of Irish existence as to work a gradual change in the national character, is a question of much interest, but too large to be discussed just now. In any case we can scarcely expect the results of centuries upon a national type to be reversed in less than a succession of generations.

Still confining myself to the past, let me point again to the very marked qualities which the conditions of their existence have produced in the people of the United States. They started with a large element of English energy already ingrained into them; they have been reinforced by millions of emigrants presumably of more than the average energy of the various races which have contributed to swell the tide. Added to this, the Americans have enjoyed the natural stimulus of a practically unlimited field for colonisation. Only the resolute, self-reliant settler could hope to prosper in the early days of their national existence; and self-reliance approaching to audacity is the special type of character which on the Darwinian hypothesis we should expect to see developed, transmitted, and increased. How far this accords with actual experience, no one can be at a loss to say. There is probably not a nation in the world whose peculiarities might not be traced with equal ease to the operation of the same universal principle. And the moral of the investigation is this: Whenever a law is sufficiently ascertained to supply a full explanation of all past phenomena falling within its scope, it may be safely used to forecast the future; and if so, then to guide our present action with a view to the interest and well-being of our immediate and remote descendants. Read by the light of Darwinism, our past history ought to solve a multitude of perplexing questions as to the probable supremacy of this or that nation in times to come in the field of commerce, as to the effects of emigration and immigration on the ultimate type likely to be developed in the country that loses and in that which gains the new element of national life, and many another problem of no less interest to ourselves and to humanity.

The subject I have thus slightly indicated seems to me to deserve a closer investigation than it has yet received: and, strange as it will sound to the ears of politicians, I cannot doubt that, in this and other ways, statesmen, if they could open their eyes, might derive abundant aid from the investigations of science, which they almost uniformly neglect and despise. H.

THE PROGRESS OF NATURAL PHILOSOPHY

[We have been favoured by Professor Tait with the following extracts from his Introductory Lecture to his class at Edinburgh University, the object of the Lecture being "to show that Natural Philosophy is a *real* science, as tested by steady growth and progression, compared with other so-called Philosophies, which have periodic cycles, and come back after a generation or two into the old, old groove, with the same old rope of sand to be spun over again."—ED.]

TO enumerate in detail all the advances effected in natural philosophy during even the past year would take more time than is usually devoted to a lecture, so that I shall confine myself to a mere mention, not exposition, of a very few of the more interesting discoveries in cosmical science which have recently been made.

First. We have obtained an immense amount of new information as to the constitution of the sun. The total eclipse which was visible in India in the autumn of last year, was singularly well fitted for applying to the strange phenomena of the sun's atmosphere the comparatively novel powers of the spectroscope. Another total eclipse has recently been carefully observed in America, and the results obtained on these two occasions agree well with one another.

One of the most marked phenomena observed in a total solar eclipse is that which, first carefully described some thirty years ago, was called the "red flames;" very singular protuberances issuing apparently from the dark body of the moon, but which were conclusively proved in 1860 to belong to the sun. Had they been lunar phenomena, their dimensions would have been considerable; but it is easily shown that, belonging to the solar atmosphere, their dimensions are *enormous*, a hundred thousand miles being often no exaggerated estimate of their diameter. They must evidently be masses of extraordinary tenuity, else they could not rest in the solar atmosphere, which must be excessively rare at such an elevation. When the spectroscope was directed to them last year, it was at once perceived that they are fiery clouds, consisting mainly of hydrogen gas, heated so powerfully as to become self-luminous. This discovery once made, the total eclipse was seen to be unnecessary, and observations of these singular phenomena are now carried on every day. In fact, in anticipation that such would prove to be their nature, they had actually been sought for before the date of the eclipse. The reason why we can see them, in spite of the comparatively overwhelming light of the sun, is simply this, that the sun's light, which may be said roughly to consist of rays of all degrees of refrangibility, can by a sufficient number of prisms be spread over any desired extent, and thus weakened throughout; while the light from the red flames consists of but a few perfectly homogeneous rays, which may be indefinitely separated from one another, but cannot be individually weakened, by increasing the power of the spectroscope. The process, in fact, closely resembles that by which, with powerful telescopes, astronomers are enabled to observe stars in the day-time. The powerful telescope diminishes the apparent brightness of the sky; but the star has no sensible diameter, and remains undimmed. A singular fact observed is, that while the bright rays in these red flames, which are due to hydrogen, correspond exactly to well-known dark lines in the solar spectrum, due to absorption by the sun's atmosphere; there are others, especially a curious one in the yellow, which have no counterpart among the dark lines. Also the hydrogen lines are sometimes broader, sometimes narrower, than the normal spectrum of incandescent hydrogen requires; sometimes they are slightly displaced from their normal positions in the spectrum. The explanation (on purely physical grounds) of all these phenomena is now being carefully sought, and the connection of the red flames with sun-spots, as well as the singular peculiarities of the spectra of spots, are being recorded for future explanation. In this one direction alone a field has been opened up for inquiries which, even with our present appliances for observation, may well occupy the world for a generation to come.

