greatly add to the interest excited; it would assist people to understand what they see, and tend to the destruction of that languid curiosity so painfully evident in the faces of sightseers. The contents of one case would serve for one or two lectures, and those who listened would necessarily carry away a few new ideas.

We have been viewing the question solely from its popular side, being convinced that it is of great importance; other plans may occur to the reader, and may be well worthy of ventilation.

HENRY ULLYETT

Colour

SINCE the publication in NATURE of my paper on "Colour," I have received several inquiries for references on the subject. These I should have given at the time, only that I wrote away from books; perhaps on the principle of "better late than never," the publication in NATURE of the following selection may save trouble to some interested in the matter.

Helmholtz: "Ueber die Theorie der zusammengesetzten Farben;" "Poggendorff's Annalen," lxxxvii. p. 45; "Philos. Magazine," (4) iv. p. 519.

Maxwell: "Experiments on Colour perceived by the Eye, with Remarks on Colour Blindness;" "Edinburgh Transactions," xxi. p. 275.

Maxwell: "On the Theory of Compound Colours, and the Relations of the Colours of the Spectrum;" "Phil. Trans.," 1860.

Maxwell: "Account of Experiments on the Perception of Colour;" "Phil. Mag." (4), xiv. p. 40.

Müller: "Zur Theorie der Farben;" "Pogg. Ann" vol. 139, p. 411.

These are the principal original memoirs. Of books on colour there are very few that can be trusted. Benson's "Principles of the Science of Colour" is recommended by Prof. Maxwell. There is also a tolerably complete exposition of the subject in Helmholtz's "Physiologische Optik," of which excellent work a French translation has, I believe, been published.

Have any of the readers of NATURE tried a double image prism for exhibiting the mixtures of two colours? By the aid of a Nicol the proportions of the components may be varied at pleasure, and the combination is, in my experience, more effective than the plate of glass referred to in the books. However, on account of the texture of the coloured papers or wafers, the mixture is not so perfect as that obtained by rotation.

J. W. STRUTT

A Hint to the Longsighted

A SMALL optical expedient which has been of service to me may be new to some of your readers, and useful, on occasion, to those among them whose sight is as long as my own. The focal length of the convex lens I require for my right eye in reading is twelve inches, and I find that by holding a lens of 30-inch focus about a foot from this eye I am enabled to see distant objects not only with singular distinctness, but also perceptibly magnified. I can read moderate-sized print at the distance of twelve feet, and make out the details of a church tower half a mile off nearly as well as with a small opera glass magnifying two and a half times. The greater the distance of the lens from the eye the greater is the magnifying power; but beyond a certain point (depending on the focus of the lens and the distance of the object) the gain is more than neutralised by the loss of distinctness with eyes that deviate but slightly from the normal standard, the lens employed must be so weak that the gain is inappreciable.

I presume that a lens thus held at a distance from the eye, like the German "Stöpfel Linse" described by Sir John Herschel, "realises the notion of Descartes as to the mode of action of a telescope, which he regarded as an enlargement or prolongation of the eye. For the natural cornea we substitute an artificial one, which is more remote from the retina, and so forms there a larger image."

W. T. RADFORD

Lignite and Selenite

WILL you kindly allow me to inquire whether any of your readers can inform me if there exists any connection between lignite and selenite when found together, and, if so, in what way the lignite assists in the formation of the crystals of calcium sulphate.

I have recently found selenite in three or four different places, and in each case associated with lignite, viz., in the Bracklesham Beds near Stubbington, in the Woolwich Beds at Dulwich, and in ochrey clay near Lewisham Chalk Pits.

June 19 AN AMATEUR

Arctic Auroras

IN answer to your inquiry, I send you the following information on a Northern Light observed at Kooltook, S.W. end of the Baikal Lake, by Dr. Dyhoffsky. It is taken from a source doubtless not at your disposition (Bulletin of the Siberian section of the Geographical Society, 1871, No. 2):—

"On October 24 (1870) evening a northern light was observed at Kooltook. It began at 9 P.M. with a red light, which appeared more and more distinctly from behind the mountains that border the landscape on the north. It was a little towards the east from the magnetic meridian. This light now increased in the form of a column, now diminished, and at times seemed to vanish entirely. After nearly an hour of such waverings, the light gradually began to increase and get broader; at midnight it reached its utmost intensity and development.

