THURSDAY, SEPTEMBER 15, 1887.

A BATCH OF GUIDE-BOOKS TO THE NORFOLK BROADS.

Hand-book to the Rivers and Broads of Norfolk and Suffolk. By G. C. Davies. Ninth Edition. (London and Norwich: Jarrold and Son, 1887.)

The Land of the Broads. By Ernest R. Suffling. New Edition. (London: L. U. Gill, 1887.)

Three Weeks in Norfolk. By J. F. M. Clarke. (London: Wyman and Sons.)

A Month on the Norfolk Broads. By Walter Rye. (London: Simpkin, Marshall, and Co., 1887.)

Notes on the Broads and Rivers of Norfolk and Suffolk. By Harry Brittain. (Norwich: P. Soman, 1887.)

SURELY no spot in the British Isles has been so "beguided" as the Norfolk Broads. For the last twenty years the literature of the subject has been on the increase, till hardly a magazine or newspaper exists from *Blackwood* to *Exchange and Mart* which has not opened its pages to the flood of contributors on this apparently fascinating subject; and the whole has culminated in a shower of guide-books which enlivens the railway book-stalls with their gay exteriors, rendering it difficult to say which of the twain is the more largely advertised—Colman's mustard or the "Norfolk Broads." The bulk of the "articles" are of the feeblest sort by people who, having spent a few days on the Broads, returned to their distant homes imbued with the erroneous impression that they were qualified to enlighten the world with regard to the features and peculiarities of a tract of country difficult of access and still more difficult to appreciate, and the very names of whose towns and villages they had not learned to spell correctly. Some of the more pretentious productions, by the aid of excellent illustrations reproduced by various processes from photographs, and accompanied by maps, most of which have a more than family resemblance, appear to carry a weight of authority which their letterpress by no means warrants. Another feature which strikes the reader familiar with the country to which these articles refer is the supreme self-reliance of their authors; for although they contain in some instances the most barefaced plagiarisms, it is from one another that they borrow, and not from what may be termed the standard authorities on the subject, which probably some of the writers have never seen.

It is remarkable that Mr. Stevenson's general description of the "Broad District" in the introduction to his "Birds of Norfolk" (1866), perhaps the best ever written, appears to be quite overlooked, whilst the Rev. Rd. Lubbock's "Fauna of Norfolk" seems to be known only to Mr. Davies and Mr. Brittain, and of course also to Mr. Rye, who does not quote it simply because he has no necessity, owing to the plan of his book, to do so. A mere perusal of either of these two authorities would have saved some of the writers from committing what are palpable absurdities.

Mr. Davies's "Hand-book to the Rivers and Broads of Norfolk and Suffolk," first issued in 1882, and which has now reached its ninth edition, of course claims priority of notice both from its having been the first hand-book and from its general usefulness. It is needless to say that from the author's long and intimate acquaintance with the district his directions as to the best methods of procedure are all that could be desired. In reviewing the first edition of Mr. Davies's book the writer had occasion to make some observations upon the false impression conveyed by all the numerous writers on the Broads as to the supposed abundance of legitimate shooting to be had by the visitor; we are glad therefore to see that, to use his own expression, Mr. Davies has "put the break on a little" in the present edition, but we could have wished that in his remarks on "Shooting and Skating" (p. 170) he had omitted the following passage: "The usual plan is to row along the river while your dogs work through the reeds on the bank inside the river wall, or embankment, which generally runs parallel with the rivers on each side," and had confined himself to the sensible remark: "Don't take guns on board unless you have leave to shoot on somebody's land." The yachtsman may have the *right* to shoot in the navigable channel, but it is as discreditable to work with dogs along any proprietor's foreshore as it would be to do the same thing from the Queen's highway; and it is such acts as these, added to the many others which Mr. Davies schedules, which are gradually compelling the owners of the soil to assert their rights more and more stringently. We cannot agree with Mr. Davies that the disorderly conduct and depredations which are becoming more and more noticeable on the rivers are by any means "home products;" unfortunately there are some glaring instances of such improprieties by Norfolk men; but it is undoubtedly the visitors from a distance, here to-day and gone to-morrow, and who care not who may suffer for their rowdyism, who thus misconduct themselves. It has been our lot more than once to travel from London in a carriage full of young fellows bound for Norfolk for a trip on the Broads, and in each instance the gun-case and a liberal supply of cartridges has formed part of their outfit, and this probably in the close time. Their eager talk of the big bags and enormous catches of fish in prospect has often led us to wonder whether these sanguine young fellows were doomed to disappointment, or did their exuberant spirits and the joy and freedom of their untrammeled life on the water cause them to make light of such trifles as the non-fulfilment of their somewhat extravagant expectations? Big catches of fish are undoubtedly frequently made, but almost invariably by the skilled *habitué*, and very rarely by the casual visitor. Mr. Davies's book is increased from 108 to 173 pages, has twenty-three excellent illustrations and a capital folding map, and is altogether a very useful and readable book.

The second book on our list is entitled "The Land of the Broads," by Mr. Ernest R. Suffling. It originally appeared in 1885 and in a subsequent edition in a gorgeous cover, embellished by the portraits of a bird and a fish, the former a great improvement on nature, and the latter fearful to behold; a still later edition is in a prettily got up cloth cover, and the illustrations are for the most part excellent; the letterpress is also increased from 80 to 322 pages. Mr. Suffling's book is much more pretentious than Mr. Davies's, although he, like the rest of the authors we shall have to mention, has adopted the narrative form, a style excellent if accompanied by plenty of incident, but rather tame otherwise; it not only purports to be a guide-book to the Broads and rivers, but also to the principal towns and villages in their neighbourhood, and enters somewhat fully into the archæology of the district, having a special feeling for the churches. Chapters are also devoted to the Broad District in the seasons of spring, summer, autumn, and winter, the dialect and characteristics of the natives of East Norfolk, the fish, and how to take them, and a variety of other useful information. Mr. Suffling, although dating from London, claims to be a native of Norfolk, and internal evidence proves him to be no stranger to the country he writes about. His book is, therefore, free from many incongruities so jarring in similar books written by evident strangers to the places and people with regard to whom they undertake to instruct others. His chapter on the characteristics and dialect of the natives, whom we wish he would call "Marshmen," and not "Fenmen," the latter (inhabiting quite another part of the country, and of Girvian descent), a much inferior people in many respects to the hardy inhabitants of the Broads. In the introduction to the first edition Mr. Suffling asks for corrections of inaccuracies, and in the subsequent edition acknowledges that one or two errors have been pointed out to him. He will, we are sure, therefore excuse our making a few remarks which may be of service to him in a future edition. Mr. Suffling appears very loose about his natural history observations, and when he speaks of the decoys which still linger in this county (p. 28) he is altogether at sea. This is inexcusable, for, as a native of the Broads, he certainly ought to be acquainted with Mr. Lubbock's charming "Fauna of Norfolk," in which so long ago as 1845 a full explanation of the mode of working these ingenious contrivances was given, not to mention Sir Ralph Payne-Gallwey's more recent and exhaustive work on the same subject. The great essential of a decoy is absolute quiet and freedom from disturbance both inside and out; the ducks are taken by *decoying* them into the pipe, not by driving, and the dog is used for the purpose of exciting the curiosity of the fowl, which *follow* him up the pipe; it is not till they are so far up the pipe as to be hidden by its curve from the fowl that are hanging about its mouth, that the decoy-man shows himself, and then it is done in such a way as not to alarm the fowl outside the pipe which he hopes to entice later on. A boat would destroy the sport for many a day, perhaps for the remainder of the season; a dog which entered the water would be hanged at once, and decoy-ducks which rushed into the purse-net with the wild ones would be useless; their business is not to follow the wild fowl too far up the pipe, but to remain quietly on the water when the man shows himself. We cannot imagine what bird is meant by the "long-winged owl" (p. 4), which is said to be "the most destructive of its tribe." We presume *Arvancusis*, at p. 7, should be *Mastodon arvernensis*. The tools mentioned as found by Canon Greenwell, at p. 8, were not in a "barrow," but in the working of an ancient chalk-pit. The Honorary Secretary to the Yare Preservation Society will be delighted to receive contributions (p. 31) for providing river-watchers, not the Board of Conservators, a totally different body with perfectly distinct functions. The so-called "monkey house" mentioned at p. 61 is a very modern erection, built by the late Sir Robert Harvey as a ferry house, and is altogether innocent of the days of "good Queen Bess." The kingfisher is known to naturalists as *Alcedo ispida*, not *hispida* (p. 143), (surely the "halcyon days" could not have been suggestive of roughness in any sense of the word!), and the cuckoo does not turn out the eggs from the hedge-sparrow's nest and deposit a *clutch* of its own in their place, as implied at p. 217, but lays a single egg, the young one hatched from which subsequently appropriates the nest entirely to its own use by turning out the eggs or young of its foster parents. It was the father of the late Mr. Robert Rising who purchased the Horsey estate (p. 199), and the fine collection of local birds was dispersed by auction in September 1885. As to the story of the Bishop of Norwich being the only abbot left in England, and sitting in the House of Lords by virtue of that office (p. 126), Mr. Walter Rye, no mean authority on Norfolk archæology, can find no foundation for such a statement, and believes it to be "just as true as the tale that William the Conqueror besieged the place, and that a recreant monk who betrayed it to him was first made abbot and then hanged by him." There are many other little matters which might be amended in a future edition, but space forbids our referring to them.

The next book on our list is "Three Weeks in Norfolk," by Mr. J. F. M. Clarke, a book chiefly devoted to a narration of the troubles experienced by the voyagers, owing, in the first instance, to an unpunctual skipper, and subsequently to a drunken one. Mr. Clarke certainly seems to have been very unfortunate in this respect, but, judging from our experience of these men, much of the trouble may have arisen from his friend H. addressing the man "sternly, in the cold unemotional tones characteristic to him in moments of wrath," a mode of proceeding not likely to be appreciated by men of his class; probably more *suaviter in modo* would have been attended with greater success and less final loss of dignity. Doubtless yachting men will be deeply grateful for the lucid explanation of the art and mystery of "tacking," accompanied by a diagram, given at p. 13. The author tells a tale of a boy of whom he "made free to ask in a spirit of banter" what fish he had caught; the reply was, in an equally "bantering" vein, "half a last." The author remarks that as he "for the moment forgot that the 'last' meant 4000 lbs.," he was without retort, and the boy gained the day. Had our author been a Norfolk man, he would have known that a "last" is 13,200 fish. Mr. Clarke seems surprised that he should meet with a gentleman in the wilds of Norfolk. Whether Mr. Girling will recognize his own portrait or not we cannot say, for he is a modest man, but such men are happily far from uncommon in this county. Scarcely in better taste are the remarks with regard to that "tall graceful, fair, and, above all, refined" creature whom he christened "Evangeline." Such remarks could hardly be very edifying to a rustic village maid should they meet her eye; but it may interest Mr. Clarke to know that the "being so refined, with so much polish of manner, and having so good a taste in dress," and her fond mamma have disappeared from Wroxham, and we believe have left no address.

"A Month on the Norfolk Broads," by Mr. Walter Rye, is a book of quite another kind, as might be expected from so accomplished a writer. The "poet, the liar, the athlete, and the antiquary" form an exceedingly well assorted crew; and the addition of an American gentleman and his wife visiting Norfolk, whence his people originally came, "on genealogical searches intent," helps to make the fun of the voyage greater. From the first page to the last the pleasant banter never flags, and there is more real information both with regard to the topography, antiquities, and local peculiarities of the country through which they passed conveyed in this agreeable manner than in many a book of greater pretensions; whilst his specimens of the Norfolk dialect, as given in the story of the ghost of Irstead Shoals, and other passages, are really excellent. The account of "Roger's Blast," at p. 51, and the adventure with the otter (p. 53), are exceedingly clever satires on the writings of a well-known author of "Broad" books, and the *finale* of the "Ancestor Hunt" is exquisite. The writer also ventures to tell the truth with regard to the too much vaunted shooting and fishing. The trip ended, as we suspect many another has done both before and since, by the companions getting just the least bit tired of each other, and the Americans departing to the much more congenial region of Scarborough, whilst the rest of the party returned to London. The maps are very useful, although mere outlines, and the pretty little sketches by Mr. Wilfred Ball charming.

The last book on our list is "Notes on the Broads and Rivers of Norfolk and Suffolk," by Harry Brittain, with sectional maps and illustrations. Like the preceding guide-books Mr. Brittain has adopted the narrative form, and conducts the reader in a very pleasantly written journal to all the principal points of interest on the rivers and Broads, with a sea trip to the quaint old towns of Dunwich and Southwold. Altogether Mr. Brittain has contrived to embody an immense amount of information in his 154 pages, including lists of fishing quarters, distance tables, table of high water at Yarmouth Bar, and a copy of the Bye-laws of the Conservators under the Norfolk and Suffolk Fisheries Act of 1877. He has, like Mr. Davies, the advantage of being a local man and an enthusiastic yachtsman, thoroughly familiar with the country, and therefore perfectly reliable; the illustrations are excellent and thoroughly characteristic, and the sectional maps, with which the text is interspersed, will be found exceedingly useful.

Some years ago a very florid article on the Broads appeared in a magazine giving such a glowing description of the abundance of fish that pike, it was said, were actually used for manuring the land, and the shooting was not less remarkably productive. The result was that a well-known naturalist residing in Norwich was flooded with letters of inquiry as to fishing and shooting quarters in this *El Dorado* of sport. His reply was that undoubtedly both fish and fowl were there, and that at certain seasons good bags of both could be made, but that unfortunately there were people selfish enough to imagine that they had some sort of proprietary right to what was found on their own land or in their own water; and as to trespassing on the snipe grounds which surround the Broads, so little right had the public that if any unfortunate individual should chance to fall into the water he must remain there till he had written to the owner of the soil for permission to land. This is literally true, with the exceptions of the towing-paths in the navigable rivers; and visitors, whilst seeking the healthful pleasure undoubtedly to be derived from a trip on the Norfolk Broads, should be careful to respect the property and rights of the riparian proprietors.

OUR BOOK SHELF.

Connaissance des Temps, ou des Mouvements Célestes à l'usage des Astronomes et des Navigateurs pour l'an 1888, *publiée par le Bureau des Longitudes.* (Paris: Gauthier Villars.)

THIS valuable ephemeris has now reached its 210th volume in unbroken annual succession since its first publication by Picard in 1679. Its form and contents have undergone a wide development since that date, a development which is still in progress, for the present volume shows three additions on those of previous years. These are (1) the insertion of local time of the moon's transit for twenty-four successive meridians; (2) a development of the tables for transforming sidereal into mean time, and reciprocally, so as to render the performance of the calculation more rapid; and (3) the insertion of the co-ordinates of 65 southern stars, 5 being circumpolars for which ephemerides are given from day to day, the co-ordinates of the remaining 60 being supplied for every tenth day. The positions of the stars have been drawn from all the existing Catalogues, and from unpublished Cordoba observations communicated by the Director of the Cordoba Observatory, M. Thome.

A Treatise on Analytical Statics. With numerous Examples. By I. Todhunter, M.A., F.R.S. Fifth Edition. Edited by J. D. Everett, M.A., F.R.S. (London: Macmillan and Co., 1887.)

MESSRS. MACMILLAN have just issued the fifth edition of the late Mr. Todhunter's work on analytical statics, edited by Prof. Everett. In his preface the editor states that the most important changes he has made in the old matter relate to attraction, virtual velocities, and general theorems on systems of forces. He has added a brief chapter on graphical statics, a series of articles on the connexion between centres of gravity and resultants of forces at a point (with an exposition of vectors), and a new theorem on a string under a central force. The omissions include most of the articles on the attraction of ellipsoids, in conformity with the design of the book in its present form, which is intended to contain such a selection of subjects as may with advantage be studied in a first course of analytical statics.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Measurements of the Heights and Motion of Clouds in Spitzbergen.

THE first measurements, as far as I know, of the heights and motion of clouds, by the method described by the Hon. R. Abercromby in NATURE for August 4 (p. 319), and practised at Upsala by M. Hagström and myself since the summer of 1884, were made in the summer of 1883 at Cap Thorelsen in Spitbergen under the Swedish Polar Expedition stationed there, of which the chiefship as well as the guidance of the meteorological observations had been committed to me by the Swedish Academy of Sciences. Those measurements having been made by the same instruments [1] and the same method as the Upsala observations, it will perhaps interest you to see some of the results. The measurements will soon appear *in extenso* in the publication of the works of the Expedition.

Mean, greatest, and least heights of clouds at Cap Thorelsen (above the mean level of the sea).

Name of Cloud.	Number of Measurements.	Number of Clouds.	Height in metres. Mean.	Max.	Min.
Strato-cumulus	6	6	2464	3123	2032
Alto-cumulus	16	13	3229	5306	2126
Cirro-cumulus	7	3	6389	7411	5180
Cirrus	15	7	7317	8590	5676

For want of time the number of observations was rather small, but nevertheless the heights agree tolerably well with those obtained afterwards at Upsala. The mean error of a single determination of lower clouds (below 3500 metres), I have found to be 3·4 per cent. of the height of the cloud, that of a higher cloud (above 4700 metres) to be 16·6 per cent. We had two bases, but the longer one was not more than 572·6 m., as I could not, for that purpose, dispose of a greater length of wire for the telephonic line. This explains the great mean error found for the higher clouds. The greatest velocity observed for higher clouds was 27 m. per sec. at a height of 7300 m. The calculations are made by the method worked out by M. Hagström and myself in the summer of 1884, and fully described in our first paper on the subject ("Mesures des Hauteurs et des Mouvements des Nuages" in *Nova Acta* Reg. Soc. Sc. Ups., ser. iii., Upsala, 1885). NILS EKHOLM.

Upsala, August 24.

Occurrence of Apatite in Slag.

I SHOULD like to be permitted to ask whether any mineralogical readers of NATURE have themselves come across, or have anywhere seen mentioned, the occurrence of crystallized apatite in a metallurgical slag or other artificially-formed silicate?