Another striking phenomenon of a total solar eclipse is the (so-called) Corona of whitish light which appears to surround the dark body of the moon to a considerable angular distance. This also has been proved to belong to the sun. Part of its light is, no doubt, merely sunlight reflected from the matter of the sun's atmosphere, or from cosmical bodies revolving about the sun; for it has long been known to be partially polarised. But it is only within the last few months that *its* spectrum also has been observed, and found to consist mainly of bright lines—*i.e.* of a few rays of definite refrangibility. The positions of the most marked of these have been measured, and they are found to correspond with those of the light of terrestrial auroras! This is one of the most startling results yet obtained by observation; for the aurora is intimately connected with, or at all events has an important effect on, terrestrial magnetism, and it has been known for some time that disturbances in the sun have a marked effect on the magnetism of the earth.

Our sun is a variable star. It has been proved that its spots have an eleven-year period of maximum frequency. Laborious calculations are now in progress at Kew Observatory, with the view of tracing the cause of this periodic effect; and it seems already to be traced with some certainty to the planets, principally to Mercury, Venus, and Jupiter; the first, though very small, being very near, and the last, though very distant, being very large. Now, the red flames, or hydrogen clouds, are intimately associated with sun-spots. Hence we connect *their* frequency with the variability of sunlight. Now, it is only a year or two since an exceedingly well-marked case of a temporary star was visible in the northern hemisphere; a star, usually of inconsiderable magnitude, scarcely visible to the naked eye, suddenly blazed out with brightness rivalling that of Sirius. The spectroscope showed that it owed this increase of its light almost solely to incandescent hydrogen, the chief material of the flame-cloud that hovers over a *solar* spot.

Nor is it only in solar and stellar phenomena that these extraordinary recent advances have been made. Bodies even more puzzling and anomalous than the sun and stars are common enough in the universe. Many nebulæ, long imagined to be immense groups of stars, at such enormous distances that the several constituents were indistinguishable by the most powerful telescopes, have been shown to shine as glowing gas merely, rendering it probable that we have to deal with objects which, though certainly at vast distances from the earth, are probably not vastly farther away than some of the nearest stars. Possibly, in some cases, they may be much nearer, in which case they may be suns which have cooled, and are still surrounded by glowing gas, due to the impacts of small cosmical masses, or meteorites, on or near their surface. Or they may be vast systems of small cosmical masses in the act of grouping themselves by mutual gravitation, impact, and friction into a new star, the incandescent gas being due to the impacts and the friction. In them we may be actually watching the formation of a solar system.