"Its least limits on the horizon were included between N. 59° E. and N. 45° W. Six columns were distinctly visible at midnight, reaching half the distance between the horizon and the zenith, the middle column was the brightest and highest, but at the same time the narrowest, and bordered with reddish-yellow. The other columns were less brilliant but far broader. When the middle column decreased, the western one began to increase, though it never reached the intensity of the middle column. The other columns also increased and diminished by turns; then the phenomenon gradually fainted away, and at three o'clock there remained but a ruddy light, which now, as at the beginning, was brighter towards the east of the meridian."

The same aurora was observed at different localities of Europe.

P. KROPOTKINE

Catherine Channel, Petersburg, May $\frac{13}{25}$, 1871

Day Auroras in the Arctic Regions

I CAN now answer Dr. Burder's question regarding the appearance of the Aurora Borealis in the Arctic Regions. The other evening (last Thursday) I had a conversation with a distinguished magnetician and Arctic explorer, and he informed me that he has often seen the Aurora in *broad daylight* in those regions, the colour invariably being crimson. This, I hope, will once for all settle the apparently vexed question (*pace* Dr. Burder) of "alleged" daylight Auroras. Not to repeat the entire "crusher" of Dr. Burder's, I think many will now discard as "unworthy of serious criticism" his cirrus-cloudy arguments. He must pardon me for being so unceremonious, and remember his own interesting way of confuting—or, better, his attempt.

JOHN JEREMIAH

SCIENCE IN PLAIN ENGLISH

I.

IN tracing the development of public opinion, no period is more instructive than the last three hundred years; and at present the review is particularly important, for we seem to be in a position analogous to the state of Europe just before the Revival of Classical Learning. We are evidently on the eve of great changes in principle, and one vital question is to consider the value of classical culture as compared with the study of science.

The distinctive work of the thirty years (1820-1850) was to "diffuse useful knowledge" among the middle classes. Beside the establishment of mechanics' institutions throughout the country, the London University was founded in 1828; and the British Association for the Advancement of Science held its first annual meeting at York on September 27, 1831, under the presidency of Earl Fitzwilliam.

Another agency has been brought into action, more especially directed to the practical arts, and bringing into friendly competition the various nations of Europe. The International Exhibition of 1851 had a remarkable in-

fluence upon the application of science and art to trade and manufactures, calling forth a memorial from the leading manufacturing and commercial towns as to the importance of establishments for instructing workmen in the principles of science and art, on which their respective industries depend. It was stated that unless this was speedily done the country would run serious risk of losing that position which hitherto had been its strength and pride.

This foreboding was confirmed by the Exhibition at Paris in 1867, which showed an advance made by Continental nations even in some departments in which England had been considered supreme. The conclusion was received with surprise in some quarters, and vexation throughout the country.

There was no doubt that remarkably rapid progress in manufactures had been made by some of the Continental nations; and this rapid improvement was attributed, in a great measure, to the scientific training of proprietors and managers in France, Belgium, Germany, Switzerland; and to the elementary instruction which is universal amongst the working population of Switzerland and Germany. The facilities for acquiring a knowledge of theoretical and applied science are incomparably greater on the Continent than in this country; and that knowledge is based on an advanced state of secondary education.

Hence, a great effort has been made to obtain similar advantages of education for this country, in order that we may retain the position which we now hold. There can be no doubt that scientific training has become a question no longer admitting of delay; and a demand has arisen for Technical Education, by which we are to understand scientific and artistic education, with a view to improvement in industry.

To promote this object, several educational reforms have been suggested; and first of all, that in the universities and grammar schools instruction in science and art should be placed on the same favourable footing as other studies. Only one-third of the boys in the great public schools go to our universities; and therefore, two-thirds pass directly from the schools to enter upon the various pursuits of life. Now there are two methods of education. One gives a youth direct preparation for his future pursuits; the other trains the mind by processes which are not directly adapted for any worldly career, but which are supposed to strengthen the intellectual faculties.

The latter object is pursued in classical education, which is defended upon the ground that, though it does not provide special instruction for the useful purposes of the world, it still furnishes general culture. No one can deny that classical education supplies excellent training in certain directions; but there is a growing conviction that, for the practical purposes of life, the classics have been tried and found wanting; that, while they serve for ornament and for delight, they are not "good for life."

But even with a view to culture, we should not overlook the importance of Science in mental training. Science, properly taught, is one of the best means of educating the highest faculties of the human mind. By proper teaching, however, we must understand, not merely instruction in the facts of science, but discipline in the methods of science. Mere head-knowledge may do a man very little good; it is the habit of mind, the training in method, that determines the character of the man. Hence, the minds of the young should be imbued with scientific principles and trained in scientific methods.