Having recently observed such an occurrence, I have been looking into the authorities I have at hand here to see whether any similar formation is previously recorded. The result is negative, and indeed Rosenbusch ("Mikroscopische Physiographie der petrographisch wichtigen Mineralien," 1885), after enumerating the various artificial preparations of the mineral, distinctly states that "the formation of apatite from fused silicate magmas has not yet succeeded." My former teacher, Prof. Weisbach, of Freiberg, who takes special interest in artificial formations of minerals, and carefully records all cases coming to his knowledge, writes to me that he is not aware of any instance of the occurrence of apatite crystals in a slag except in the case of the "Thomas slags" of the basic Bessemer process. These can, of course, not be classed as "silicate magmas," containing as they do so large a proportion of phosphoric acid, and a relatively small amount of silica; nor do they bear any analogy whatever to the silicate rocks in which we are accustomed to observe the occurrence of apatite in Nature.

The slag in which I have observed the formation of apatite is produced during the smelting of lead ores in a blast-furnace. It is a basic silicate of lime and ferrous oxide, containing about 30 per cent. of silica. The principal "flux" used in the reduction of the ore is "tap cinder" from the puddling furnaces, and it is mainly from this source that phosphoric acid is introduced into the slag. The slag itself, in bulk, is dark brown to nearly black in colour. It flows into slag-pots of about 3 cwts. capacity, and cools slowly.

I recently prepared some thin sections of this slag for microscopic examination. The greater portion consists of a mass of crystals of olivine, surprisingly colourless and transparent considering how much iron is present. The spaces between the crystals are occupied by deep-brown and yellow amorphous slag, and black sulphides of iron, &c.

Both olivine crystals and dark amorphous matter are penetrated through and through by great numbers of apatite crystals in long needles. It is a most beautiful occurrence, analogous in every way to what one sees in rocks.

[1] The altazimuths employed were constructed by Prof. H. Mohn in Christiania for the use of the Norwegian, Swedish, and Danish Polar Expeditions.

Nearly all the apatite crystals have taken up and inclosed more or less of the amorphous dark material, which forms in the majority of cases a rod running down the centre, but there are also many cases of symmetrical arrangement of dark matter parallel to the sides of the hexagon.

The apatite does not only occur in the mass of the slag as above described; it is formed also in free crystals, lining cavities which are formed in the centre of the lumps of the slag owing to gases carried over from the furnace and liberated during cooling. Some of these cavities are of considerable size, and are often lined entirely with a thick growth of apatite needles, some as thin as the finest hair, others of much larger dimensions. I have taken out crystals over a quarter of an inch long for microscopic and chemical examination. Most of them contain a good deal of the amorphous slag, &c., inclosed, as in the case of those in the mass of the slag.

Sometimes in such cavities very beautiful little crystals of volatilized sulphides are seen among and on the apatites. I have seen galena crystals in this manner, but it is very difficult to remove them from the cavities without damage or loss.

It appears to me strange that while we have here so plentiful a formation of apatite going on constantly, in many tons of slag daily, it should still be on record that experiments purposely conducted with a view to obtaining the mineral in a silicate magma have not succeeded. W. M. HUTCHINGS.

Eversley Park, Chester, September 3.

Electricity of Contact of Gases with Liquids.

MAY I be allowed to reply to Dr. Lodge (NATURE, Sept. 1, 412)? That the escaping gas was charged was proved (1) by *collecting* it in an insulated vessel; (2) by *generating and collecting* it in insulated apparatus. Electrification resulted in the first case, but not in the second. Details of these experiments I intend to publish later.

With all possible respect for Dr. Lodge I cannot accept his explanation of the electrifications I have described. I fail to see any analogy between Armstrong's machine and the experiments with zinc and hydrochloric acid which I have made, except, indeed, that, as I hold, they are all cases of contact electricity. Sir W. Armstrong directs a jet of steam against solid wood grooved and shaped to increase the surface of contact. In my experiment, on the contrary, I find that the effect is distinctly lessened when the hydrogen passes through narrow tubes or openings, and accordingly the strongest deflections are obtained when a large open dish is used. I take an evaporating dish, 8 or 10 inches in diameter, and put a small quantity of a 10 or 16 per cent. solution of HCl into it. The acid is at every point at least 4 or 5 inches distant from the edge of the dish. When a small fragment of zinc is thrown in a gentle effervescence is set up, the hydrogen shooting straight up through the middle of the liquid into the air. I submit that in this experiment whatever electrification results is due to gas and liquid, and not to gas and solid. Moreover, after a lapse of a few minutes when a sufficient quantity of $ZnCl_2$ gets into solution, the charge on the dish changes its sign. Is Armstrong's machine also in the habit of reversing itself? On this reversal of the electrification I base my case. The dish does not vary, but the liquid does, and its variation is accompanied by a change in the sign of the charge.

With regard to the atomic charges I do *not* hold that the charge on the hydrogen has anything to do with them. It is true that at first I set out to inquire as to the equality of these charges, but when I found that the charges on the evolved gas and the generator were of opposite sign, I was constrained to admit that the electrifications were not connected with the atomic charges as I had, during the earlier experiments, supposed. Had I found things the other way—that is to say, that the charge of the gas had been of the same sign as the charge on the generator—I should not have thought it at all improbable that the electrifications were due in some way to atomic charges. In fact, at the outset this is exactly what I thought I might possibly fall upon. However, the unexpected occurred.

"But that a gas should be thus electrified strikes one as improbable." Can this be so? Surely the distinguished champion of the "air effect," who has so stoutly maintained that the contact of copper or zinc with gas gives rise to a difference of potential, cannot consider it very improbable that the contact of a gas and a liquid should produce a similar effect. Perhaps it is well to remember that the hydrogen in these experiments is in the nascent state. J. ENRIGHT.

Cocoa-nut Pearls.

REFERRING to the letter of Dr. Sydney J. Hickson, published in your paper of June 16 last (p. 157), I have the pleasure to communicate to you that I have a collection of fourteen cocoa-nut pearls (one of them I myself found in 1866 at Holontalo, North Celebes, in the endosperm of the seed of the cocoa-nut); two melati pearls (*Jasminium sambac*); one tjampaka pearl (*Michelia longifolia*), found in the flowers, according to the natives. One of the cocoa-nut pearls has a pear-shaped form, the length being 28 mm. The common name amongst the natives for this kind of pearls is mustika.

Utrecht, September 6. J. G. F. RIEDEL.

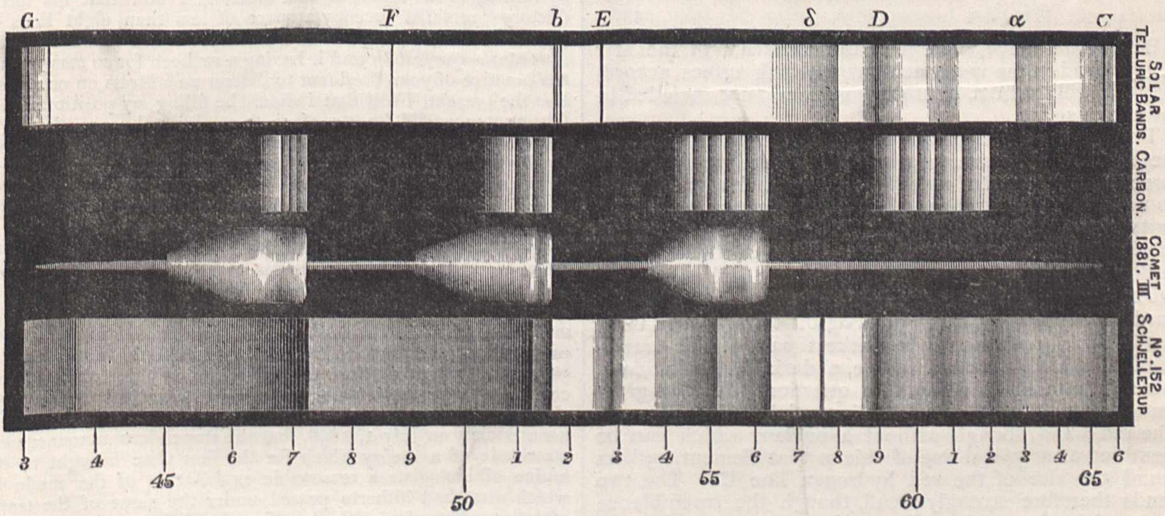
STARS WITH REMARKABLE SPECTRA.

I.

No. 152 *Schjellerup* (*D.M.* + 46° *No.* 1817).
Place 1887·0, *R.A.* 12*h.* 39*m.* 47*s.*, *Decl.* 46° 3'·5 *N.*

THIS star, No. 290 in Mr. Birmingham's Catalogue of Red Stars, may very fittingly be taken as a sample of the stars possessing spectra of the fourth type, to use Secchi's nomenclature, or of the second division of the third type, to follow Vogel's—spectra, that is, in which the prominent feature is a series of dark bands alternating with bright spaces, and in which the dark bands are, as a rule, sharp and dark on the less refrangible side, or that nearer the red, but which gradually fade away into nothingness on the more refrangible side, or that towards the violet. The present star, though not perhaps the one in which the series of bands is most completely developed, has yet a spectrum which is a very beautiful example of the type; the bright interspaces, or zones as they are technically called, are vivid and striking, and the bands broad and dark, and it possesses the additional advantage that, though only of magnitude 5·5, it is yet the brightest star of its class in the northern heavens.

The purpose of the accompanying diagram, in which the spectrum of 152 Schjellerup is seen side by side with that of Tebbutt's comet of 1881, and with a particular carbon spectrum, is to bring into prominence the meaning of the remarkable series of shaded bands which characterize it. In 1869, Secchi had declared that these bands coincided as to position with the bands of the carbon spectrum; but, as Dr. Huggins shortly after stated that he had compared the spectrum of carbon with that of a



SCALE OF WAVE-LENGTHS.

red star, and found that the two did not coincide, it was generally assumed that the Italian observer was mistaken, the well-known skill and accuracy of the great English spectroscopist rendering it very unlikely that his observation should be in error. As the event proved, both were right; it was only the natural inference that the two observations were contradictory that was at fault. Our knowledge of the beautiful and complicated spectra of carbon had not then attained its present precision, and it escaped remark that the spectrum with which Secchi had compared the red stars was not the same that Huggins had used for that purpose. Even now spectroscopists are not wholly unanimous as to whether we should regard these two spectra as both belonging to elemental carbon at different temperatures, or as belonging to two different classes of carbon compounds—those with oxygen and those with hydrogen. The spectrum which Secchi had used was that which, according to Thalén and others, characterizes the hydrocarbons; whilst Huggins used that of the oxides.

The former spectrum is one which was already of high importance to the astronomer. Huggins had shown, in 1868, by comparing Winnecke's comet with olefiant gas, that the three bright bands so typical of a comet coincided precisely with this form of the carbon spectrum; and now Dunér and Vogel have placed it beyond a doubt that in the spectrum of the red stars we see the same spectrum, only reversed—an absorption instead of an emission spectrum. The agreement as to the place of the sharp, well-marked, less refrangible edge of the three principal bands—the yellow, the green, and the blue—is exact within the limit of errors of observation; the shading-off towards the violet is similar in character, and there are indications of the presence of some at least of the secondary flutings which in the carbon spectrum follow the great leaders of the bands in so charmingly rhythmical a manner. The orange band also, placed in a fainter part of the spectrum, and so more difficult to observe, is present, there can be little doubt, in the absorption spectrum of the red stars, though its bright analogue has seldom been satisfactorily traced in the spectrum of a comet; the violet band, on the other hand, appears to have been better seen in the comet than in the red star.

The following table will show the character of the correspondence of the principal bands of the three spectra—

hydrocarbon, comet, and star. The wave-lengths are expressed in millionths of a millimetre :—

Colour of band.	Carburetted hydrogen. Thalén.[1]	Comet 1881 III. (Tebbutt's). Copeland.[2]	Comet 1881 III. (Tebbutt's). Maunder.[3]	Typical red star. Dunér.[4]	Typical red star. Vogel.[5]
Orange	618·7		"A band about half-way between C and D."	621·0	622·0
	611·9				
	605·6			604·8	606·5
	600·1				
	595·4				
Yellow	563·3	563·2	563·0	563·3	563·1
	558·3	555·4			
	553·0				
	550·0			551·0	552·0
	546·6			545·0	544·0
Green	516·4	516·7	516·3	516·3	515·9
	512·8	513·4			513·2
	509·8				
Blue	473·6	473·3	473·4	472·7	472·9
	471·4				
	469·7				
	468·2	467·5			
Violet	431·1	430·2	"A band in the violet near G."		End of spectrum. 430·0

Beside the above, there is in the spectrum of the star a faint band in the violet at λ 437·0, which agrees, according to Vogel, with a hydrocarbon band, not included in the above series.

The carbon bands thus account for the best-marked of the dark bands characteristic of the type, but there are three or four bands of a slightly different character which do not fall into the series. Thus, the green zone is interrupted by a narrow band at λ 528·0, and the yellow zone by another at λ 575·7 somewhat similar, both of which remain at present unexplained; and in the orange and red we find two bands in which the abrupt commencement on the redward side, and the gradual shading off towards the blue, is no longer apparent. The darkest part of the orange band is, indeed, near its centre, a dark line, coincident, there is scarcely any room to question, with the giant doublet of sodium, the great D lines of the solar spectrum. The red band, though without a nucleus which can be identified as a typical line of this or that element, gathers round the site of the red hydrogen line C. The two bands therefore strongly recall, though the resemblance may perhaps be a misleading one, the great water-vapour groups around C and D in the absorption spectrum of our own atmosphere. The dry-air bands a and δ—A and B being out of sight in the extreme red—do not appear to be represented. With a view to exhibit the relationship of these telluric bands to those in the less refrangible part of the spectrum of the typical red star, an outline of the solar spectrum has been added to the diagram, and the positions of the great Fraunhofer lines and of the principal bands due to the absorption of our own atmosphere have been indicated.

THE BRITISH ASSOCIATION.

SECTION D.

BIOLOGY.

Opening Address by Alfred Newton, M.A., F.R.S., F.L.S., V.P.Z.S., &c., Professor of Zoology and Comparative Anatomy in the University of Cambridge, President of the Section.

In opening the business of this Section I cannot but call to mind the last occasion when the British Association met in the city of Manchester, just six-and-twenty years ago; and, while my memory brings back to me many pleasing recollections of that gathering, I cannot help dwelling upon the extraordinary difference between the state of things that then existed and that which we have before us to-day. The moral of the contrast I shall not seek to enforce. Those, if any there still be, who despair of the future of our Association may reflect upon it at their leisure; while those who believe, as I do, that our Association has no justifiable cause for thinking that its work is accomplished, that it had better settle its worldly affairs, and compose its robes around it in a becoming fashion, before lying down to die, will at once appreciate the difference.

Yet there is one difference between our proceedings to-day and those of more than a quarter of a century since which I, personally, do not appreciate. In that remote and golden age it had not become obligatory on the President of this Section to prepare beforehand an address to be delivered to a critical, even though kindly, audience. A few words of friendly greeting to old faces, and a hearty welcome to those that were new, with a general statement of the objects of our coming together, comprised all that was expected from the occupant of the chair. Such was my case when my predecessor, who was, I may observe, my excellent friend and colleague, Prof. Babington, opened the proceedings of this Section—then called the Section of Zoology and Botany—at Manchester in 1861; and I am sure I have reason to envy his happy lot, for, on refreshing my memory by turning to the report of that meeting, I find that his introductory "remarks" occupy a space of less than eight lines of print. In this respect, but in this only, I must confess myself *laudator temporis acti*, and it having now been for so many years the practice of your President to deliver an address on occasions like the present, I feel that I should be filling my position under false pretences did I not conform to established usage, though I am well aware that what I have to say will, for many reasons, hardly bear comparison with what has been said by many of my distinguished predecessors.

But to continue the contrast of what took place in this Section at our last meeting in Manchester with what may be expected to happen now, I would remark that the year 1861 was one which, when the history of biology comes to be written, will be found to deserve particular recognition. This is not merely because of the all-important discovery of *Archæopteryx*, for that had not been made known when the Association met, and did not affect our proceedings here. When we met, it was a time, so to speak, of "slack water"; but slack water is commonly the effect of two contrary streams, and perhaps I ought to state how this came about. All present should be aware that it was before the Linnean Society on July 1, 1858, that the stupendous announcement was made of a theory which for the first time brought to the notice of biologists a reasonable explanation of the mode by which what had hitherto passed under the name of the transmutation of species could be effected. It is notorious that this announcement attracted but little attention at first, and, though it were easy to account for this fact, I see no need to occupy your time by so doing. I would, however, beg your attention to another fact which is by no means notorious. So far as I am aware, the first zoologist publicly to accept and embrace the theory propounded on that memorable evening on behalf of Mr. Darwin and Mr. Wallace, was my old friend Canon Tristram, and moreover he did this ere little more than a twelvemonth had expired (*Ibis*, October 1859, pp. 429-433). To me it will always be a matter of rejoicing that the adoption of this theory was so early accepted, and additional evidence in its favour adduced, by one who has devoted so much time and energy to the particular branch of zoology which has long recommended itself to me; for thereby I hope that the study of ornithology may be said to have been lifted above its fellows. This, however, is a digression, for introducing which I trust I may be pardoned. And now to return to my main business. Late in the autumn of 1859, as you know, Mr. Darwin's essay on the "Origin of Species" appeared—a mere abstract, as it still remains, of an enormous mass of materials industriously accumulated by him through many long years—a mass out of which, as he himself has modestly said, a competent man might have written "a splendid book"—but a mass with which he, chiefly through ill-health, had been unable to deal properly. Yet I am not sure that we have any reason to lament the result. The handy size of that celebrated little volume gave it a power of penetration and circulation that would not have been possessed by a work of greater bulk, while the studied absence of tech-

[1] "Recherches sur les Spectres des Métalloides."
[2] *Copernicus*, v. I. ii. p. 227. [3] *Observatory*, vol. iv. pp. 305, 306.
[4] "Sur les Etoiles à Spectres de la Troisième Classe," p. 122.
[5] "Public. des Astroph. Obs. zu Potsdam," vol. iv. p. 31.

nicalities and of reference to scientific authorities in the form of foot-notes (which last, I need scarcely point out, would have largely increased its dimensions) brought its closely-reasoned argument within the comprehension of hundreds whom it would have at once repelled had it been made up of learned phraseology.