Finally, let us consider what we have recently learned about comets—bodies which have hitherto puzzled the astronomer quite as much as have the nebulæ. Several ingenious speculations have recently been published on this very interesting subject, but I shall only mention one with any detail. There seem to be good grounds for imagining that a comet is a mere shower of stones (meteorites and fragments of iron). This at least is certain, that such a shower would behave, in its revolution about the sun, very much as comets are seen to do, and that, as we have reason to believe is the case with comets, it would be drawn out after a few revolutions, if it described a closed path, so as to be spread over the greater part of its orbit. If the earth, then, were at any time to intersect the orbit of the comet, it would pass through a stream of such stones, all moving approximately in parallel lines and with equal velocities. On entering the earth's atmosphere with the enormous relative velocity due to revolution about the sun in differently sized orbits, described sometimes with a retrograde motion, these fragments of stone would, by the laws of perspective, describe paths all apparently diverging from one point in the heavens, and these paths would be rendered visible by the incandescence of the meteorites due to friction of the air. Now this is exactly what we see, markedly in August and November every year, less definitely at other fixed periods. And the orbits of the August and November meteorites have been determined, and found to be identical with those of two known comets. I cannot enter very fully into this most interesting subject now, but I may say a few words more in explanation. Unfortunately, since spectroscopes have been in everybody's hand, no notable comets have appeared. [How strange it *now* seems to us that the magnificent comets of 1858 and 1860 were allowed to pass without having been looked at through a prism by anyone, whether as a matter of chance or of curiosity!] Such small comets as have been observed have given *continuous* spectra from their tails, so far as could be judged with regard to an object so feebly illuminated. This, then, it would appear, is simply reflected solar light. The heads, however, give spectra somewhat resembling those of the nebulæ I have just mentioned—the spectra of incandescent gases. This is quite consistent with the descriptions given by Hevelius and others of some of the grander comets; which presented no peculiarities of colour in the tail, but where the head was blueish or greenish. Now these appearances are easily reconciled with the shower-of-stones hypothesis. For the nucleus, or head, of a comet is that portion of the shower where the stones are most numerous, where their relative velocities are greatest, and where, therefore, mutual impacts, giving off incandescent gases, are the most frequent and the most violent. This simple hypothesis explains easily many very striking facts about comets, such as their sometimes appearing to send off *in a few hours* a tail many hundreds of millions of miles in length. Wild notions of repulsive forces vastly more powerful than the sun's gravity have been entertained; bold speculations as to decomposition (by solar light) of gaseous matter left behind it in space by the comet have also been propounded; but it would seem that the shower-of-stones hypothesis accounts very simply for such an appearance. For, just as a distant flock of seabirds comes suddenly into view as a dark line when the eye is brought by their evolutions into the plane in which they fly, so the scattered masses which have lost velocity by impact, while they formed part of the head, or those which have been quickened by the same action, as well as those which lag behind the others in virtue of the somewhat larger orbits which they describe, show themselves by reflected solar light as a long bright streak whenever the earth moves into any tangent plane to the surface in which they are for the time mainly gathered.

It is a most valuable principle in physical science, never to be lost sight of, that we must not seek to explain by the assumption of new species of force or action any phenomena which have not been recognised to be inexplicable by means of properties of matter or motion already proved to exist. Before leaving this subject I must refer to the extraordinary fact, lately ascertained, that the spectrum of the head of one of the smaller comets is that of incandescent vapour of *carbon*, of a substance which, with the most tremendous heat attainable in our laboratories, we cannot even melt, much less reduce to vapour: so that to find its spectrum we are obliged to employ it as it exists in olefiant gas or other combined form. But it is premature to speculate further on such incomplete data as we yet possess with respect to the spectroscopic appearances of comets. It is not rash to venture the prediction that the very first application of the spectroscope to a really fine comet will give us at least as much additional insight into the nature of these bodies as the total eclipse of 1868 gave with regard to the atmosphere of the sun. P. G. TAIT

DANA'S MINERALOGY

A System of Mineralogy: Descriptive Mineralogy comprising the most Recent Discoveries. By James Dwight Dana, Silliman Professor of Geology and Mineralogy in Yale College, etc., aided by George Jarvis Brush, Professor of Mineralogy and Metallurgy in the Sheffield Scientific School of Yale College. Fifth edition, 8vo. pp. 827, figures 617. (London: (Trübner & Co.)

II.

