton's thoughts on gravitation, has never- eless stated, with his usual clearness and precision, the essential truth ich the traditions of science have done well to cherish. Those who have en competent to judge of the calibre of Newton's mind, of its powers of re abstract reasoning, have with one voice assigned it the highest place in e records of human intellect. Doubtless, it was those powers which enabled m to *prove* what otherwise would have remained conjecture. But it is not e less important to observe, that the suggestion on which these powers were

called to work was one eminently characteristic of a mind where simplicity and greatness were indeed synonymous. That the celestial motions, about which so many wonderful facts were then already known, and which had been referred to so many mysterious and imaginary forces, should be indeed identical in kind with the motions which took place close beside him, and that the same rules should be applicable to each, this was an idea in which, to use Dr. Whewell's words, "Newton had no forerunner." We do not need to compare the relative importance of those qualities of mind which are indicated in the first conception of such an idea, and of those other faculties which could alone crown it with demonstration, and add it to the number of established truths. For the attainment, by a single individual, of results so grand and so complete as those which were reached by Newton, each was necessary to the other. But characteristics, which were in him united, have not the less had their separate value when divided in other men; and it cannot be too often repeated, that habits of wakeful observation on the commonest phænomena of nature are often alone enough to yield a rich harvest to the man of science, and to crown his labours with an immortal name. This has been a result of continual recurrence in the progress of knowledge. It is the expression and evidence of a truth of equal importance in the moral and the physical world, that the common things which surround us in our daily life, and many of which we do not really see, only because we see them too often and too familiarly, are governed by principles of infinite interest and value, and whose range of application is wide as the universe of God.

And this brings me to say a word on the value of instruction in Physical Science, not merely with a view to its own advancement, but as in itself a means of mental training and an instrument for the highest purposes of education. It is in this latter point of view that its claims seem to be least admitted or understood. We may bear an exception made in favour of the exact sciences, which involve the application of Mathematical knowledge, since this has been long recognized as requiring the highest intellectual exertion; but with regard to other sciences, how often do we hear them condemned as affording "mere information," and as tending in no sensible degree to strengthen and invigorate the mental powers! But, again I say, this would entirely depend on how Science is to be taught—whether by a mere cramming of facts from manuals, or by explaining how and by whom former problems have been solved,—what and how vast are other problems yet waiting for, and capable of solution. And even where the researches of Physical Science can do little more than guide conjecture, or illustrate merely what it cannot prove, how grand are the questions which it excites us to ask, and on which it enables us to gather some amount of evidence! In Geology, is it true, or is it not true, that "we can see no trace of a beginning —no symptom of an end?" To what extent, and in what sense are we yet entitled to say, that there has been an advance in organization as there has been advance in time? In Physiology, what is the meaning of that great law, of adherence to type and pattern, standing behind as it were, and in reserve of that other law by which organic structures are specially adapted to special modes of Life? What is the relation between these two laws; and

any light be cast upon it, derived from the history of extinct forms, or m the conditions to which we find that existing forms are subject? In getable Physiology do the same, or similar laws prevail,—or can we trace eers, such as those on the relations between structure, form and colour, of iich clear indications have already been established, in communications ely made to this Association by Dr. M'Cosh and Dr. Dickie of Belfast? (Chemistry, how is it that some of the most powerful actions escape our est analyses? In Medicine, what is the action of specifics? and are there more discoveries to be made such as rewarded the observation of Jenner, he almost total extinction of a fearful and frequent scourge? It is in refer- ee to such great questions, and ten thousand others equally interesting and portant, that the pursuits of science call forth the highest activities of the nd, and exercise every power of thought and reasoning with which it has en endowed.