Much of what followed on the publication of this work will be in the recollection of many of my audience, while the rest must have heard of it from their seniors. The ever-memorable meeting of this Association at Oxford in the summer of 1860 saw the first open conflict between the professors of the new faith and the adherents of the old one. Far be it from me to blame those among the latter who honestly stuck to the creed in which they had educated themselves; but my admiration is for the few dauntless men who, without flinching from the unpopularity of their cause, flung themselves in the way of obloquy, and impetuously assaulted the ancient citadel in which the sanctity of "Species" was enshrined and worshipped as a palladium. However strongly I myself sympathized with them, I cannot fairly state that the conflict on this occasion was otherwise than a drawn battle; and thus matters stood when in the following year the Association met in this city. That, as I have already said, was a time of "slack water." But though the ancient beliefs were not much troubled, it was for the last time that they could be said to prevail; and thus I look upon our meeting in Manchester in 1861 as a crisis in the history of biology. All the same, the ancient beliefs were not allowed to pass wholly unchallenged; and one thing is especially to be marked—they were challenged by one who was no naturalist at all, by one who was a severe thinker no less than an active worker; one who was generally right in his logic, and never wrong in his instinct; one who, though a politician, was invariably an honest man—I mean the late Prof. Fawcett. On this occasion he brought the clearness of his mental vision to bear upon Mr. Darwin's theory, with the result that Mr. Darwin's method of investigation was shown to be strictly in accordance with the rules of deductive philosophy, and to throw light where all was dark before.

Now the reason why I have especially mentioned this essay of Prof. Fawcett's is not merely that the approval of the disputed theory by such a man did not a little contribute to the success which was then impending, but because I have for a long while maintained that, as a matter of fact, what is now known as the Darwinian theory did not, except in one small point, require a naturalist—and much less naturalists of such eminence as Mr. Darwin and Mr. Wallace—to think it out and establish its truth. Pray do not for a moment imagine that I wish to detract from the value of their demonstration of a discovery that is almost unrivalled in its importance when I say that the demonstration might have been perfectly well made by any reflective person who was aided by that small amount of information as to the condition of things around him which is presumably possessed by everybody of common sense. It might have been perfectly well made by any of the sages of antiquity. It might have been as well made by any reasoning man of modern time, even though he were innocent of the merest rudiments of zoology or botany; and, as is admitted, the discovery was partly and almost unconsciously made by Dr. Wells in 1813, and again by Mr. Patrick Matthew in 1831—neither of whom pretended to any special knowledge of those branches of science. It is equally a fact that anyone who applied the doctrine of Malthus, the political economist, to the animal and vegetable populations of the world, could have seen that what came to be called "natural selection" was the necessary consequence of the principles enunciated by him; and we have Mr. Darwin's acknowledgment that his reading the "Essay" of Malthus was with him the turning-point which settled his conviction as to the soundness of the crude speculations in which he had been indulging. Moreover, years before Malthus wrote, a great French writer, though no naturalist, had pointed out, in terms that were *mutatis mutandis* repeated as regards plants at a later time by the elder De Candolle, that all animals were perpetually at war; that each, with a few exceptions, was born to devour others; and that the males of the same species carried on an internecine war for the females.[1] The fact of the "struggle for life" being thus recognized, all the rest should follow, and really no close acquaintance with natural history was needed to guide an investigator to the end so far reached.

But in order to see the effect of this principle upon organic life the knowledge—the peculiar knowledge—of the naturalist was required. This was the knowledge of those slight variations which are found in all groups of animals and plants—a point on which I need not now dwell, for to my present audience it must be known in thousands of instances. Herein lay the triumph of Mr. Darwin and Mr. Wallace. That triumph, however, was not celebrated in Manchester. The question was of such magnitude as to need another year's incubation, and the crucial struggle came a twelvemonth later, when the Association met at Cambridge. The victory of the new doctrine was then declared in a way that none could doubt. I have no inclination to join in the pursuit of the fugitives.

But in tracing briefly, as I am now doing, the acceptance of the teaching of Mr. Darwin and Mr. Wallace, there is one point on which I should like to dwell for a few moments, because it has, so far as I know, been very much neglected. This is the great service rendered to the new theory by one who was its most determined opponent, by one of whom I wish to speak with the utmost respect, by one who was thoroughly a philosophical naturalist, and yet pushed his philosophy to overstep the verge of—I fear I must say—absurdity. I mean the late Prof. Louiz Agassiz, whose labours in so many ways deserve far higher praise than it is in my power to bestow. There must be many here present who will recollect the time when the question "What is a 'Species'?" was always coming up to plague the mind of every zoologist and botanist. That question never received a definite answer, and yet every zoologist and botanist of those days felt that an answer ought to be given to it; for without one they knew that they were sailing on an unknown sea, and that theirs was likely to be lost labour. The chief reason why no answer was given lay in the fact that hardly any two zoologists or botanists could agree as to the kind of reply which should be made, for hardly any two of them could agree as to how a "Species" was constituted. It will be enough for me to say now that Louis Agassiz pinned his faith on every "Species" being not merely the result of a single direct act of creation, but, when he found that physical barriers interposed (as they often do) between two or more parts of the area which the "Species" occupied, he did not hesitate to declare that a "Species" might have been created directly in several places, at sundry times, and even in vast numbers. If the same Species of freshwater fish, for instance, was found in several rivers which had no intercommunication, it had been, he asserted, separately created in each. Before his time people had been content to talk of each Species having had a single birthplace—its own "Centre of Creation"—but he maintained that many Species must have had *several* Centres of Creation, and creation was in his mind no figurative expression. He meant by it, just as Linnæus before him had meant, a direct act of God; in other words, his belief was that there had been going on around us a series of mysterious performances, not one of which had ever been consciously witnessed by a human eye, but each of which had for its object the independent formation of a new living being, animal, or plant. That is to say, that there had been going on from time indefinite a continuous series of operations which could only be termed miraculous, since there was no known natural law by means of which they could be produced. Though the author of this theory was, in the country of his adoption, regarded as the especial champion of opinions that are commonly termed orthodox, it is not surprising that many minds revolted from such a conclusion as it required—a conclusion which they not unfitly deemed a *reductio ad absurdum*. Yet the position of Prof. Agassiz was perfectly logical when once his premises were admitted; and, more than that, it became obvious to all clear-seeing men that one of these alternatives must be adopted—either Agassiz's logical doctrine of centres of creation, or the theory of the transmutation of species, which had been so long condemned because no reasonable explanation of its *modus operandi* was known.

I have called these alternative opinions because I believe that no third course had been suggested by any naturalist, and yet it is hard to say which of them was most unpalatable to the world at large. On the one hand, people were called upon to believe that man was in some inexplicable and unaccountable way produced from a monad. On the other hand, they were called upon to believe that the inhabitants, vegetable and animal, whether

[1] "Tous les animaux sont perpétuellement en guerre; chaque espèce est née pour en dévorer une autre. Il n'y a pas jusqu'aux moutons et aux colombes qui n'avalent une quantité prodigieuse d'animaux imperceptibles. Les mâles de la même espèce se font la guerre pour les femelles, comme Ménélas et Paris. L'air, la terre, et les eaux sont des champs de destruction."—Voltaire, "Questions sur l'Encyclopédie par des Amateurs," article "Guerre."

bestial or human, of nearly every group of islands in the Pacific Ocean were the result of innumerable special acts of creation entirely performed within the limits of almost each cluster of coral reefs. The natural consequence of this was that most people, and even most biologists, remained in an apathetic if not an unthinking condition on this subject, and went on as their fathers had done, not caring to trouble themselves in this matter. It was only a few—an extremely few—among them who ever gave the question any consideration at all, and these few were not so much the men who had confined their labours to museums, libraries, or laboratories, but they were, with scarcely an exception, men who had studied Nature in the field, and had seen her works under varied aspects in the most distant and diverse climes. They were men who had personally compared the geological formations of the Old World and the New, men who had circumnavigated the globe, who had surveyed Antarctic volcanoes or Himalayan snows, who had dredged the depths of Australian oceans or had explored Amazonian forests. Out of the abundance of their observation and reflection these men—to this audience I need not name them—in due time delivered their verdict, and when it was delivered its effect was crushing. The position of the supporters of the doctrine of "Centres of Creation," logical as it had seemed, was swept away—not of course without a gallant struggle on the part of its defenders—and the theory of the "Transmutation of Species," fanciful and unreasonable as it had been thought, was under a new name established, the very fact of its success being an additional proof of, to use Mr. Herbert Spencer's happy phrase, the "Survival of the Fittest."

But perhaps some of you have been thinking or whispering to your neighbours, "Why should our President be taking up our time by making us listen to all these platitudes, this old story with which we are all familiar?" and if you have been so doing you will have some excuse, but I trust you will think that I also have some excuse in thus recurring to what may be almost deemed a portion of ancient history when I state that in my belief this year 1887 will in future be remembered as that in which "The Life and Letters" of our great biologist, Charles Darwin, appeared; and I hope that in a few minutes you will admit that in accordance with the fitness of things it is meet and right that this should be so. There can be little doubt that before the end of this year that work which all naturalists have been expecting with so much anxiety will be published, and published, moreover, in three languages. It can hardly fail to be accounted by biologists as the chief event of the year. By favour of its author, Mr. Francis Darwin, I have been allowed to see some of his proof-sheets, and I am sanguine that it will not disappoint the expectations of its readers. On one point I venture to speak with some certainty. The noble character of the man will be made manifest to the world in words and deeds that cannot be spoken against, and we may feel assured that in future

> "Whatever record leap to light,
> He never shall be shamed."

He is unsparing of his own mistakes or shortcomings; and, while admitting with the utmost generosity the assistance he received from others, the dignified way in which he thought of and expressed himself toward the many who attacked him, often unscrupulously and in a manner which he could not but deeply feel, will ever redound to his credit, and prove him to have been that great philosopher which all his friends and adherents would wish to believe him. Do not mistake me, however, in one respect; there where times when he "did well to be angry"; but his anger was slowly excited, and his occasional vehemence soon subsided into his wonted calm. More than all this, you will find that the childlike simplicity of his mind and the single-heartedness of his devotion to the study of Nature which characterized the beginning of his scientific career endured unto the end. His admission at the outset of "utter ignorance whether I note the right facts"; his confession that he was "nothing more than a lions' provider"; his unfeigned astonishment at discovering that his early observations were of any worth—are all of a piece with the humility he subsequently displayed when his success was declared. As he found, one after another, many of his contemporaries and still more of the younger generation of naturalists adopting his views, his joy was great; but that joy was not alloyed by any feeling of pride. He did not care for making a convert to "Darwinism"—his exultation was that the strength of truth, of reason, and of observation had prevailed. In the same lowly spirit he, when at the height of his fame, expressed his gratitude to those, whosoever they might be, that helped him in his labours; and, if I might be critical on this point, I should say that his inherent goodness of heart often caused him to exaggerate the importance of the help they gave. Not a spark of jealousy was kindled in his mind; and at what may be considered the most trying moment of all, when the theory he had for twenty years been testing by every means in his power, the theory on which he built all his hopes of future recognition, the theory which he not unnaturally believed to be his peculiar possession—when this theory, I say, was independently conceived by another naturalist, his conduct was emphatically that of a man of honour. It pained him acutely to think that this naturalist, a trusted correspondent, an esteemed philosophical observer, and at the very time a wanderer far from home, should be deprived of the full glory of his ingenuity; and, but for the counsel of judicious friends (whose good advice on this occasion is indisputable), Mr. Darwin would have withdrawn every claim of his own to this great discovery, and left it entirely to Mr. Wallace! In the history of science and invention I think there are few cases like this. When you come to read the book you will find that though he unreservedly placed the matter in the hands of Sir Charles Lyell and of Sir Joseph Hooker, it was some time before he could reconcile himself to the notion that they were not unduly favouring him at the expense of his competitor. Such was the man! Though you are doubtless all aware of the fact, it would be wrong in me if I omitted to remind you that Mr. Wallace's conduct under these circumstances—sufficiently disappointing, as all must admit, to him—was in every way worthy of Mr. Darwin's. If in future you should meet with any cynic who may point the finger of scorn at the petty quarrels in which naturalists unfortunately at times engage, particularly in regard to the priority of their discoveries, you can always refer him to this greatest of all cases, where scientific rivalry not only did not interfere with, but even strengthened, the good-feeling which existed between two of the most original investigators.

I said but a few minutes since that it was fitting that the Memoir of Mr. Darwin should appear this year—this year of jubilee—and a very remarkable anniversary I now have to point out to you. I learn from the Memoir that Mr. Darwin's pocket-book for 1837—just fifty years ago—has this entry:—

"In July opened first note-book on transmutation of species. Had been greatly struck from about the month of previous March on character of South American fossils, and species on Galapagos Archipelago. These facts (especially latter), origin of all my views."

Other passages in his already published works confirm this memorandum; but we had not hitherto known with certainty when the views originated. We may now, therefore, celebrate among other jubilees that of Mr. Darwin's adopting the theory of the Origin of Species by Natural Selection, though I am bound to tell you that it was not until a few months later—about the beginning of 1838—that, after reading Malthus's work, the full conviction of the truth and sure ground of his speculative views came upon him.

I would not have my audience disperse with the impression that my business here is merely to point out what has been done by the genius of the great man of whose character and labours I have just been speaking. Enormous as are the strides which he has enabled us to make, you will all admit that it behoves us to follow in the paths he has indicated. We may depend upon it that what we know bears a very small proportion to that which we do not know, and I venture to recall your attention to that subject, which, as I have just said, was the origin of all his views. That subject is the Geographical Distribution of Animals and Plants, not only at the present time, but in bygone ages. As regards botany, I do not dare in the presence of so many distinguished authorities to say more than this—that I believe the greatest and most important results of their labours in this direction are inadequately known to zoologists, while in zoology I am certain that there are many large groups of whose distribution we are almost entirely ignorant.[1] That excellent work has been done in some groups all will admit, and in regard to the difficulties which have precluded the investigation of the subject in other groups I am well aware. But not only do we

[1] I say this after having studied Prof. Heilprin's recent work, "The Geographical and Geological Distribution of Animals" (International Scientific Series, 1887)—in many respects the fullest on the subject—and also Mr. Hemsley's admirable Introduction to the Botany of the "Biologia Centrali-Americana," which will shortly appear. The opportunity of reading the latter I owe to the kindness of Mr. Salvin.

need further investigation in regard to them, we want much more correlation of results than we yet possess, and still more a comparison of the results obtained by botanical and zoological inquirers. Here there is a wide field, and a field worthy of cultivation. I do not know that a more competent body of cultivators can be found than within this Section of the British Association, and if they can be persuaded to make common cause, the study of biology will be much advanced. We have been told that it is as useless to investigate the origin of life as the origin of matter. That may be true or it may not; but it seems to me that to learn the way in which life has spread over the globe ought to be within the capacity of man, and we can hardly learn that way except by far more intercommunication of special knowledge than has hitherto been made. It is evident that with the existing minute subdivision of biological research the subject is beyond the power of any one man; but I should rejoice if anything I could say on this occasion might put in train some alliance between botanists and zoologists for the object I have just suggested. It may be said that we have not sufficient information as to certain parts of the world to enable such an alliance to effect its work satisfactorily. If that be the case I am sure you will join with me in thinking that these insufficiently known parts of the world should be subjected to a thorough biological exploration. For many years past I have been accustomed to hear an adage that "Property has its duties as well as its rights." If I am strongly in favour of the rights of property, I am no less prepared to exact from it its duties. Various events have given to this nation rights of property in many parts of the globe. I think we ought to justify those rights, and there is no better way of doing this than by performing the corresponding duties. It is incontestable that among the dependencies of the British Crown there are innumerable places—islands, large and small, territories the limits of which no geographer or diplomatist can define, and so forth—of which the fauna and flora have never been scientifically investigated. It is right, of course, that I should recognize the successful efforts made in many instances by the directorate of the Royal Gardens at Kew, and to a less extent by private persons. But why should not a properly organized biological investigation of all the portions of the Empire be made? You will, I think, all agree that it is our duty to carry out investigations of this kind. Whether they would be better performed under the superintendence of Her Majesty's Government or not is a point on which I reserve my opinion, only mentioning that the success which has attended those instituted by the botanical authorities at Kew leads me to suppose that an extension of the method there followed might produce results as satisfactory; but, if this be the course adopted, I must point out that the organization of a corresponding zoological and geological directorate will be needed. This matter I merely throw out for your consideration; but I would add that if anything is to be done no time is to be lost.

When on a former occasion (at Glasgow in 1876) I had the honour of addressing a Department of this Section, I pointed out the enormous changes that were swiftly and inevitably coming upon the fauna of many of our colonies. The fears I then expressed have been fully realized. I am told by Sir Walter Buller that in New Zealand one may now live for weeks and months without seeing a single example of its indigenous birds, all of which, in the more settled districts, have been supplanted by the aliens that have been imported; while further inland these last are daily extending their range at the cost of the endemic forms. A letter I have lately received from Sir James Hector wholly confirms this statement, and I would ask you to bear in mind that these indigenous species are, with scarcely an exception, peculiar to that country, and, from every scientific point of view, of the most instructive character. They supply a link with the past that once lost can never be recovered. It is therefore incumbent upon us to know all we can about them before they vanish. I have particularly instanced birds because I happen to have studied them most; but pray do not imagine that the same process of extirpation is not extending to all other classes of animals, or that I take less interest in their fate. The forms that we are allowing to be killed off, being almost without exception ancient forms, are just those that will teach us more of the way in which life has spread over the globe than any other recent forms, and for the sake of posterity, as well as to escape its reproach, we ought to learn all we can about them before they go hence and are no more seen.