EXCEPT in the subdivisions of the silicates, Professor Dana has adhered pretty nearly to the classification adopted in his fourth edition; which accords also in its general features, though not in its details, with that on which the minerals in the British Museum are arranged. The arrangement of the silicates in his new edition is a step that must be called tentative towards a simpler and more philosophical classification of these numerous and important salts. We certainly feel some hesitation in adopting either the terminology or the divisions Professor Dana introduces. The terms bi- and uni-silicate are not happy for the expression of oxygen ratios; not so happy, for instance, as the term singulo-silicate used for the latter by Rammelsberg, or the ortho-silicates of Odling. We own to a partiality for the view of Dr. Odling regarding the different classes of silicates, on the ground partly of the harmonious relations he introduces between these and other multibasic salts, and also from the satisfactory way in which these very important minerals group themselves as ortho-, para-, or meta-silicates. We may take another occasion for illustrating this, and pass on to Professor Dana's new and scholarlike handling of the whole question of nomenclature.

Our author has shirked no labour or odium in the way he has faced this question. That trivial names are absolutely necessary in mineralogy no one who has dealt with the subject at all philosophically will question. Even such semi-trivial terms as ferrous aluminic garnet, calcioferric or magnesio-aluminic garnet, are almost too long for use; but how should the composition of these bodies be described by names purely chemical?

Generally, therefore, we feel bound to acquiesce in the use of a trivial name for each mineral, and to subscribe to the rules Professor Dana has laid down for such names. These may be stated as the use of the termination *-ite*, except in names that have a hold on literature or use; some care in adhering to proper etymological principles in derivative names; and, finally, the law of priority of claim accorded in general, but with proper exceptions, to the first describer of a mineral. In applying these rules, Dana retains, so far as wec an enumerate them, some thirty-four names not ending in *-ite*, and changes about forty-seven of the names more or less generally received.

We cannot, however, concur in the Professor's criticism in his derivation of the spellings in all cases from the pseudo-Latin names given to metals by the chemist. Thus, to call nickeline "niccolite" and not "nickelite" is to lose sight of an essential part of the original form of a word of which, in fact, our familiar term "Old Nick" is the English shape. Surely, too, bismuth ochre should become not bismite, but bismuthite. Nor can we agree with the dismissal by Dana of the term hemimorphite, which was given to the monohydrated dizincous silicate by Kenngott. Our author reverts to the old name of calamine, between the use of which and of smithsonite, as names sometimes attached to the zinc carbonate, sometimes to the silicate, there has long existed a confusion that is best ended by the adoption of at least one new name. And Kenngott's term had at any rate this great merit, that it seized a characteristic of the crystallised silicate, by virtue of which it stands conspicuous among almost all other minerals, and certainly is distinguished from the other calamine, the character, namely, of being truly hemimorphous; that is to say, of presenting a given crystalline form all the planes that should occur on one side of a plane of symmetry, and none of the planes of that form that would, if the crystal were holosymmetrical, be met with on the other side of that plane of symmetry. We plead, therefore, strongly in behalf of Kenngott's name. As regards the merging of the term hornblende in that of amphibole as carried out by Dana, we would prefer to see the whole nomenclature of these augitic and hornblendic minerals so handled that we might have a general term for all the groups of minerals united under a common chemical type; and separate terms, still generic, that might embrace the minerals, whether of prismatic, oblique, or anorthic type, that present the kind of homœomorphism that demarks these groups. The trivial names for the different species or varieties under each group would remain nearly as they are. Now Professor Dana selects the term amphibole for the most general of these expressions, and he includes under a pyroxene sub-group enstatite (prismatic), wollastonite (oblique), and what he further calls pyroxene (oblique but homœomorphous with enstatite); and then after a spodumene sub-group he introduces an amphibole sub-group. We venture to think that the term "amphibolic minerals" used for the whole might well be made to embrace: Firstly, an augitic group, including as its members, (*a*) enstatite, with hypersthenic minerals, (*b*) diopside, with sahlite, hedenbergite, and the fassaite (aluminous varieties, (*c*) spodumene and petalite, (*d*) achmite, (*e*) rhodonite and babingtonite; Secondly, a hornblendic group, embracing as its subdivisions, (*a*) kupfferite with anthophyllite, (*b*) tremolite, with actinolite, grünerite