A twofold advantage is asserted by scientific advocates: that as science has now reached so high a stage, it may be used as a means of the best mental cultivation; while, at the same time, it communicates a kind of knowledge which may be made practically useful in every walk of life.

A movement has already been made in some quarters, but sparingly, not to say grudgingly. Some schools have admitted science on about equal terms with dancing, that is to say, they give one or two hours a week to it. Or they may even admit it on equal terms with French; but it is generally made quite subordinate; and while classics are rewarded with high honours, science receives few distinctions. At Harrow the teaching of physical science has been introduced, but has not yet been made part of the regular curriculum; boys are not obliged to learn physical science, though they may get prizes for it. The most difficult point in this part of the subject is where to find suitable masters for the teaching of science. This, no doubt, must be a work of time; but if the demand springs up, the supply will follow.

But beside the demand for a reform in the institutions already existing, there is a general conviction that scientific and technical schools are required in all the great centres of industry; that such schools ought to be established; that we must have "Technical Education." In many districts those who desire to send their own sons or the sons of their better workmen for instruction in science, are unable to carry out their views because no suitable schools exist in their neighbourhood. There are numerous grammar schools in different parts of the country, but many of them were founded in the two centuries which followed the Revival of Classical Learning. Consequently, they are generally under the influence of classical traditions; and a comparatively small proportion of the boys are learning the physical or natural sciences.

The fact is that technical schools cannot be permanently supported unless we diffuse a taste for science and art. If we create the taste, the technical schools will be well filled. We must introduce the elements of science and art into the primary schools, and we shall soon change the secondary education of the working men.

It too often appears that, from the utterly defective education of the people, they do not know what is good for them, and have not the slightest conception of the methods that should be taken to improve their present ignorant and imperfect condition. In some instances so deplorable is the state of elementary education that it is found impossible to give the working classes the instruction which they desire to receive in the sciences connected with their work. They are not able to read with sufficient facility to master the books put before them; they cannot write well enough to take notes of the lectures which they hear; nor are they sufficiently familiar with arithmetic to make the necessary calculations. Hence it results that one of the first difficulties in promoting technical instruction is the want of fundamental training as the basis of scientific knowledge.

The learned will have to revise the method of teaching. There is a well-founded suspicion that the course commonly pursued has been wrong in principle. The teachers proceeded from generalities, constructed very pretty systems, and dealt largely in refinements. Many people now believe, on the contrary, that we ought to begin with individual instances, then lead the pupil to construct a broad outline, and gradually to fill up the picture as his knowledge advances.

Or take another illustration. If a man works his way up the mountain side he meets with many difficulties, but at length, when he reaches the top, he enjoys a fine prospect all around. Now, if that man wishes to guide others up the mountain, it is not sufficient for him to harangue from the top, or to dilate upon the fine prospect which he enjoys. He must come down again to the valley; he must take others by the hand, and lead them by the way which he took himself, or very nearly by the same way.

Until recently elementary treatises on science were written *from the top of the mountain*. The authors, enjoying an expanded prospect, were disposed to take general views; and to discuss principles which, however interesting to themselves, had little or no interest for

the pupil. There was a want of sympathy with the learner. For example, the writers on Geography began with the globe, and expounded the elements of Spherical Trigonometry and Astronomy, talking of *meridians*, *parallels*, the *tropics*, the *equator*, and the *ecliptic*. At present the best teachers of geography *to young children* begin with the place where the pupil lives and dwells; thence they proceed to the surrounding districts, to neighbouring countries, and end with the Globe.

Bacon says that "wherever it is possible knowledge should be *insinuated* into the mind of another in the manner in which it was first discovered." If this principle were fairly carried out it would work great changes in our methods of teaching.

WILLIAM RUSHTON

Queen's College, Cork

MOSS LOCHS

AS these lochs are seldom visited save by sportsmen of either the rod or the gun, it will be necessary for me to give a short description of them. These lochs are generally situated high up, near the tops of the hills, the hills being wholly or in part covered with heather and moss. They are of small size, varying from about a mile to a hundred yards in length; the water is of a dark porter colour. They look as if an immense hole had been dug in the peat, and the hole then filled with water; the banks, which are wholly or in part composed of peat, rising almost perpendicularly out of the water, and at some places extending downwards for many feet under it; at other places going only to a depth of a foot or two, and then extending for some feet in a nearly horizontal direction, when they again dip abruptly to a considerable depth. These abrupt precipices of peat, as seen under the water, are often formed in curious, fantastic shapes, and look more like rock than soft peat; and when seen by the sunshine—broken by the passing waves– through the dusky water, with the surroundings of bleak, bare hill, total silence, save the plaintive cry of some bird passing overhead, and no life, save the lizard and the snake—the whole presents a scene, the weird effect of which on the imagination is seldom if ever exceeded by anything else in nature.