I have just now applied to these expiring forms of New Zealand the epithet ancient, and in connexion therewith I would, by way of conclusion, offer a few remarks on the aspect which the subject of Geographical Distribution presents to me. Some of us zoologists—I am conscious of having myself been guilty of what I am about to condemn—have been apt to speak of Zoological Regions as if they were, and always had been, fixed areas. I am persuaded that if we do this we fall into an error as grievous as that of our predecessors, who venerated the fixity of species. One of the best tests of a biologist is his being able to talk or write of 'Species' without believing that the term is more than a convenient counter for the exchange of ideas. In the same way I hold that a good biologist should talk or write of "Zoological Regions." The expression no doubt arose out of the belief, now scouted by all, in Centres of Creation; and, as sometimes used, the vice of its birth still clings to it. To my mind the true meaning of the phrase "Zoological Region" is that of an area inhabited by a fauna which is, so to speak, a "function" of the period of its development and prevalence over a great part of the habitable globe, but at any rate of the period of its reaching the portion of the earth's surface where we now find it. One great thing to guard against is the presumption that the fauna originated within its present area and has been always contained therein. Thus I take it that the fauna which characterizes the New-Zealand Region—for I follow Prof. Huxley in holding that a region it is fully entitled to be called—is the comparatively little changed relic and representative of an early fauna of much wider range; that the characteristic fauna of the Australian Region exhibits in the same way that of a later period; and that of the Neotropical Region of one later still. But while the first two regions have each been so long isolated that a large proportion of their fauna remains essentially unaltered, the last has never been so completely severed, and has received, doubtless from the north, an infusion of more recent and therefore stronger forms; while, perhaps impelled by the rivalry of these stronger forms, the weaker have blossomed, as it were, into the richness and variety which so eminently characterize the animal products of Central and South America. I make no attempt to connect these changes with geological events, but they will doubtless one day be explained geologically. It is not difficult to conceive that North America was once inhabited by the ancestors of a large proportion of the present Neotropical fauna, and that the latter was wholly, or almost wholly, thrust forth—perhaps by glacial action, perhaps by the incursion of stronger forms from Asia. The small admixture of Neotropical forms that now occur in North America may have been survivors of this period of stress, or they may be the descendants of the more ancient forms resuming their lost inheritance. Beyond the fact that these few Neotropical forms continue to exist in North America, its fauna seems to be in a broad sense inseparable from that of the Palæarctic area, and, in my belief, is not to be separated from it. The most difficult problems are those connected with the Ethiopian and Indian (which Mr. Wallace calls the Oriental) areas; but I suppose we must regard them as offshoots from a somewhat earlier condition of the great northern or "Holarctic" fauna, and as such to represent a state of things that once existed in Europe and the greater part of Asia. To pursue this subject—one of most pleasing speculation—would now be impossible. I pray you to pardon my prolixity, and I have done.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY COLONEL SIR CHARLES WARREN, R.E., G.C.M.G., F.R.S., F.R.G.S., PRESIDENT OF THE SECTION.

"The geographer should therefore chiefly devote himself to what is practically important."—STRABO, c. i. § 19.

MY predecessors in former years have used their discretion in the opening address either to generalize on the science of geography or to lay stress upon those particular subjects to which they considered it desirable to call attention. I propose on this occasion to refer to matters which have long been of importance to those who are desirous of the spread of the knowledge of geography, and in which I trust the public generally are acquiring an interest. I refer to the teaching of geography in our schools and the economy and advantage to the State which would result from a more perfect and skilful system of instruction.

The term geography covers a very wide area, and while limiting its use to-day to the more restricted sense generally accorded to it in modern times, I must protest against its being applied only to a dry digest of names of places and record of statistics, rendering it a bugbear in the instruction of youth instead of allowing it to cover all those interesting and engrossing subjects which truly belong to it, and without the knowledge of which the mind of youth cannot be trained and expanded in the direction to which the science tends.

As the geographer Strabo points out, our science embraces astronomy, natural history, and is closely connected with meteorology and geometry, the arts, history, and fable; but since his day so much progress has been made in the arts and sciences that the branches of geography have become specialities to be taught separately, and the old root geography has been almost laid aside and treated with contempt, though it is only by a thorough acquaintance with it, the knowledge of common things, that the branches which depend upon it can be thoroughly comprehended. We may take geography, then, to embrace all that knowledge of common things connected with the surface of the earth, including the seas and the atmosphere, which it is necessary for every human being to be acquainted with in order that progress in other knowledge may be acquired and acquaintance with the world be made which will fit man for life in any capacity, whether as occupying the highest position even to the most humble. Indeed, it is difficult to say in what capacity in life this knowledge is most required. No man can do practical work without it, and to the theorist it is absolutely essential.

The science may be divided under two heads; that which we learn from others, that which we acquire from our own observation and researches. All experience tells us that the information is most valuble which we acquire by our own exertion, and therefore every effort should be made by those interested in the welfare of mankind to endeavour that each one should learn everything that can be learned from his own observation properly directed.

Year by year, as the surface of the earth becomes better known, the districts in which explorations of an adventurous nature can be made diminish more and more, and as scientific research takes the place of that of a ruder nature the chances of excitement grow perceptibly less. Indeed, when we look upon the knowledge possessed by the ancients and study their cosmogony we cannot but feel the loss we have sustained in approaching the truth. The poetic halo with which everything was encircled, the deep shadows and gloom, have gradually been dispersed and dispelled, together with all the distant and uncertain light which gave so much scope to the imagination, and we now view the hard stern realities of fact, brilliant and gay in their colouring, but leaving no room for fancy, or for a change of ideas—always the same vivid rigidity of outline which admits of no two opinions. It is like the change of scenery from our own beautiful cloudy island, where the tints and shades change from hour to hour, and where the grey and purple distances leave so much to the imagination, to the bright scenes of the Mediterranean shores, where everything is bathed in intense sunlight, and distinctness of outline reigns supreme, where there is no possibility as to doubt.

In each case we may balance the advantages and disadvantages; but as we have gained in knowledge so we are losing in understanding. We are fast losing our human nature and are becoming machines, and we call it being civilized. We are drifting into a condition in which we learn nothing of ourselves or by our own individual efforts; we are coming to a time when, as we know more about science, and are better educated in arts, we know less about mankind, and are the less able to assist in gaining knowledge of the world; all power of doing so is day by day becoming vested in the hands of a few scientific men, on whose word we have to rely. In this progress we are losing all we used to hold most dear; the desire of living for others is departing, and with it hospitality, chivalry, enthusiasm, unselfishness, and because we are unable to exercise the talents given to us they rust and corrode. No doubt we are able to seek other channels for our energies of mind, but how are we to exert our physical powers for the benefit of man? In days of yore it was open to any man of spirit and strength and activity to set out in quest of adventures of the unknown for the assistance of his fellow-men, to relieve the world of its monsters, to risk everything for others. But those days of daring are now gone by; the doubt, uncertainty, and mystery attached to unknown danger are no longer to be met with, and though the same chances are always presented to human nature to practise self-denial, they are now, though more difficult perhaps, of a passive instead of an active nature, and do not so distinctly belong to the domain of geography as they did in olden times.

As the people of olden times are to those of the present day, so may we consider the child to the man; and we adults in this assembly must recollect that, however strong may be our emotions and passions at the present time, they are but of a mild and vapid nature when compared with the aspirations and feelings of youth. Each prosaic-looking child is full of poetic and romantic feeling, to which as a rule utterance is never given, but which, nevertheless, cannot be rudely shattered without injury to the mind, and which, if taken advantage of, may assist greatly in training the mind and developing a love of geography.

It should be a matter of great interest to those who instruct in geography to study its gradual development from the earliest date and to watch the progress it has made. And this is not a matter of very great difficulty, for as geography is the knowledge of common things, and the ancients were more experienced observers than ever we may hope to be, the earliest records we possess are full of geographical accounts. In the books of Moses, three thousand years ago, we obtain our first recorded view of the cosmogony of the ancients, at which time the world is supposed to be a flat disk with water surrounding the land, and this idea pervades later books, and is dwelt upon in the Psalms of David. Homer also held a similar view, and to him is accorded by Strabo the honour of being the founder of geographical science, because he excelled in the sublimity of his poetry and his experience of social life; and a reason why he excelled is carefully related. He could not have accomplished it had he not exerted himself to become not only acquainted with historical facts, but also with the various regions of the inhabited land and sea, some intimately, others in a more general manner. "For otherwise he would not have reached the utmost limits of the earth, traversing it in his imagination." Herodotus, to whom we are indebted for furnishing us with the *earliest known* system of geography, also held the same view concerning the earth; but it is worthy of remark that he speaks in his day (450 B.C.) of there being another view, as to the world being round, which he considers to be exceedingly ridiculous, and therefore it may be surmised that even at that early period there were minds that had arrived generally at the conclusion which now obtains as to the shape of the world. The idea that the sun, moon, stars, and planets revolved round the earth was the view in early days, and continued up to quite a recent period, and even now we are unable to prove that the generally received system is correct, and only use it as being more convenient than that which makes the earth the centre of the universe.

When we come, however, to consider the progress of discoveries on the surface of the earth itself, the strides in later years appear to be enormous, but yet we must not forget that there is an ebb and flow constantly going on. Discoveries are made and lost sight of, and again are brought forward as new. Sometimes after an account of discoveries has been published a second account differs most materially from the first, and the public have to wait for further examination. Cases have occurred, as in the early Portuguese discoveries in Central Africa, in which the plans and accounts have been laid on one side and forgotten, and the territories rediscovered and surveyed years afterwards. Again, sketches of new countries have been made, and the surveyor has omitted to show what is conjecture and what is from actual observation, and his plans throughout have been discredited. In some cases these mistakes have retarded discovery, in some they have directly led up to it—as, for example, in the gigantic geographical error in placing on the globes of the fifteenth century the eastern extremity of Asia no less than 150° of longitude too far east, which prompted Columbus to endeavour to reach Asia from the west, and thus led to his discovery of America.

In gauging the progress of our knowledge of geography we must not, however, simply take into account what has been made by ourselves, but by the known world generally; for example, although the Portuguese circumnavigated the Cape and proved that it was practicable to do so, it is still a moot question whether they were attempting what was known or unknown. At any rate it seems certain that in the thirteenth century—not to go back earlier—the Arabians were aware of the fact that

Africa on the south was surrounded by the ocean, and the geography of Abulfeda clearly points this out.

It is, then, a difficult matter to decide what is a discovery in geography. We may possess an exact description of a town and know its position, and yet it may never have been visited by a traveller from what we term civilized Europe.

What we require, however, is precise and accurate information of the earth's surface, however it may be obtained, and to train the minds of our youth in the powers of observation sufficient to enable them to obtain this information; and if in so doing our countrymen continue to be stimulated to deeds of daring, to enterprise and adventures, to self denial and hardships, it will assisting in preserving the manhood of our country, which is more and more endangered year by year in consequence of our endeavour to keep peace within our borders and to stave off strife with our neighbours.

Probably many of us here to-day of mature age, on looking back at our early acquaintance with geography, will recollect little but a confused list of proper names and statistics, learnt by rote, and only imperfectly carried in the mind, so that only a few portions stand out still visible, and those probably connected with pleasurable and, in some cases, painful accessories; perhaps those particular lessons which we may have assisted some school friend to master still remain as clear as ever; or, again, those learnt under the terror of the rod.

Taking schools and subjects all round, nothing probably has ever been worse taught than geography was only a few years ago, and very little progress towards a good system has even yet been introduced into higher-class schools, though in the schools of the people an effort has been made to render the subject more palatable and instructive.

The faults, however, of the system hitherto in use are now fully recognized, and objections are general that the study has been made too painful a grind, and that the whole process has been of too severe a character. If this were the only fault to be found in the old method, I for one would be inclined to adhere to it, assured, as I am, that no training of the mind can take place without great denial and sacrifice in learning self-control. But the real question is as to the practical results of the old system. Are they of such a character with all or the majority of minds (of all classes and conditions) that they have become stored with useful knowledge and at the same time trained to take a pleasure in increasing it in the future? It the results are short of this we cannot but pronounce the old system to be a failure, as the knowledge of geography is the knowledge of common things inseparably connected with the life of each one of us, and there is no better medium through which the mind can be trained to be always in a condition for acquiring knowledge without making too great an effort.

Unfortunately for the prospects of introducing a complete and perfect system of teaching geography (suitable to most minds), the reaction that has set in recently is likely to lead to evil results if not carefully curbed. It seems now to be desired to promote the acquirement of knowledge at the earliest age without effort and without hard work; but this appears to be directed towards alleviating the toils of the instructor as much as the instructed, and we have now, as a result, children taught common things without any effort to strengthen their memories, and then a system of cramming introduced at a later period, when the memory has ceased to be capable of responding to the efforts made, and consequently all the information crammed in is dropped again in a few months.

The memory of youth is like a cup swinging freely on a pin thrust horizontally through its sides. If the pin is below a certain line, the cup will tilt over and lose its contents when filled up beyond a given level; but if the pin is near the upper edge the cup can be filled with more and more security. By careful training in the earliest years the cup may be constantly kept full in later years; but by the training at present in use the cup tilts over far too soon.

It seems to me that the remedy recently adopted is worse than the disease it was to eradicate, and that however injurious it was to attempt to store the mind with mere names, yet the memory was trained thereby to retain something definite; and it is still worse to attempt to store the mind with mere ideas without the connexion of names, and leave the memory to rust.

There is obviously a middle course which may rid us of the errors of the past without leading us into still greater difficulties. And if we keep the object to be gained always in view, we cannot fail to take a direct line. We want first to lead the memory to constant exertion of such a nature that it grows stronger day by day, but is not overstrained or wearied; at the same time it must be stored with useful facts, which may be quite above the capacity of the mind to comprehend at the time, but which will be required all through life: this can readily be done by means of verses or rhymes set to simple airs and committed to memory by song. There are facts of the greatest importance which can be learnt in this manner with very little effort, and which, if not fixed in the mind at a very early age, the want of them may be felt throughout life.

As, for example, the directions in which latitude and longitude are reckoned, in which the sun rises and sets, the relations of the east and west respectively to the north and south, and many other matters which appear to be of a trivial character, but which require to be as rigidly committed to memory by rote as does the multiplication table.

These very small matters are the foundations of everything we require to know, and if we do not have these foundations firmly and securely fixed, we shall be the sufferers all our lives. Too much attention cannot be paid to them, as it is the early lessons which remain most clearly fixed in our minds.

A point connected with this subject, which admits of much discussion, is as to *how* such verses should be learnt, whether with the assistance of books, pictures, or metaphor. Should they come to the memory through the eye, or the ear, or through both? As a beginniug, I think that geography should not be learnt from books, but from the teacher, who may use diagrams and pictures, but at the same time text-books should not be done away with, as is so constantly advocated; on the contrary, they should be adhered to most rigidly. There are few teachers who could improve on a good text-book, but these books should be for the teachers, and not for the children. But the teacher should not use the text-book when teaching.

Children have a remarkable capacity for making pictures for their mind's eye of every thing they think of, which is dulled gradually as books are taken into use; this faculty, if made right use of, may be developed, and will greatly assist the study of geography, and will lead to a "picture memory," which will be most useful in regard to maps, drawing, and spelling. This faculty can, of course, be over cultivated, but there is not the remotest danger of this occurring at present in any of our schools. When highly developed, we find it employed by novelists, who can bring their characters up before them and picture them enacting their parts, and also by artists, who sometimes lose the power of discriminating between that which they actually see and that which their picture memories call up.

Although it seems to me absolutely essential to cultivate and develop the memory, so often called the "parrot memory," of young children, this is by no means all that is necessary. At the same time must be taught the proper use of the powers of observation with reference to Nature, which in towns is so difficult a matter, placing the bulk of our population at so great a disadvantage. One of the first points neglected by teachers generally is to explain to children what the object or result of the lesson is to be. In most minds it is very difficult to pay real attention unless it is known what is to be the general drift of the conversation, for otherwise the mind will be directed to points quite irrelevant. Children should be first told in a few words the line the lesson is going to take; this will greatly tend to secure the attention of what are termed dull children, who often, if properly treated, would turn out the cleverest, but who cannot grasp a subject until they see it from all sides, and know it thoroughly, while the "clever children" are satisfied with a view of one side only. The foundation should be laid slowly, the progress being governed by that of the "dull children," who often will most amply repay the teaching. The clever child will not be hurt by having the subject impressed upon his mind over and over again, so long as it is made interesting.

Great care must be taken in the method of presenting maps at an early age before children, and a distinct idea should be given of the difference between a map and a picture.

It must be recollected that from the moment geography is taught, children will make maps or pictures in their mind's eye, whether they are actually presented to them or not.

For example, if a house or a garden is mentioned, both the teacher and the child must view it from the outside and from a certain distance, for it is impracticable for most minds to look all round and behind at one time. To have a full view of what is mentioned, it is necessary to get outside and beyond it. Children will differ among themselves in their method of viewing what is spoken of, but the teacher can readily ascertain what mental pictures they have formed, and can make use of this faculty in the first use of maps. Children should first be instructed in maps of the village or town in which they live. It is remarkable how readily uneducated natives in uncivilized countries can understand plans from their constant observation of Nature. Most intelligent Bedouins are able to make a rough plan or diagram in the sand with a stick of the district they know, and will also take care that the orientation is correct. Kaffirs can do the same, and can point out the direction of a cattle post fifty or sixty miles distant with unerring sagacity.

It is of vital importance that children in our island, who cannot under ordinary circumstances have sufficient opportunities for using, cultivating, and developing their powers of observation to any purpose, should have the use of maps put before them in such a manner that they will not be led into error. Otherwise they will have fixed in their minds factors of discord which the teacher may know nothing of, and which will trouble them through life, and which if they do get rid of with great labour in after years, will constantly return at unseasonable moments.

It is very common for children to mistake east for west, north for south, and even to make still more ridiculous errors which appear on reflection to be quite impossible. Yet these errors remain often unobserved until the youth is eighteen or nineteen years old, when he begins to think the matter out for himself, from finding that he is continually making absurd mistakes, but then it is too late for him to do more than know that he is liable to the error, for on an emergency it will crop up in spite of himself.

I am aware of one instance in which an educated surveyor when thinking of London invariably placed the portions about Regent Street and Charing Cross in an inverted position while picturing all the rest correctly, and it was only by an effort that he could turn this portion upside down into its place. Another, when thinking suddenly of Paris, always placed it to the north of London; and another always thought of the west end of London as being towards the eastern coast.

Out of thirty cases of well-instructed men at an age between eighteen and twenty, I have found that about eighteen were under the impression that while the sun rises in the east, the stars rise in the west, from having learned that the sun has a proper motion among the stars.

I fancy there are few educated men who have not grown up with some curious errors with reference to geographical facts which have bothered them all their lives, and which they have found it impossible to get rid of even when they have discovered where the errors lay; and I believe that many of the numerous blunders and accidents which constantly occur on railways, with shipping, machinery, &c., and the causes of which cannot be accounted for, are really to be ascribed to some early error in learning geography or the knowledge of common things, errors which, when attention and watch over self is suddenly withdrawn, influence the actions in a contrary direction to that which is right.