Indeed it may fairly be questioned whether those sciences which are called ct, are necessarily the best preparation for the actual business of the world. s the rare exception, and not the rule, when exact and perfect demonstration comes applicable to the affairs of life. In general, men have to balance ween a thousand probabilities, and to take into account a thousand con- ting tendencies. Surely there can be no training better than that which ches us by what careful inductive reasoning—by what separation between manent and accidental causes,—by what constant reference from the pre- t to the past, and from the past back again to the present, our existing wledge has been attained in the paths of physical research. It is true, eed, that where men's passions and prejudices are much concerned, no unt of teaching will ever induce them to follow or attend to the best thods of arriving at the truth. But even where there are no such dis- bing causes, where moderate and candid men are expressing their sincere victions, how constantly do we hear them ascribing effects to causes, iich the slightest habit of correct reasoning would have been sufficient to miss! In questions of great social or political, as well as of philosophical portance, the want of such habit is often most painfully apparent, and ves in no small degree to retard the progress of mankind. The necessity considering all questions with reference to fundamental principles or laws, l these again with reference to the disturbing causes which delay or sus- d their operation, the mode of weighing evidence, and the degree of value be attached to that which is of a merely negative kind—these are things which we are perpetually reminded in the pursuits of science; and these ely are no useless lessons, whether in religious, social, or political affairs.

And then there is another consideration of no small importance. As ence has now come to a stage in her progress, when she heads the Arts, flings back upon them her reflected light, so also has she now reached a ree of development, which casts some rays forward on questions of higher ort than those which she can fully answer. It is in vain that we try to w definite lines between the Physical and the Metaphysical,—between the ular and the Religious. There is a felt relation between the laws which ain in each—such indeed as we might expect to find in provinces of a

universal empire. The consequence is, that in every speculation on those higher questions on which men will and must speculate—in every system of Philosophy, whether ancient or modern, they draw not merely their illustrations, but not a few of their conclusions from science, or from that which passes by the name. If, therefore, her discoveries, and above all, her methods and her history be but partially and superficially understood, the popular mind will be a perpetual prey to the most specious forms of error. But that history teaches caution. It is full of warning as well as of example. In being a history of the progress of knowledge, it is a history also of the obstructions which Knowledge has encountered, and an index of those to which she is still exposed. The influence of opinions and theories preconceived,—of rash conclusions, and of false analogies, has been, and still is, a perpetual source of danger. So much is this the case, that we soon learn to receive with extreme caution the inferences drawn by men of science from the facts they may bring to light, wherever these inferences touch upon other departments of knowledge. The relation in which a new fact or law stands to others is seldom at once rightly understood. It is only through fightings and controversies of every kind that it gradually finds its place; and becomes, not unfrequently, an instrument in defence of truths which at first it was supposed to sap and undermine. I do not mean to say that the full meaning of the discoveries of science is always brought to light. Far from it. It would be more true to say that their ultimate meaning is never reached; and that for every question which Science answers, she propounds another which it is beyond her powers to solve. But in this we may see the strongest of all arguments against our entertaining any fear of science, as regards the interests of religion. It is sometimes proudly asked, who shall set bounds to Science, or to the widening circle of her horizon? But why should we try to do so, when it is enough to observe that that horizon, however it may be enlarged, is an horizon still—a circle beyond which, however wide it be, there shine, like fixed stars without a parallax, eternal problems in which the march of science never shows any change of place. If there be one fact of which Science reminds us more perpetually than another, it is that we have faculties impelling us to ask questions which we have no powers enabling us to answer. What better lesson of humility than this—what better indication of the reasonableness of looking to a state in which this discrepancy shall be done away; and when we shall "know, even as we are known!"

But, Gentlemen, I have already detained you too long, and occupied your time far less profitably than it would have been occupied by many who are present on this occasion. The hospitality of this great city will afford you, I trust, a pleasant, and your own exertions will secure a profitable, Meeting. You may well engage in its business and discussions, with a sense of the high interest and value of your pursuits—not less interesting in themselves, —not less conducive to the progress and happiness of mankind,—not less tasking the noblest faculties of the mind, than those which engross the attention of jurists, of soldiers or of statesmen, when their motives are the purest, and their objects are the best.