What strikes the observer of these lochs is, that not only are the banks made of peat, but the sides and bottom are wholly or in part made of the same material; and there seems to be no difference between the peat at the bottom of the loch and that on the banks. It looks exactly like as if the peat had begun to be formed at the bottom of the loch, and had gradually extended upwards till it had risen above the water. Yet it could not have done so, because, although water-lilies and some grasses are seen growing under a depth of a foot or two of water, yet all vegetation ceases at a depth of a very few feet. How then came the sides and bottom of these lochs to be formed of peat? There are no signs of any convulsions of nature after the peat had been formed to account for it. If produced by any upheaving of the earth stopping the exit of the water, the upheaving must have been very violent, because many of these lochs are deep and yet of but small size. How, then, came the peat in the position in which we now find it? An examination of the outlet will at once explain the difficulty. The stream which leaves the loch winds its way through mossy ground, the bottom of its channel being covered with water plants. These water plants, as they grow from year to year, are gradually filling up the channel, and so adding to the depth of the loch. It is now easy to understand how peat is found at such depths in these lochs. We will suppose the loch to begin from marshy ground or from a small loch. The channel of the outlet—being covered with water plants—gradually gets filled up, so increasing the depth of the water in the lake, while vegetable life is busy adding peat to the banks. And thus marshy ground or a shallow loch with shelving beach is converted into a deep moss loch with perpendicular sides. The rising of the channel of the outlet and of the sides does not always take place at the same relative rate. In one loch recently visited the peat bank was about eight feet above the water, whilst in another where there was a vigorous growth of water plants in the outlet, the water was within a few inches of being over its banks. That water plants are capable of producing this result will be doubted by none who have seen them fairly establish themselves in a pond, how soon they over-run, and, if left alone, fill it up.

Moss lochs stand in marked contrast to other lochs. In other lochs the water, as it passes from them, has worn their channels, and is year by year wearing them further, so lowering the water in them; whilst in moss lochs the channels are year by year being filled up, so gradually raising the water in them. It may be objected that the water plants in the outlet would be uprooted by the water from the loch during floods; but such is not the case, because in most cases, when the water leaves the loch, it passes through a nearly level channel, so that it never gets up speed sufficient to damage its bed. And besides, these lochs being situated near the tops of the hills, they drain but a small extent of country. In no case visited had any of the lochs a stream of any size running into it, and the amount of water which passed from them was in every case small.

As there are few rules without exceptions, it is possible that the rule that the outlets from moss lochs are covered with water plants may not hold good in every case; it is quite possible that the outlet from a moss loch might be over a rocky channel. If such should happen to be found, it does not necessarily prove that it was not formed in the way shown. The plants might continue to fill up the outlet till the water was raised to such a height that it found a passage over a new channel at a part of the hill where there was no moss and nothing but bare rock. We would thus have a moss loch grown in the way shown, but which had ceased to grow.

JOHN AITKEN

WRITERS ON SCIENCE

AT the recent dinner of the Royal Literary Fund, Sir Henry Anderson proposed the toast of "Writers on Science." We make the following extracts from the reply by Dr. Richardson from the report of the Society:—

"Who are the writers on science? Are they as well known as other great writers? They are not. They are less fortunate, and, therefore, the more worthy of the exceptional honour you would bestow on them. Excuse me a moment or two while I indicate the peculiarities of the position of the writer on science. He is a man communicating to the word that which is, by comparison, new to the world. The poet can cast back for his models to a time when the Greeks had not so much as the figment of an alphabet. The theologian may go back for his lesson to the earliest manifestations of the life of intellect on the planet. The historian finds subject and matter ready for his hand from the oldest and remotest, as well as the newest, writings and traditions of races and peoples. The story-teller is embarrassed with the richness of the past, and troubled by the greed of his admirers for more of his work. These all, indeed, are but the continuing interpreters of things, events, thoughts, which every man who claims to read claims also to understand. The writer on science has none of these advantages; he is but newly born into an old world of thought, and is not simply telling of new wonders, but is often himself learning at the same time as he is instructing an audience unlearned in his knowledge. Thus he comes slowly into the recognised