As an instance of the natural liability to error, even apart from those which may be ingrained while under instruction, I may allude to the feeling when the eyes are shut when travelling by rail or carriage that the vehicle is going in an opposite direction to that in which it actually moves, to the impression when approaching or leaving land in a boat or balloon that the earth is moving and that oneself is stationary; even when on horseback under excessive fatigue in the dark the traveller has been known to imagine that the horse was moving rapidly backwards. The effect of excessive fatigue from physical exertion has somewhat the same result as a want of self-control from bad training of the mind, and perhaps those who have ridden for many miles on horseback or in a coach may have noticed how in the dark a fixed lamp may be seen to make various fantastic signals due to the motion of the horse or coach transferred by the eye to the lamp. As another instance of the difficulty of self-control I may mention a case in which a man well instructed in taking astronomical observations and in the rudiments of astronomy could not divest himself of the idea, which he had gained as a child, that the moon shines with light of her own, and that her phases are due to the earth getting between her and the sun, this error continually interfering with his mental astronomical pictures, though when his attention was specially called to the subject he was aware of the error which intruded itself so constantly in his views of the heavenly bodies. The difficulties regarding east and west, north and south, probably arise from a multiplicity of causes, such as the southern side of the Mediterranean being the northern coast of Africa, or the southern view of a house being obtained by looking towards it in a northerly direction, and these difficulties as to orientation do not only occur in modern times, but are to be found in ancient writings. Another constant source of error is inverting names unconsciously, such as speaking of Jupiter's rings and Saturn's belts. As an instance of this I mention a case in which, a lecture being given on the Franco-Prussian war, the lecturer inadvertently in the middle of his lecture used the word "Prussian" for "French," and *vice versâ* continually throughout, and though he was quite aware of some anomaly every now and then, he could not ascertain where he was in error until near the end of his lecture. Another source of error which cannot be too carefully guarded against results from placing the celestial globe by the side of the terrestrial globe and treating them as though they are of the same character; this is certain to confuse east and west with most children, as one has to be looked at from the outside and the other from the inside in actual fact. Again, as some star charts are made that they may be looked at from above and others from below, causing the east and west points to differ, there is sure to arise confusion. I venture to say that there are few young minds which are not absolutely and hopelessly confused by the use of celestial globes and charts. I believe it to be essential that, until the mind is fully trained and developed, the stars should be looked at from within and not from without, and it appears to me that all the information which a child can require, apart from practical observation, concerning the phenomena of day and night, the seasons and months, the circles and zones, the phases of the moon and eclipses, can be imparted by the use of a lamp with a reflector and two globes, though a good orrery placed in the school for children to examine and observe for themselves would often enable the dull ones to keep up with the rest more easily.

It will be interesting to note whether the class of error alluded to does not arise principally among those bred in towns, and who have not had an opportunity of developing their observation in the country; as with those who do use their observation a habit is required of unconsciously working out questions which arise, and the mind arrives at a correct conclusion. This end should be the great aim and object in instructing in geography, for as there is no royal road to knowledge divested of grind and pain, there is yet the path which provides the greatest amount of result with the least amount of grind, in which all the labour expended is productive, and in which after a time labour even becomes a pleasure.

It seems very desirable that the first maps presented to a child, viz. those of the school grounds and the parish, should be placed on the floor and properly orientated; this will go far to fix the correct positions of east and west, north and south, and will prevent the idea of the north necessarily being *up* and the south *down*. It is to be observed that if the child looks up to a map it is almost equivalent to looking at the map when lying on the back, in which case the east and west are inverted. The motion of the sun over the map might with advantage be pointed out at various times of the day, and if the position of the rays of the sun on the floor when on the meridian could be shown each day when practicable on the line drawn north and south, it would do much to fix in the mind the fact that the sun is in the meridian at apparent noon each day. A sun-dial should also be available in every school-yard to which children may have access.

The map of the district round the school should only be made use of in order to clear the way to understand what a map is, for reference in describing other maps, and for practical purposes in giving the child useful information as to the places in the neighbourhood. While this is going on, the child should be taught to point out the actual directions in space of the principal towns, &c., in the county and island, and then an outline map of the British Isles with the principal places and features marked on it should be brought under review. Too much detail should not be crammed into the early lessons; a good firm foundation is required, something to start upon before the great test of faith is made in teaching, viz. that the world is round.

Children should be taught, as far as is practicable, to make this discovery for themselves, and many will arrive at it one way or another, or think they do so, which is equally important. It is far better they should grasp truths themselves than have them drummed into them; it gives them confidence in their own deductions, and leads to further observation of Nature. In introducing the world as round, a *blackboard* globe should be used, about 3 feet in diameter, on which the continents are outlined boldly in red, with some meridians and parallels of latitude in white. It would be well if a portion of this globe could be taken to pieces to show how a horizontal sun-dial for the particular latitude is constructed, and for other matters of interest. It is material to show that the earth revolves on a fixed axis from day to day, and in one direction. All the great difficulties in learning geography are at the threshold of the science for those who have not observed Nature; the more abstruse subjects are comparatively easy to teach.

The first difficulty common to all is that with reference to latitude and longitude, regarding which there are so many elements of error. It is so difficult for the child to recollect which term means length and which breadth, and then to get the restive imagination to grasp the fact that the length is sideways and not up and down, as it apparently should be; for even if the earth is shown to be an oblate spheroid, there is nothing to lead a child to see that there is a greater circumference round the equator than round the poles, and the time has not arrived to perplex the child with the views of the ancients on the subject. Then, again, if the child does recollect that the meridians of longitude run from north to south, and the parallels of latitude from east to west, it is probable that he may measure the longitude in degrees along the meridian and the latitude along the parallels; a very common and recurring error, difficult to deal with. The only practicable method is to put the facts of the case into amusing verse and commit it to the memory by song. At this stage, also, some easy standards of measurement put into verse and to music should be learnt by rote, to enable the child readily to recollect the relative measurements of the earth, sun, and moon, and the radii of their orbits and times of progression.

I lay great stress upon these matters at the beginning, because they are really all in all to those who wish to succeed in the science in after-life, and I have viewed the matter from the stand-point of what will be required at the age of eighteen to twenty, when the mind ought to be capable of taking up any subject, instead of considering what show of learning the child should be able to produce in an examination at an early age. The stock-in-trade of knowledge for each young person need be very slender, but it must be of the right sort and best quality. No doubt there are many children badly trained who can gradually work out matters correctly for themselves, but these are the few with originality of mind, and even they would be benefited by not having to spend a portion of their lives in unlearning.

Once the preliminary difficulties are over and the power of observation and reflection is acquired, even in a small degree, the study of geography becomes but a simple matter, for it is the learning of common things, matters of every-day life, which we may, if in the country, acquire to a partial extent of our own experience; but though so simple it requires continuous application and attention.

In each calling or trade a man may become an experienced geographer to a limited degree. The pilot, for example, is an expert in the geography of the seas he works on, for he not only knows the ports, the coast lines, and the sunken rocks and sandbanks, but he also knows the tides, the winds, he studies the clouds and the currents, and has an intimate knowledge of the contours of the shallows; moreover, he knows the shipping of various countries, the merchandise they carry, and the produce shipped from each port. In the same manner, by hunting, shooting, fishing, bicycling, birdsnesting, &c., we acquire a knowledge of natural history and topography which aid us most materially in the study of geography, and which in a limited degree *is* the study of geography.

Even in large towns it is practicable to learn lessons in geography from actual experience and observation, for if the markets and railway produce are examined, it can soon be ascertained from whence the articles come and from what ports, and with careful attention most valuable lessons in political economy can be gained.

The bulk, however, of our children are cooped up in towns and walled playgrounds, and even when in the country are too often confined to one field; they have few opportunities of insensibly studying the wonders of Nature, and therefore, in order to develop their powers of observation and to understand geography, artificial means must be made use of. Great efforts are now being made under the new Code to produce these artificial means, by raised models and water and other devices, and it is to be trusted that, if these schemes can be carried out, the habit of observation will be induced; but the memory also must be at the same time actively exercised and stored with fresh facts day by day.

The knowledge of geography thus, even in its restricted sense, embraces the life of an Englishman of every class and occupation, and its study is of the greatest importance to every man who has an occupation; it is singular that so little comparatively is thought of cultivating the science, and how small interest the State has hitherto taken in fostering this class of education.

But while the Board and other schools for the people are gradually taking up the work, and endeavouring to work out a good system of education, it is mortifying to find how little progress has been made in the higher-class schools where such heavy fees are charged; and the question arises whether in these schools the teachers of geography really understand the subject they teach, and would pass an examination before a Government inspector.

The boys of the wealthy classes are put to the greatest disadvantage with regard to the study of geography. The son of a labourer will hear the price of provisions and clothing constantly discussed, so also with the son of a mechanic and tradesman, and will learn much about geography on the subjects with which the parents are connected, and will also in some measure learn to exercise his observation; but the son of wealthy parents is too often carefully kept from hearing all that might teach him geography, and he is seldom obliged to exert himself to use his observations in any essential matters of daily life; this is reserved for the playground, where nothing of real importance is at stake, and must have the most deleterious and detrimental effect on many young minds, and naturally results in so large a proportion becoming useless for any occupation.

It is apparent that, as education throughout the country progresses, the sons of the wealthy classes, if they are to compete successfully with others, must have some better mental training than they obtain at present, otherwise they will in a few years be distanced by the sons of the labourers, artisans, and shopkeepers. What an Englishman asks for is a fair field and no favour, and it seems hard upon a parent who struggles through life to make money to be enabled to give his children the best and most expensive education the country affords, that with it he must risk a training of the mind which is inferior to that in the less expensive schools of the people. As we are behind the Continental States and our colonies in so many of our institutions and land laws, so we are behind them in our training of the mind in our upper-class schools; by neglecting by artificial means to develop the power of observation among boys, who until they are put out in the world are never accustomed to do anything that will tend directly to any practical and useful result, we are putting them to the greatest disadvantage, and handicapping them in the race of life.

We omit to train the memory in early years, to lay a foundation of facts in the mind, and to develop any power of observation; we carefully prevent their doing anything useful, and bring them up in a moral atmosphere in which the idea of anything but amusement is practically excluded, and then in later years we attempt to adjust all our errors by cramming, when the memory is incapable of being crammed, and the mind has ceased to desire to acquire information; the result is that many young men are deliberately rendered unfit for work in life, and those who have sufficient courage and energy to look their prospects in the face find the enormous disadvantages to which their teaching has subjected them, and lose precious years in unlearning and learning again.

More unfortunately still, the best and choicest of our minds cannot be crammed; and thus drop out at our examinations many minds of the class that for practical purposes would be most useful to the State. I allude more particularly to the minds endowed with reflective faculties, which tend to originality and research; these minds cannot be successfully trained unless combined with the teaching there is something useful to do. It is often observable that an indolent, inert, and lazy boy suddenly becomes filled with enthusiasm and emulation, both at studies and in the playground, when subjected to a change of training. I venture to assert that every year at our public examinations many men are rejected who are of the most superior class of mind for all practical purposes, who are physically most capable, who are so constituted that they cannot cram, and who, though retarded by want of proper training, are beginning to train their minds for themselves, and who if brought up under a good system in early years would take the highest places in examination. We are thus losing year by year from our front rank the men who would be of the greatest service to the State.

The pleas given for the study of geography by Strabo are worth bringing before the mind of youth, for he points out that while the success resulting from knowledge in the execution of great undertakings is great, the consequences of ignorance are disastrous, and he refers, among other instances, to the shameful retreat of the fleet of Agamemnon when ravaging Mysia, and to bring it more home to our every-day life he says:—"Even if we descend to such trivial matters as hunting, the case is still the same; for he will be most successful in the chase who is acquainted with the size and nature of the wood; and one familiar with the locality will be the most competent to superintend an encampment, an ambush, or a march."

He further calls attention to "the importance of geography in a political view. For the sea and the earth on which we dwell furnish theatres for action; limited, for limited action; vast, for grander deeds; but that which contains them all, and is the scene of the greatest undertakings, constitutes what we term the habitable earth; and they are the greatest generals who, subduing nations and kingdoms under one sceptre and one political administration, have acquired dominion over land and sea. It is clear, then, that geography is essential to all the transactions of the statesman, informing us as it does of the positions of the continents, seas, and oceans of the habitable earth."

Of all persons who require a knowledge of geography stand first those who are most concerned in the government of our Empire, and yet, as has been mentioned, they have for the most part been brought up at schools where the mental training for geography is most defective. Our statesmen as a rule have neither theoretical teaching nor practical experience in the science, and it is perhaps not too much to say that, putting on one side those who are merchants and sailors, there are no more ignorant persons with regard to geography than our law-givers. This ignorance endangers the safety of the country, for the people are continually perceiving, with regard to matters of every-day life and practical experience, that their law-givers are more ignorant than themselves, and are consequently continually interfering and giving advice in the details of the administration of the Empire.

The progress and development of a free country depend upon the characteristics of the inhabitants, but these again depend in great measure upon the natural resources of the country—the soil, climate, mineral wealth, navigation, mountain ranges, risks and dangers from natural causes, and we must not omit the position of the country both with reference to commerce and war.

It is not usually the country too greatly favoured by Nature which develops most rapidly, neither is it necessarily a long term of peace which favours progress; on the contrary, all experience shows that man requires a certain amount of opposition to bring out his energies and stimulate him to exertion, and though we are constantly talking in our country of the blessings of peace and horrors of war, we must generally acknowledge that our present foremost place among nations is due in a great degree to the keeping up of our innate energies by incessant turmoils and differences of opinion within and little wars and commercial rivalry without. It is not, then, to a reign of peace in which our energies would stagnate and become effete, but to a continuance of political excitement, which keeps the people on the alert, that we should be indebted for progress, and our statesmen should be sufficiently well educated and trained to take advantage of every time of excitement in furthering the welfare of the Empire.

We owe the benefit (before railways) in the improvement of our great northern roads for military purposes to the rebellion of 1745, leading to our being able to run coaches between London and Manchester in 1754, and between London and Edinburgh in 1763. Scotland and Ireland are both indebted to war and disorder for the first roads, constructed for purely military purposes.

But while the duty of taking advantage of each fitting opportunity for developing a country lies with the statesman, his prospect of success depends in great measure upon his geographical knowledge. His work may serve but for the purposes of the moment, and never benefit posterity, if he has no knowledge or foresight, no originality of purpose and perception of the fitness of things.

The measures that can be taken may be divided into two classes—domestic and international: the former designed to benefit the country or Empire directly; the latter to shield the land from hostilities from without, and in which the consideration of geographical position has a most all-important bearing. In this latter class a complete knowledge of geography is an absolute necessity, as the question arises so often as to whether the acquisition of geographical positions will weaken or strengthen a kingdom. For example, were Ireland 2° further to the west, it is probable that all our views as to the method of connecting it for administrative purposes with Great Britain would be greatly modified. Again, the particular points at which our coaling stations may be situated about the world may depend upon a variety of circumstances, changing from year to year. Thus Gibraltar, from its geographical position, was an absolute necessity to us thirty years ago, but, owing to various changes, it is not now of equal value, either as a coaling station, for protecting our commerce, or as a depot for our wares, and the question is arising with some geographers whether it might not with advantage be exchanged for Ceuta on the opposite coast.

It is possible that a more full geographical knowledge of Egypt and the Suez Canal might have materially modified our present occupation of Egypt. The Canal could not be held without a fresh-water supply, and the possession of Cairo and the Nile is the key to the fresh-water canal supplying Ismailia and Suez. Had it been known that a plentiful supply of water could be obtained close to the maritime canal, independent of the Nile water, it is questionable how far any occupation of Egypt would have been necessary.

In such cases it is not sufficient that the Government subordinates should have a knowledge of geography, for, even if they are fully conversant with what they ought to know, it would be almost impracticable for them to convey to statesmen knowledge which their untrained minds render them incapable of retaining or making use of.

In settling political boundaries it may appear at first sight that they should coincide with certain geographical features, forming natural boundaries, not only in international matters, but also in cases of provincial, county, town, and parish boundaries, and also in accordance with historical associations; but we must do our statesmen the justice to admit that the deviations they adopt may not always be the result of ignorance, but arise from an astute perception that it may be necessary in the future to have a cause for further modification, or even for raising the whole question anew. It is difficult, however, to see how this can, with any propriety, arise in domestic matters, and, apart from the doubtful political morality involved, it would only occur in international matters on the assumption that our Empire is paramount, and can quarrel when it chooses; and, moreover, in such a case could only be justified by being carried out with so perfect a knowledge of geography that in any reopening of the question our country should be in the right; whereas bitter experience has shown us that our statesmen have almost invariably placed us in the wrong.

It is fatal in domestic matters to ignore the physical features within a country, and attempt to obliterate its historical and topographical associations, as the French Revolutionists attempted, by substituting their departments for the old provinces. This has only led to an artificial division, which has not taken root among the people, and French geographers are still calling attention to the absurdity of present divisions. In such cases we must keep alive to what are the ostensible and what the actual reasons for such changes, and if the so-called simplicity introduced by lawyer statesmen leads to increased law expenses, we may reasonably look with suspicion on such an interference with the economical administration of the affairs of the nation. In our own country geography is intimately connected with all kinds of divisions of land, which are dealt with by the administration. A simplification of the arbitrary political divisions, and a modification and synchronization of boundaries may lead directly to simplification of administrative machinery, and saving of expenses in salaries, &c. London itself is a glaring instance of the waste of money and friction of departments, from the extraordinary overlapping of boundaries—political, magisterial, petty-sessional, police, statistical, postal, public works, &c. Probably a great portion of the time and energies of the superior officers in the various departments is occupied in waging war on one another, keeping the peace, or temporizing with or watching each other; and this not from their own desire to quarrel, but from the fault of the system which overlaps duties as well as boundaries, and often gives one and the same duties to be performed by distinct departments. Perhaps, in some instances, this friction may call out latent energy, but it at least most successfully prevents departmental superiors from looking into their own departmental affairs, and developing and perfecting the local administration, and keeping up to the times.

With regard to international boundaries, too little attention is usually paid to the changes which are caused by the advance of civilization. For example, a natural boundary may, in time, become merely conventional owing to development of communications.

At one time the Rhine was a natural boundary, but it has now become a channel of communication. Again, the Zambesi is at present a national boundary, completely separating distinct tribes; the time may come when it also will be a great channel of communication. The usual natural international boundaries are broad or rapid rivers and arms of the sea, mountain ranges, deserts, and swamps; but the highlands and lowlands of a country are also naturally separated, as they usually are inhabited by people of different nationality.

In Europe we find natural boundaries gradually losing their efficiency as political boundaries. The Rhine, for example, throughout a great portion of its length has ceased altogether to be a political boundary, for though it is still a military line of great strength, each large town on either bank has its suburb on the opposite side, and the population has become so assimilated that the river has ceased to be a practical political line. Consequently the line of the Vosges is deemed by many to have become the natural boundary between France and Germany, on account of its coinciding with the linguistic barrier. But, again, linguistic boundaries are no tests of the limits of nationalities or national feeling. When a foreign language is forced upon an unwilling people, they may for many generations be acutely opposed to the nation whose language they have adopted. On the Lower Danube, however, the physical, linguistic, and political divisions all coincide, and the river has become neutralized, and is a natural boundary.

In Central Europe we find the highlands of the Alps forming the natural and political boundary, though the people speak three different languages; but in these cases the people probably will not be found to be of the same race as those speaking the same language in the plains below.

Again, in the Pyrenees we find a natural, political, and linguistic barrier coinciding, assisted by the fact that the mountain people are a different race from those in the plains to the north and south.

In our own country we have a curious instance of language being no proof of the nationality of the people, as the Iberians in Wales speak Celtic, and the Celts in Western Britain speak Anglo Saxon. Again, in South Africa we have the people of French extraction speaking Dutch, and still feeling resentment to the Government on account of its having forced a foreign language upon them, although the British have succeeded the Dutch.

Among Asiatic and African territories boundaries are often very ill-defined and uncertain. Frequently it happens that between two powerful States there is a large tract of country which owes a double allegiance, paying tribute to each, and yet in some respects remaining independent, probably consisting of lands which are easily ravaged and are comparatively speaking unprotected by Nature.

When we look into the subject of boundaries among pastoral tribes, we find curious anomalies. The land belongs in many instances to the tribe and not to the individual, and cannot be alienated. In the desert of Arabia a tribe in one part will have an interest in the date palms or corn lands of a tribe in another part, and this system is rather fostered than discountenanced, so that when evil befalls an individual in one part he may go and live with his tribal friends elsewhere. It is a knowledge of the intricate connexions of these tribes and the topographic divisions of their lands which admits of any control being kept over these warlike people. A mistake arising out of a misunderstanding of this Bedouin system nearly led to a disastrous result in the Egyptian campaign of 1882, owing to an outlying branch of one of the most powerful tribes in Arabia being supposed to be a petty independent tribe of no consequence.

In many instances the cattle posts of tribes during peace time by mutual consent intermingle and overlap, yet are kept separate and distinct, so that no geographical boundary is practicable; in fact among such people it is the tribe before the territory which is under the control of the chief. Thus it is quite practicable to conceive instances of a tribe living on lands within the area occupied by another tribe and yet governed by its own laws. Many of the difficulties the British have encountered in South Africa have arisen from a complete ignorance of, or wilfully ignoring, the native land laws. Under the tribal system even the chiefs in council have not the power of disposing of any portion of the land they use; it belongs to every individual of the tribe, and of the tribal branches, and to their children's children. Thus, when a chief gives over his territory, it does not follow that he gives over the land for disposal as Crown lands, but only the government of the people. It is on this account that the offer of Khama and other chiefs of the Bechuanaland territory was of so great value. They proposed by agreement in council in their respective territories to hand over to Great Britain their territories, keeping for themselves the lands they used, and offering for emigration purposes their vast extent of hunting lands, which are not now of the same value for hunting purposes as they were in former days.

But this proposal has not been accepted, and a parallel of latitude has been proclaimed without consent of the Bechuana chiefs as the northern limit of the British Protectorate, dividing Khama's territory into two parts, and cutting a portion of Matabeleland off from Lobongolo's territory; so that the Boers of the Transvaal cannot raid upon the Matabeles without violating the British Protectorate, and *vice versâ*, while we have no means of securing its protection. Again, the Matabeles when making their annual raid upon Lake Ngami will violate the portion of the State of Khama without the Protectorate, and he, if he wishes to oppose them, must do so from his capital within the Protectorate. This will bring us into conflict with the Matabeles, or else will practically deprive Khama of part of his territory.

It is difficult to conceive any arrangement more likely to lead to complications in the future. The Protectorate, based on geographical principles, should extend as far as the Zambesi, taking in all Khama's certain territory, and as much of the neutral territory as might be necessary to provide a natural boundary to east and west.

In East Africa, again, the definition of spheres of action recently is anomalous. A boundary ten miles from the coast for the Zanzibar dominions can of course have only a tentative character, and the exact definition in the future cannot fail to lead to conflicts. Far worse, however, is the adoption of the River Tana as the northern boundary of the British sphere of influence—a river occupied on both banks by the same agricultural tribes. It is not clear for what reason the Commissioners have left this difficulty for the future.

It would not be difficult to give many recent instances in which those charged with diplomatic definitions of international boundaries have failed in their duty owing to a want of geographical knowledge of the localities with which they had to deal.

For example, the boundary treaty of 1783 with the United States was incapable of being carried into effect, as the geographical features did not correspond with the assumption of the Commissioners. This led to a dispute lasting thirty years, resulting in the boundary treaty of August 9, 1843. The ignorance of the geography of the country in this case led to very inconvenient and even disastrous results.

Again with the San Juan controversy. Historical and geographical knowledge and ordinary care for the future development of Canada might have led to such measures having been taken in the first instance as would have prevented cession of valuable positions to the United States in 1846.

In India, again, our want of knowledge of the country to the north of the Afghan boundary has led to a series of unnecessary concessions to Russia. Had the slightest encouragement been given in former years by the Indian Government to enable officers to acquire information as to the territories beyond our Indian Empire, no doubt we should now be in a more secure position.

But, fortunately for the British Empire, foreign politicians have also much to answer for to their respective countries on account of their ignorance of geography.

For many years past Germany has been increasing the population of the United States and our own colonies without assisting to further the influence of the German Empire; whereas, had her statesmen been able to look forward, a German colony might have been established. Many Germans as far back as 1866 were desirous of establishing a colony in the Transvaal. But Germany now has to cast about for unoccupied territory, and has chosen a piece of useless territory on the western coast of South Africa, whereas with a little foresight Prince Bismarck might have obtained on easy terms the whole of the French colonies in the Gulf of Guinea and north of the Congo, which France had actually abandoned as worthless. Germany would thus probably have held the position of France with reference to the reversion of the Congo State.

By the Treaty of Frankfort it was intended that all German-speaking villages were to be ceded to Germany, but the boundary as originally laid down, for want of geographical knowledge on the part of German *employés*, left several German villages near Metz in possession of France, and it was necessary subsequently to rectify the error.

As a Section of the British Association we are interested in the development of geographical knowledge in the world generally, but more particularly in our own Empire, and it is only by unceasingly calling attention to our shortcomings with regard to the science which causes us to meet here to-day that we may hope for that progress to be made which will enable us to maintain the proud position we at present hold among nations owing to our practical skill and energy. Hitherto we have possessed so many other advantages that we have been able to dispense with a good system of instruction, but owing to many causes other nations are gaining upon us in various ways, and we in our turn should use every effort to successfully grapple with a subject which if properly taught must affect our welfare as a nation so deeply.

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SECTION G.

MECHANICAL SCIENCE.

OPENING ADDRESS BY PROF. OSBORNE REYNOLDS, M.A., LL.D., F.R.S., M.INST.C.E., PRESIDENT OF THE SECTION.

AT a meeting of the British Association in Manchester the subjects of interest to the members of this Section are sure to be numerous, and the attendance of those members whose opinions on the various subjects presented the Section will like to hear is sure to be such that every moment of the time at the disposal of the Section will be well occupied. It is also particularly undesirable to prolong the sittings, and so reduce the opportunities of visiting the Exhibition and numerous works which abound with things which cannot fail to be of intense interest to members of this Section.

For these reasons I feel extremely unwilling to occupy the time of the Section with more than the briefest remarks by way of an address. Indeed, were it not that when in this chair in 1872 Sir Frederick Bramwell laid down the rule that for the President to break the custom of an address would be to show disrespect to the Section, I should have felt justified in consulting my inclination and proceeding at once with the regular work which lies before us.

It is now twenty-six years since the last meeting of this Section was held in Manchester, and it certainly seems fitting that in an address on this occasion something should be said as to the achievements in mechanical science accomplished in the interval. I wish sincerely that the task had fallen to some of you, gentlemen, whose far greater experience and power of expression would have enabled you to do justice to the subject. But under the circumstances I can only ask you to take it as a mark of my extreme respect for the Section, and proof of the appreciation in which I hold the honour conferred upon me in placing me ln this chair, that I venture as a matter of duty to make a few remarks, of the inadequacy of which I am only too conscious.

It is always difficult to arrive at a just appreciation of the relative importance of the events of our own time; and in any endeavour to review or take stock of the mechanical advance of the last quarter of a century, during which time things mechanical have divided the attention of the civilized world with matters political, it seems very necessary to remember that as the mechanical age gets older its relative activity is not to be gauged by the relative number and importance of such epoch-marking mechanical departures as compared with those which have distinguished past periods.

If you recall—and again, to quote Sir Frederick Bramwell, the only purpose of an address is to force you to recall what you already know—in 1861 not only had we railways, ocean steam-ships, including the *Great Eastern*, still the giant of the tribe, a complete system of machinery for cotton and textile fabrics, besides the steam hammer, Armstrong's accumulator, and types of all machine tools, but also one attempt had been made to lay an Atlantic cable; the Suez Canal was in course of construction; if not perfected, the Bessemer process was in use; as were steam ploughs, steam threshing-machines, reaping-machines, and other agricultural machinery; we had also monster ironclads and rifled ordnance.

As new departures since 1861 which have already established themselves we have the telephone, the incandescent electric light, the dynamo and the secondary battery, the gas-engine and sewing-machine, not to mention the bicycle. We have also the tin can and freezing-machine and roller mills, as well as the machine gun and Whitehead torpedo.

One of these departures, the telephone, both from its usefulness and from the scientific interests which surround it, as affording, like the telescope, a means of directly increasing the power and range of one of our senses, must for ever remain recognized as a step in mechanical science for the introduction of which this period will be distinguished.

The sewing-machine, too, though little calculated to attract notice, in its influence on the welfare and appearance of all grades of society yields in importance to few, if any, previous mechanical steps. While the process of preserving food by means of the tin can and its more striking contemporary, the freezing-machine, direct results of the discoveries of Pasteur, have already opened up the food-producing resources of the whole world for the supply of the few chosen spots, and in doing so created a most welcome demand for further advance in the application of steam.

Great things have been and still are hoped from the electric departures which have interested us so much during the last few years; also of the gas-engine, which has most usefully occupied ground for which the steam-engine is not well adapted; and as to the importance of machine guns and torpedoes many will think the less the better.

However high or low an estimate we may form of the probable future importance of some of these inventions, and however much disappointment we may feel at the non-success which has attended some of the boldest and apparently most promising departures, such as the Crampton process for substituting a blast of coal-dust for the ordinary furnace, or Sir Henry Bessemer's endeavours to prevent distressing motion at sea, there is still no ground for discouragement.

For whether or not this period be henceforth remarkable for what, to borrow language from Section D, may be called the origination of new mechanical species, is a small matter compared with the fact that it has undoubtedly been remarkable for unprecedented achievements in the development of higher states of organization in those mechanical species which were already in existence.

There has never been a time in which mechanical revolutions have followed one another with such rapidity. In all the main departments of practical mechanics progress has been so rapid that appliances have been superseded long before reaching the term of their natural existence. There are some steamboats like the steel mail-boats between Dover and Calais still on the same service as in 1861, but very few, and only such as were then much in advance of their time. The Atlantic fleet of Royal mail-steamers has twice undergone complete revolution. Not only have the paddle-boats which constituted the Cunard line in 1861, and which included the *Scotia*, then new, entirely disappeared off the line, but the iron screw-steamers which displaced them have given place to the steel boats with compound engines—*Servia*, *Aurania*, *Etruria*, and *Umbria*.

In railway appliances the iron road has given place to that of steel, iron tires and locomotives to steel, the block system has become general, as have continuous brakes; while the carriages in which members have spent four hours and a quarter on their way from London to this meeting, although mostly still of the English plan, are very different in size and ease from those in which five hours and a half were spent in 1861.

In the works and mills the change is not less complete. It is, indeed, the change here that has not only rendered possible, but forced on, the revolution in our means of communication. The great step in the production of steel was already taken in 1861, and great results were then anticipated; there were, however, doubts and difficulties, and it was not for some years that sufficient mastery was obtained over the detail of the manufacture and use of the new material to bring about the general revolution which has therefore only reached its height during the last few years, if indeed it is yet reached—certainly it is yet far from complete.

To turn for one moment to the last year. Since the last meeting of this Section in Birmingham, the second Tay Bridge has been completed, over two miles long, having occupied only five years in construction.

The Severn Tunnel, one of the most difficult pieces of engineering ever attempted, has been completed and opened for passenger traffic.

The Forth Bridge, that structure the very thought of which causes those who have seen the place to hold their breaths, and of which the relative size may be best realized from the fact that, held out in arms an eighth part of a mile long, at a height of 200 feet above the sea, as a mother might hold out an infant, are structures no less than the single spans of the Britannia Bridge, 400 feet long. This gigantic structure, the progress of which Section G has watched since the meeting at Southampton, has now attained its full height of 360 feet, although otherwise not by any means fully formed.

Nor, as you well know, is it by the completion and progress only of great undertakings that this year is marked in the annals of engineering. It will be memorable, particularly in this district, as the year of the commencement of the Manchester Ship Canal. This undertaking, for which there is no precedent in this country, has excited so much interest that it cannot be otherwise than a matter of congratulation that a paper descriptive of this work is to be read before this meeting by the engineer, Mr. Leader Williams.

The completion of the Tay Bridge, the Severn Tunnel, the progress of the Forth Bridge, and the commencement of the Manchester Ship Canal in one year and in one country is sufficient assurance that, as yet, there is no lack of enterprise or sign of falling-off in heroic undertakings; nor are these by any means the only signs of great mechanical activity, notwithstanding the continual complaints of commercial depression.

In one direction, in particular, after many years of progress, so slow as to be something like stagnation, there has been a decided advance. The steam-engine is such a familiar institution, and has been for so long looked upon as the prime mover of our entire mechanical system, that anything which affects its welfare excites a deeper interest than would a mere mechanical advance. It was therefore with anything but a feeling of pure exultation that we heard and felt the force of predictions a very few years ago that the days of the supremacy of the steam-engine were numbered, that it would soon be a thing of the past, only to be found in the museum, a relic like Newcomen's engine and the stone implements by which our children would gauge the depth of mechanical barbarism of the age from which they had emerged. If sentiment be allowed in relation to anything mechanical, it must be with a sense of relief that it is now perceived how, so far from succumbing in the competition with what threatened to be formidable rivals, the only effect has been to bring about an important step in that internal development of the steam-engine which has been long looked for, but the accomplishment of which had for so long baffled the utmost efforts to bring it to a practical issue that it was almost despaired of—at least until it should be brought about by that circumstance which we all dread, the scarcity of coal.

The uppermost step of this advance yet reached is represented by the triple and quadruple expansion engines. These engines, of which the first seem to have been the triple engines of the *Propontis* in 1874, designed by Mr. Kirk, the next those of the steam yacht *Isa*, by Messrs. Douglas and Grant in 1878, and the third those of the *Aberdeen*, again by Mr. Kirk, in 1881, rapidly sprang into favour for cargo steamers, in which they have already proved of such advantage as to more than threaten the necessity of another revolution in steamships almost before the last is complete. Each week brings the announcement of some new accomplishment in the use of higher ratios of expansion and higher pressures of steam, so that while 60 or 70 pounds was the maximum three years ago, we now hear of 130, 150, and 175 pounds; and it is impossible to say to what they have not been carried at the present moment, and with commercial success.

There can be no doubt but that this latest step, as well as those of the surface-condenser, high-pressure boilers, and compound engines which led up to it have been the immediate results of the premium on economy of coal offered by the opening up of the long steam routes, first through the Suez Canal and recently round the Cape. But these steps must none the less be considered as the results of the unprecedented attention and labour, theoretical and practical, which has been devoted to this object during the last fifty years. They have been a result of the theoretical work of Carnot and Regnault, crowned by the great discoveries of Joule and Meyer, and the subsequent work of Rankine, Thomson, Clausens, and Hern, besides others, which, about the commencement of the period I am speaking of, accomplished that complete exposition of the principles underlying the internal economy of all heat-engines which have since furnished incitation and guidance to practical efforts. And not less have they been a result of the many practical attempts which have in the meantime been made to introduce similar and equally effective developments in the steam-engine without waiting till they were called forth by circumstances; as notable amongst which I may instance the labours and successes of Mr. Perkins, who has experimentally developed the organization of the steam-engine beyond any point it has commercially reached. Each and all of these efforts has undoubtedly taken part in that readiness to take the forward step, as soon as circumstances were favourable, which is as necessary to development as are the favourable circumstances themselves. The fact that a great advance has been made in the use of higher-class steam-engines, while it is the most gratifying circumstance one could have to record, affords the greatest encouragement to all those numerous workers for mechanical advance whose work is good, yet who do not see its immediate effect. It also emphasizes the lesson that the most perfect machine is that which is most perfectly adapted to the circumstances under which it has to work; and amongst these circumstances is efficient attendance, which involves sufficient knowledge of its requirements and familiarity with its detail on the part of those who have it in charge; and while in a process of gradual development this education is insured, in the case of a sudden step it is generally wanting.

How far the present advance towards the limits to economy which are theoretically evident may extend in the immediate future it would be dangerous to predict. The present rate is immense, and not by any means confined to the marine engine, although I am not aware of any other class of engine in which triple expansion has yet been adopted as a system. The recent compound pumping-engines have attained to a very high organization; and even in those classes of engines where economy of coal is more a matter of morality than of proved commercial importance, as mill engines and locomotives, great activity is evident in adapting and substituting compound engines, so as to allow of the use of greater pressures and higher degrees of expansion. The slow-breathing compound locomotive of Mr. Webb has drawn many members of this Association on their way to this meeting. Nor is the portable engine behind, as has been shown by the recent trials of the Royal Agricultural Society at York. The result of these trials cannot but offer the greatest encouragement to engine-makers of all kinds in their attempt at higher organization. It is indeed difficult to say which has been the most gratifying—the high state of economy which these trials have shown to be realized, or the reinstitution of the trials themselves after a lapse of twenty years, during which interval their non-continuance has called forth but one expression—that of regret.

These almost sudden steps towards the realization of efforts now extending over a century, to bring higher developments of the steam-engine into practical use, have not passed without notice. The interest and excitement amongst those more directly acquainted and concerned with the steam-engine and the use of steam are probably such as have not existed since the very early days of the railway. It is not, therefore, as something likely to be new to the members of this Section that I have dwelt upon it. Remembering that there was another subject other than actual mechanical achievements on which I was, as it were, in duty bound to say something, it seemed hopeless for me to attempt to touch on all the many advances towards a higher degree of organization in mechanics which constitute the mechanical feature of our era. I therefore have chosen this decided movement of the prime mover as the most significant and most gratifying, besides being of a kind the full importance of which is not so likely to be generally apprehended until pointed out, as the importance of advances such as the electrical and metallurgical, involving some new departure or novel application.

That the character and rate of recent mechanical advance are both exactly such as would be expected to follow as the result of a deeper and broader knowledge of scientific methods and the principles involved, seems to be the very best proof of advance in that other side of mechanical science in which this Section takes interest, or, more correctly, for which it exists—the increase and spread of mechanical knowledge.

It is as impossible as it is unnecessary for me to comment on the *furore* to which the movement first for popular scientific and now for technical instruction has reached—bringing into existence, by means of South Kensington, a complete system of sensibly free elementary scientific education over the country; then the City and Guilds Technical Schools, with a general system of examination; and culminating in a Parliamentary Commission on Technical Education, with the prospect of seeing its labours result in an Act of Parliament providing for absolutely free technical instruction.

Elementary education, whatever may be its subjects, must of necessity depend for its permanent existence on some source of higher knowledge in those subjects. Without raising such questions as whether there exist at present means of training efficient teachers in all the branches for which technical education is promised, or whether such means will be forthcoming as a result of the demand for teachers, I would recall to your attention the recent progress made towards a higher training in that branch of science which most directly relates to mechanical progress, and which, according to no less an authority than the late Prof. Rankine, received its first impulse from the institution of Section G.

So long ago as 1855, Rankine, in his characteristically concise address, dwelt upon the good work which this Section was doing in making it known that the application of the laws and principles of abstract mechanics to the purposes of practical mechanics constitutes a science of itself; a science the knowledge of which is essential before a knowledge of mathematics and abstract science can be of use to the practical engineer or mechanic; and for this science he then and there claimed the name of Applied Mechanics. As a proof of the influence of Section G in making known the usefulness of this science he instanced the apparent increase in the desire to profit by the lectures of the late Prof. Lewis Gordon which had taken place since the Section was instituted.

Prof. Gordon, who held the Chair of Mechanics in Glasgow University, was the first in this country to collect and embody in his lectures, and subsequently in a text-book, the important though scattered results of individual efforts to found the laws of practical mechanics on exact science. And at the time Rankine was speaking, this chair, to which Rankine himself was called the same year, was the only chair in this country from which such lectures were given.

Since that time the appreciation of that science has steadily increased; other colleges took up the subject mostly as forming part of courses entitled engineering or naval science. Amongst these was Owens College, in which, not till after the last meeting in Manchester of this Association, the leading engineers founded and endowed, which is more important, the chair which it has been my fortune to occupy for nineteen years.

During the earlier part of this time both teachers and students were labouring under the disadvantage arising from the novelty of the subject—the former having to make an almost arbitrary selection of what they would teach, and the latter not knowing exactly what it was they were going to learn. Gradually, however, by the help of experience from the somewhat earlier French schools and with the admirable works of Rankine as a foundation, the lectures or theoretical courses have become clear and distinct, while the advantage to be gained has become so generally recognized that of late years there has been almost a scramble to found new colleges to teach engineering or to introduce such teaching into existing colleges; and most satisfactory to those engaged in the introduction of this subject is the fact that it is from the engineers themselves that the interest and funds necessary for this work have come. Since 1867 the Owens College has received gifts and bequests from engineers, including those of highest standing in the neighbourhood, of upwards of £150,000. In the same way at Sheffield and at Leeds, where, as is well known, an engineering school has just been founded by Sir John Hawkshaw and the engineers of the town, and again at Liverpool.

It cannot for one moment be doubted that this movement has been brought about by the conviction of the necessity of an education which, in its subjects and methods of teaching, is much more closely related than was the older system of the Universities to the actual work which the students may eventually be called upon to undertake. That it is in fact evidence of the appreciation, by those having the greatest experience, of the necessity of higher scientific training for engineers. This is what engineering schools during their struggle for existence have endeavoured to supply. And in spite of the danger which seems to beset all schools as they become older, to fall into the academic or pure—not because it is the most desirable to be learnt, but because it is by far the easiest to teach—in spite of this danger, such in this case is the pressure from without, that it may be hoped the schools of engineering and applied science may be kept up to the mark, both in extending our knowledge of the laws and principles which more immediately underlie the results of practical experience in art, and in teaching the methods of most useful application; and that while encouraged to offer every inducement to the attainment of a sound knowledge of the principles, they will not be allowed to fall into the fatally easy errors of carrying the abstractions of this science outside all possible application, or blocking the way by the insistence on impossible preliminary attainments in mathematics and pure science.

To be hailed as one of the greatest inducements to keeping alive in engineering schools a real scientific interest in the practical work which is going on around them is the introduction of what are now called engineering laboratories, in which students may familiarize themselves with the actual subjects for which the theoretical work is undertaken, and have placed before them in their most naked forms the data and mechanical actions on which practical achievements depend, as well as being taught the use of all those instruments and methods of measurement which it is one of the first objects of these laboratories to extend and to perfect, and which measurements are now, as the result of a better knowledge of principles, rapidly displacing the older methods of arriving at conclusions in engineering.

It is to our Continental neighbours that we principally owe the origination of these laboratories as a means of research, but, as a system of instruction distinct from a workshop it owes much to Prof. Kennedy, who was, I believe, the first to introduce the testing machine and regular engine trials as part of the regular course of instruction for students in engineering, under the title of a laboratory course. The want of such a course must, however, it would seem, have been severely felt, to judge by the rapidity with which Prof. Kennedy's example has been followed in almost all the engineering schools in the country.

It is true that as adjuncts to academic institutions these laboratories can hardly be said to have passed the experimental stage, and it evidently remains to be seen whether when the present arrears of outstanding questions in engineering science are worked up, and the courses of instruction become stereotyped, sufficient variety of work will be found to justify the expense which, both as regards qualified instructors and maintenance of apparatus, must, as compared with the number of students receiving instruction, be greater than is general with academic instruction. At present, however, thanks to the liberality of engineers and their friends, there seems no ground for fear, each new laboratory being furnished with more complete and expensive apparatus than the last. During the erection and fitting of the Whitworth Laboratory in Owens College, which is only now on the verge of completion, it has been very impressing to see the goodwill shown toward the work by everybody who has had to do with it; the ready help of engineers of the greatest experience, like Mr. Rambottom and Mr. Robinson, who have spared neither time nor trouble in giving it the benefit of their experience; also by those who have undertaken the construction of the appliances, particularly Mr. William Mather, of Salford Iron Works, where neither trouble nor money has been considered in the efforts made to render the engines for the laboratory as perfectly adapted as possible to the very novel and numerous requirements. Taking this particular instance as evidence not only of the general feeling in favour of this movement, but also of the solid support it is to receive, one cannot help concluding that there is a great future before it; and that at last a method has been found of extending and spreading the higher knowledge of mechanical science which commends itself alike to the practical and theoretical.

Everyone who has paid attention to the history of mechanical progress must have been impressed by the smallness in number of recorded attempts to decide the broader questions in engineering by systematic experiments, as well as by the great results which in the long run have apparently followed as the effect of these few researches. I say apparently, because it is certain that there have been other researches which probably, on account of failure to attain some immediate object, have not been recorded, although they may have yielded valuable experience which, though not put on record, has, before it was forgotten, led to other attempts. But even discounting such lost researches, it is very evident that mechanical science was in the past very much hampered by the want of sufficient inducement to the undertaking of experiments to settle questions of the utmost importance to general advance, but which have not promised pecuniary returns—scientific questions which involved a greater sacrifice of time and money than individuals could afford. In recent periods the aid and encouragement which it has been one of the first objects of the British Association to afford such researches has led to many results of the greatest importance, both directly and indirectly, by the effect of example in calling forth aid from other institutions—that of mechanical engineers, for instance, which recently induced Mr. Tower to carry out his already celebrated research on "The Friction of Lubricated Journals," the results of which research certainly claim notice as constituting one of the most important of recent steps in mechanical science. Such investigations it is now the function as well as the interest of mechanical laboratories to undertake, and thus what has hitherto been a great obstacle in the path of mechanical progress seems in a fair way to be removed and steady advance to be insured.

To what all this may lead us it is no part of my undertaking to consider, but I venture to end this imperfect address on the progress of mechanical science during the past twenty-six years by what appears to me the most satisfactory conclusion—viz. that to such mechanical progress there is apparently no end: for, as in the past so in the future, each step in any direction will remove limits and carry us past barriers which have till then blocked the way in other directions; and so what for the time may appear to be a visible end or practical limit will turn out but a bend in the road.

NOTES.

DR. JOHANNES SKALWEIT, the well-known chemist, has died at Hanover, of heart disease. The deceased was in the prime of life, and enjoyed a high reputation all over the Continent. He was, according to the *Times*, President of the German Union of Analytical Chemists—whose annual conference has been postponed in consequence of his death—and editor of the *Repertorium für Analytische Chemie*. A large number of essays and other short works on questions of sanitary science, State medicine, and chemical analysis have issued from his pen. Among the most important may be mentioned "Ueber Fette im Polarisirten Licht" (Hanover, 1879); "Ueber die Titration der Phosphorsaüre mit Uran" (Hanover, 1880); "In wie weit ist der heutige Kampf gegen die Lebensmittelfälschung gerechtfertigt?" (Hanover, 1880); "Ueber die Beziehungen zwischen Bauordnung und Oeffentlicher Gesundheitspflege" (Magdeburg, 1885). Dr. Skalweit was an authority on milk and butter analysis.

SIR WILLIAM GROVE, F.R.S., has resigned his seat on the Bench as Judge of the High Court of Justice.

THE Secretary of State for India has sanctioned the appointment of a scientific assistant in the Revenue and Agricultural Department of the Government of India, and Dr. Watt, C.I.E., has been selected for the office.

MR. G. BROWN GOODE has been appointed United States Commissioner of Fish and Fisheries in succession to the late Prof. Spencer Baird. *Science* approves highly of the appointment, observing that it meets at once the requirements of an exacting office and the exceptional provisions of the law creating it. "Prof. Goode was intimately acquainted with the methods of Commissioner Baird, whose scientific zeal and knowledge he shared, and his experience and attainments in practical fish culture and in the science of ichthyology made him easily first among those whose qualifications the President has been called upon to consider." At the same time it regards the provisions of the law under which the appointment was made as sadly in need of amendment, for under them the Fish Commissioner is not paid a salary commensurate with the importance of his office, and discharges the duties of two offices for the pay of one.

ACCORDING to a Reuter's telegram, dated September 9, from St. Paul de Loanda, Major Barttelot, who was left at the camp at Yambunga at the foot of the Aruwhimi Rapids with a garrison of about 100 men, has forwarded the following information to Leopoldville concerning Mr. H. M. Stanley's Expedition:—"Major Barttelot received news from Mr. Stanley, despatched about July 12, after he had made a ten days' march from Yambunga towards the interior. Mr. Stanley was at that date still proceeding up the Aruwhimi, which he had found to be navigable up to a certain distance above the rapids. Here he launched a steel whale-boat which he had brought with him, as well as several rafts manufactured by the Expedition, and which had been utilized for conveying the heavy baggage. All the members of the Expedition were in good health, and provisions were easily procured in the large villages near the river. The country through which the Expedition was passing showed a gradual rise towards some high table-lands. Another caravan of 480 men was following the Expedition on the left bank of the Aruwhimi, the advanced guard, consisting of forty Zanzibaris, under the command of Lieut. Stairs, being composed of men lightly burdened, whose duty was to search for provisions. Mr. Stanley hoped to arrive about July 22 in the centre of the Mabodi district, and expected to reach Wadelai in the middle of August, or even before. The advance had been so peaceably accomplished that Mr. Stanley had instructed Major Barttelot that, should it continue so, he would shortly send him orders to follow the Expedition by the same route at the head of the 100 men left at Yambunga." Major Barttelot had paid a visit to the Falls, accompanied by Tippoo Tib, and had left a detachment of twenty men there. Tippoo Tib arrived at the Falls Station on June 16.

IN moving the second reading of the Coal Mines Regulation Bill in the House of Lords on the evening of the 7th instant, Viscount Cross said he took that opportunity of tendering the thanks of the Government to the Royal Society for the trouble they had taken in the matter of coal-mines. In the year 1879 he had asked the Society to join, or send some of their members to assist, the Royal Commission which was then appointed for the purpose of seeing how accidents in mines could best be prevented. The Royal Society, he said, met the appeal in the most handsome way, and several of their most distinguished members served on the Commission. The labours of the Commission lasted for a period of six years; they went minutely into a long series of experiments, and while he was quite sure the results of those experiments would tend greatly to the safety of life and the prevention of accidents, it was satisfactory to know that they had also added very much to their own scientific knowledge, because he believed the members of the Commission all candidly admitted that in the course of their investigations they made several discoveries about gases and other matters that were absolutely unknown to them before. The result had been that a great many of their recommendations had been embodied in this Bill.

THE International Medical Congress at Washington held its final sitting on the 10th inst. The meeting for 1890 will be held at Berlin, with Prof. Virchow as President.

THE Technical Schools (Scotland) Bill was read a third time in the House of Commons on Friday night last, and a second time in the House of Lords on Tuesday night.

THE Japanese Minister of Education has invited the Seismological Society, the Institute of Architects, the Association of Engineers, and the Physical and Mathematical Society to appoint a joint committee to examine and report upon the type of buildings best calculated to resist the effects of earthquake shocks, as well as the methods by which these effects may best be mitigated. Formerly Japanese houses were built wholly of wood; but of late years brick and stone are being largely employed. Many public edifices are now constructed of masonry, and almost all public buildings will in future be of this character. The Minister of Education accordingly thinks it well that the subject of the protection of these from the results of earthquake shocks should be carefully studied by competent persons.

THE meeting of the Astronomische Gesellshaft at Kiel, under the presidency of M. Auwers, terminated on the 31st ult. The meeting for 1889 will be held at Brussels. Amongst the papers read was one by M. Peters, of Kiel, on the causes of error in marine chronometers, based on observations in the German marine. One source of error was found to be variations similar to those caused by differences of temperature, and produced by the great humidity of the air at sea. Prof. Gylden described a new and simple method of maintaining chronometers at a constant temperature. There were some discussions on the orbits of comets. Prof. Shœrer read an historical paper on sunspots, based on a manuscript of Stolberg, commenced in 1749 and concluded in 1799. From this it appears that the periods observed in 1700 were quite different from those noticed in our own day. Between 1645 and 1670 the spots were very much fewer. Other circumstances also show that these phenomena are subject to curious vicissitudes. At the final meeting on August 31 the Congress was mainly occupied with photography. M. Hartwig presented a plan of the Bamberg Observatory, and M. Hertz described the new Observatory at Vienna.

WE have received the programme of Technological Examinations for the coming year of the City and Guilds of London Institute. Amongst the alterations and additions for the year are the following: the grant made to teachers on account of students who are awarded the full technological certificate in the honours grade of any subject is £3 for a first class, and £2 for a second class certificate; the examination in subject 29 is divided into two parts; the syllabus of 16B has been reconstructed; the syllabus in subject 2 and also that in 3A are new, and in many other cases the syllabuses have been revised and altered.

WE have received the Calendar of the University College, Dundee, for the coming academical year. The volume also contains the report of the Principal for the session 1886-87. The latter exhibits very satisfactory progress in every direction.

MR. ALVAN CLARK, of Cambridgeport, Mass., U.S.A., who died the other day at the age of eighty-three, had made for himself a splendid reputation as an optician. Mr. Clark was what is called a self-made man, as his education was neglected, and at the age of seventeen he was thrown on his own resources. For some time he supported himself by engraving for calico-printing at Lowell. Afterwards he became a painter of miniature portraits on ivory. In 1835 he opened a studio at Boston, but in the following year he removed with his wife and family to Cambridgeport, where he ever afterwards resided. His attention was attracted to the making of telescopes almost by accident, and he began his labours in this department with telescopes of small sizes. His first success was a 4½-inch instrument, with which he discovered that the star 8 Sextantis is double. Other discoveries soon made his lenses well known; and he may be said to have established his reputation by the production of the 18-inch refractor ordered for the University of the Mississippi. The use of this glass, before the completion of the telescope, led to the discovery of the companion of Sirius—a discovery which was rewarded with the Lalande medal of the Paris Academy of Sciences. Since that time some of the largest telescopes in existence have been made by Mr. Clark and his sons. The telescope constructed by them for the Naval Observatory at Washington is of 26 inches aperture, and the magnificent instrument now being made for the Lick Observatory, Mount Hamilton, California, is of 36 inches aperture. Clark telescopes are known in every part of the world where astronomy is seriously studied.

THE inaugural address at St. Thomas's Hospital Medical School, at the commencement of the session 1887–88, will be delivered in the theatre of the hospital on October 1 at 3 p.m. by Mr. R. W. Reid, F.R.C.S.

A NOTE was presented by M. Ch. V. Zenger, at the meeting of the Paris Academy of Sciences on September 5, on a possible relation between the periodical showers of shooting-stars and the occurrence of fires of unknown origin. From a study of the statistics for several years, he infers that such coincidences are extremely frequent, the fires usually breaking out in woods, farmsteads, barns, mills, and also in villages and even in large towns. He points out that during the period from August 1 to August 18, 1887, violent storms, rich meteoric displays, and conflagrations were of frequent occurrence.

PROF. DITTMAR, of the Glasgow and West of Scotland Technical College, is about to publish a series of exercises in quantitative chemical analysis, with a treatise on gas analysis. The publishers are Hodge and Co., Glasgow.

A NEW gaseous oxide of manganese, of the composition MnO_4, has been discovered by Dr. Franke (*Journ. für praktische Chemie*, 1887, No. 14, p. 166). This new gas, which possesses a dark blue colour, is readily obtained by passing a current of carbonic acid gas, saturated at 40° to 50° C. with aqueous vapour over the new oxysulphate of manganese, $(MnO_3)_2SO_4$, recently described by Dr. Franke; the issuing mixture of gases is afterwards passed through two U-tubes, in the first of which the less volatile MnO_3 condenses out, while the MnO_4 may be condensed at a lower temperature in the second to a bluish-violet amorphous body, which after long shaking dissolves in water with evolution of oxygen and formation of a bright red solution which is found to contain manganic acid. The properties of the tetroxide MnO_4 are sharply distinguished both from those of the trioxide MnO_3 and those of the heptoxide Mn_2O_7, in fact it is possible, owing to its small affinity for water, to collect the gas at the pneumatic trough. The decomposition of the oxysulphate by aqueous vapour probably occurs as follows: $(MnO_3)_2SO_4 + H_2O = MnO_4 + MnO_2 + H_2SO_4$.

IN addition to this most interesting gaseous oxide, Dr. Franke has also prepared a crystalline oxide of the composition Mn_5O_8, by treating a new double sulphate of manganese and potassium, $2Mn_5(SO_4)_8 . 5K_2SO_4$, with a large quantity of water, when brilliant yellow tabular crystals of Mn_5O_8 fall out, and may be isolated by removal of the supernatant acid liquid by decantation. After washing successively with water, alcohol, and ether, and drying at 80° to 100°, the oxide has the appearance of a brownish-black mass, which on closer examination is found to consist of small yellowish metallic-looking plates. Dilute sulphuric acid decomposes it with formation of two molecules of $MnSO_4$, and one molecule of the hydrate of manganese dioxide, $3MnO_2 . 2H_2O$; hence this new oxide may be considered to have the constitution $3MnO_2 . 2MnO$.

THE fauna of the Kirghiz Steppe is the subject of a short but suggestive paper by M. Nazaroff, in the Bulletin of the Moscow Naturalists (vol. lxii., No. 4). The zoological sketch is preceded by a very clear summary of the orography and geology of the region, and by a picture of its present vegetation; a map shows the limits of the forest tracts, the meadow-land with scattered, mostly deciduous, forests, the steppe-land covered with *Stipa*, the *Artemisia* steppe, and the deserts. The animal inhabitants of these different sub-regions—mammals and birds—are described and tabulated, and very interesting conclusions are arrived at. It appears that when most of Russia was covered with the immense Scandinavian and Finnish ice-cap, and the Aral-Caspian Sea covered the steppes, the Southern Urals—as already pointed out by M. Menzbier in his "Géographie Ornithologique"—remained a refuge for many animal species. Owing to the greater moisture, the vegetation of the region was much richer than now, and thus it provided plenty of food for many animals, some of which were immigrants from the north, while others came from the south. It is for this reason that the fauna of the Southern Urals offers now such a great variety of forms. Many species have abandoned the region recently. In the last century the *Equus onager* and the wild horse were numerous in the Southern Urals, while the castor was common in the land of the Bashkirs, bears and *Cervus alces* were frequent in the steppe, and tigers reached Turgai. The corsac fox went as far as the 51st degree of latitude, and the sub-polar *Arctomys bobac* was widely spread in the forest region, while the reindeer, now found only beyond the 53rd degree, reached the southern parts of the Urals. Immense herds of antelopes abandoned the region only about thirty years ago. Notwithstanding this notable diminution of species inhabiting the Kirghiz Steppe, its fauna is still remarkably varied. As a whole the paper of M. Nazaroff, revised by M. Menzbier, will be most welcome to zoo-geographers. It is one of those partial, but not narrowly conceived descriptions of a limited region which are most needed now, when materials are so rapidly accumulating.

THE additions to the Zoological Society's Gardens during the past week include a Larger Hill Mynah (*Gracula religiosa*) from India, presented by Mr. P. Wilmot Bennitt, F.Z.S.; a Peaceful Dove (*Geopelia tranquilla*) from Australia, presented by Mr. R. O. Law Ogilby; a Green Bittern (*Butorides virescens*) from the West Indies, presented by Miss Mayrick; a Mexican Crocodile (*Crocodilus rhombifer*) from the West Indies, presented by Capt. J. Smith, s.s. *Godiva;* seven Angulated Tortoises (*Chersina angulata*), two Hoary Snakes (*Coronella cana*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; ten Short-nosed Sea-horses (*Hippocampus antiquorum*) from European coasts, presented by Prof. W. H. Flower, C.B., F.R.S.; a ——— Flying Squirrel (*Pteromys* ———) from Szechuen, China, presented by Mr. Percy Montgomery; a ——— Frog (*Discoglossus pictus*) from Sardinia, presented by Mr. Alban Doran, F.R.C.S.; an Oyster-catcher (*Hæmatopus ostralegus*) British, nine Smaller Rattlesnakes (*Crotalus miliarius*), four Testaceous Snakes (*Ptyas testacea*), two Alleghany Snakes (*Coluber alleghaniensis*), seven Milk Snakes (*Coluber eximius*), a Seven-banded Snake (*Tropidonotus leberis*), a Striped Snake (*Tropidonotus sirtalis*) from North America, deposited; two Common Squirrels (*Sciurus vulgaris*) British, a White-eyebrowed Guan (*Penelope superciliaris*) from North-East Brazil, two Smaller Rattlesnakes (*Crotalus miliarius*), a Testaceous Snake (*Ptyas testacea*), two Milk Snakes (*Coluber eximius*), a Copper-bellied Snake (*Tropidonotus erythrogaster*) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

THE NEUCHÂTEL OBSERVATORY.—Dr. Hirsch, the Director of the Neuchâtel Observatory, has published his Annual Report for the year 1886, dated June 21, 1887. On the whole, Dr. Hirsch reports that, as far as his Observatory is concerned, the year 1886 was somewhat more favourable for astronomical observations than was 1885. In 1886 there were 154 nights on which observations were made, and 124 days on which no observations were possible, the longest interval without observations having been 7 days; whilst in 1885 the number of observing nights was 150, the number of days without observations 135, and the longest interval without observations 20 days. The meridian observations made during the year comprise 192 observations of the sun, 16 of planets, 1401 of fundamental stars, and 909 of stars contained in M. Lœwy's Catalogue of Moon-Culminating and Longitude Stars. The equatorial telescope has been employed in the observation of planets and comets with the ring micrometer, the position micrometer not being available until the small incandescent lamps, which are to be provided for purposes of illumination, have been supplied. Dr. Hirsch gives some interesting particulars with regard to the azimuthal movements of the meridian circle, as well as of the distant marks used for determination of azimuth error. The maximum easterly azimuth (+ 3·03s.) of the meridian circle during the year was observed on March 11, whilst the maximum westerly azimuth (− 1·02s.) was observed on September 1; the total range throughout the year 1886 was therefore 4·05s., the corresponding mean value for 22 years being 5·20s. It appears, however, that the three meridian marks (two to the north and one to the south) do not participate in this movement. The azimuth of one of the north marks, situated at a distance of 100 m. from the Observatory, varied during 1886 between + 0·24s. on May 19 and − 0·25s. on August 29, thus showing a total range of only 0·49s. The other more distant north mark showed a range of 0·42s., the extremes being + 0·18s. on April 16 and − 0·24s. on August 7; whilst the south mark at about 10 km. distance varied from + 0·40s. on May 14 to − 0·01s. on July 3, the range being therefore 0·41s. The marks are consequently well adapted for determining the azimuth of the meridian circle, the mean of the three giving this element, according to Dr. Hirsch's estimation, to ± 0·012s. nearly.

THE WEDGE PHOTOMETER.—Prof. Pickering has recently published two papers relating to the wedge photometer employed by Prof. Pritchard in the formation of his Oxford Uranometria. The first of these, forming No. 2 of the papers comprising vol. xviii. of the Annals of the Harvard College Observatory, consists in a detailed comparison of the Oxford magnitudes with those of Wolff's second Catalogue, and of the Harvard Photometry. The latter comparison appears to show the existence of some real, though small, systematic error, since the mean difference of magnitude between the two catalogues changes with the brightness of the star; the Oxford magnitude being on the average less than the Harvard magnitude for stars down to the third magnitude, but greater for the fourth and fifth, and less again for stars below the sixth magnitude. If stars below the sixth magnitude be put aside as influenced by some special cause not yet ascertained, the results would seem to suggest the use of a different constant in the reduction of the observations made by means of the wedge from that actually employed. The comparison of the three catalogues gives the following result: mean deviation of Wolff's catalogue from that of the Harvard College, 0·140; Oxford from Harvard, 0·146; Oxford from Wolff's, 0·191. On the whole, therefore, the mean outstanding differences are but small, but will evidently repay further and detailed investigation.

The second paper, which was presented to the American Academy of Arts and Sciences last November, is an investigation into the behaviour of a wedge photometer similar to those used by Prof. Pritchard. Its first portion contains some trial observations made by Prof. Young with a wedge photometer attached to the great Princeton refractor on the stars in the "region following γ Pegasi" of the American Association star magnitude charts. The result was decidedly favourable to the wedge, as, though all the stars observed were faint, the magnitudes ranging from 10 to 13, the probable error of the magnitude determined from four nights' observations was ± 0·04. The second portion of the paper contains a very full and interesting examination by Prof. Langley, by means of his bolometer, of the coefficients of transmission of the wedge. Here again the result of the examination is, on the whole, favourable to the wedge within the limits that Prof. Pritchard employed it; but it appears that there is a remarkable variation in the coefficient of transmission for the different rays of the spectrum. Speaking broadly, the transmissibility always increases from the violet towards the red, increasing very greatly in the infra-red. Within the visible portion of the spectrum the change in the transmissibility only becomes great as the red is approached, and as Prof. Pritchard had always recognized the inapplicability of the wedge photometer to deeply-coloured stars, this selective absorption will probably have but little affected its practical value in the work on which it was actually employed.

BROOKS'S COMET.—Dr. Franz gives in the *Dun Echt Circular*, No. 151, the following elements and ephemeris for this object, based upon observations obtained with the Königsberg heliometer on August 27, 28, and 29 :—

T = 1887 October 13·6623 Berlin M.T.

$$\left.\begin{aligned} \pi - \Omega &= 72^\circ\ 9'{\cdot}7 \\ \Omega &= 85\ 29{\cdot}2 \\ \iota &= 45\ 49{\cdot}0 \end{aligned}\right\} \text{Mean Eq. } 1887{\cdot}0.$$

$$\log q = 0{\cdot}08481$$

For Berlin Midnight.

1887.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
Sept. 16	10 16 6	29 55·3 N.	0·0861	0·2843	1·5
20	10 36 30	29 31·3	0·0785	0·2779	1·6
24	10 57 10	28 56·5	0·0719	0·2725	1·7
24	11 17 57	28 10·4 N.	0·0663	0·2682	1·8

The brightness on August 27 is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *SEPTEMBER* 18–24.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on September 18

Sun rises, 5h. 41m. ; souths, 11h. 54m. 8·9s. ; sets, 18h. 7m. ; decl. on meridian, 1° 54′ N. : Sidereal Time at Sunset, 17h. 56m.

Moon (at First Quarter Sept. 24, 5h.) rises, 6h. 30m. ; souths, 12h. 50m. ; sets, 18h. 55m. ; decl. on meridian, 0° 11′ N.

Planet	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury	6 15	12 20	18 25	0 15 N.
Venus	6 36	11 59	17 22	8 2 S.
Mars	1 42	9 20	16 58	17 45 N.
Jupiter	9 27	14 26	19 25	12 28 S.
Saturn	0 44	8 35	16 26	19 38 N.

Occultation of Star by the Moon (visible at Greenwich).

Sept.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
24	29 Sagittarii	6	22 43	23 24	180 264

Sept.	h.	
20	6	Jupiter in conjunction with and 4° 18′ south of the Moon.
21	16	Venus in inferior conjunction with the Sun.
23	9	Sun in equator.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
λ Tauri	3 54·4	12 10 N.	Sept. 19,	0 51	*m*
			,, 22,	23 43	*m*
R Canis Minoris	7 2·5	10 12 N.	,, 21,		*M*
U Monocerotis	7 25·4	9 33 S.	,, 24,		*M*
S Cancri	8 37·5	19 26 N.	,, 18,	3 39	*m*
δ Libræ	14 54·9	8 4 S.	,, 19,	3 39	*m*
			,, 23,	19 22	*m*
U Coronæ	15 13·6	32 4 N.	,, 23,	0 17	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 21,	3 59	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·5	27 47 S.	Sept. 21,	23 0	*m*
			,, 24,	20 0	*M*
W Sagittarii	17 57·8	29 35 S.	,, 19,	19 0	*m*
β Lyræ	18 45·9	33 14 N.	,, 21,	22 0	*M*
η Aquilæ	19 46·7	0 43 N.	,, 18,	23 0	*m*
δ Cephei	22 25·0	57 50 N.	,, 22,	20 0	*M*

M signifies maximum ; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near α Arietis	31°	20° N.	
,, η Aurigæ	74	41 N.	Swift ; streaks.
,, δ Draconis	290	70 N.	Swift.

GEOGRAPHICAL NOTES.

To the September number of *Petermann's Mitteilungen* Dr. G. Gürich contributes a useful sketch of the geological structure of the African continent. Much of his article is devoted to the Atlas and Cape regions, and that naturally, since on these regions the material is most abundant, only scanty notes for the most part being available for Central Africa, where, however, the prominence of granite Dr. Gürich thinks specially noteworthy. To the same number Dr. Baumann, the companion of Dr. Lenz, contributes a fairly detailed study of the physical geography of Fernando Po, where he stayed for some time on his return from the Congo. Both papers are illustrated by maps, that of Fernando Po being a specially good one on a large scale. Dr. Radde continues his preliminary account of his journeys in 1886 into the Transcaspian region and North Khorassan.

HERR ED. GLASER contemplates a third journey into Southern Arabia, and will attempt to explore the northern and eastern part of the old Sabæan kingdom, which in his first two journeys he was not able to reach. If political conditions permit, he will also cross the Serat Mountains into a part of Hadramaut hitherto almost unexplored.

AN original communication of some value on the aboriginal Indian races of Vera Cruz, Mexico, by Consul A. Baker, will be found in the September number of the Proceedings of the Royal Geographical Society.

IN the course of a short exploratory visit of six weeks' duration, in March and April last, to the delta region known as Aird River, New Guinea, Mr. Theodore Bevan made the important discovery of two large rivers, flowing from the interior highlands, at a distance apart of about 60 miles, into that part of the Gulf of Papua. One of these, the Douglas, enters the head of the Aird delta, and the other discharges at Bald Head ; both rivers were navigated for about 100 miles.

WITH reference to the recent Russian expedition to the New Siberian Islands, we learn further that Von Soll made a special exploration of the mountain in New Siberia known to travellers of the beginning of the present century as the "Wood Mountain," which was found to be a beautiful Tertiary profile with carbonized tree trunks, and a rich collection of leaf impressions and fruits, corresponding exactly with the Tertiary flora of Greenland and Spitzbergen, as described by Heer. He made a complete circuit of Kotelnoy Island in forty days, obtaining from the northern point a view of the still untrodden land of Ssanikow, 100 miles distant. The northern part of Kotelnoy is Devonian, and the southern Trias. On Liakov Island, Dr. Bunge found that, with the exception of some granite peaks, the prevailing formation is Quaternary. The ice blocks are covered with loamy deposits, in which are found fossil bones. Besides the fossil remains of the mammoth, rhinoceros, and musk-ox, Dr. Bunge discovered the remains of two species of oxen, deer, horses, and some smaller animals. About seventy Phanerogams were collected. Both birds and insects are poorly represented.

THE India-rubber, Gutta-percha, and Telegraph Works Company have issued tables of the soundings taken by their vessels in 1885–87 in the two Havanna expeditions, the second West African expedition, and the Congo repairs expedition.

GRANTS FOR SCIENCE AND ART INSTRUCTION.

A SUMMARY of grants made by the Department of Science and Art is printed in the new number of the "Directory," issued by the Department, containing regulations for establishing and conducting Science and Art schools and classes. The summary is as follows :—

1. Payments to the Local Committees of Schools and Classes on the results of instruction, as tested by Examination, of Students of the Industrial Classes.

Science.	Art.
(*a*) £2 and £1 for a 1st and 2nd class respectively in the Elementary and Advanced Stage of each subject. (*b*) £4 and £2 for a 1st and 2nd class respectively in Honours. (*c*) In Practical Chemistry and Practical Metallurgy £2 and £1 for a 1st and 2nd class respectively in the Elementary Stage, £3 and £2 in the Advanced Stage, and £4 and £3 in Honours.	(*a*) £1 and 10*s*. for a 1st and 2nd class respectively in each subject of the 2nd Grade Examination, *including Modelling*. (*b*) £1 10*s*. and £3 for a 1st and 2nd class respectively in 3rd Grade Examination. (*c*) £2 or less per student for works executed in local classes. (*d*) £3 each on account of Free Students (being artisans) under certain conditions. (*e*) £15 each for not more than two Art Pupil Teachers. (*f*) £5 for each student who obtains a National Scholarship or who obtains admission to Training Class.

2. Prizes and medals are awarded to candidates.

Science.	Art.
(*a*) Prizes to students obtaining a 1st Class in the Advanced Stage of each subject, and Bronze Medals to those obtaining a 1st Class in Honours. Certificates or cards to all successful candidates.	(*a*) Prizes of books or instruments, to the value of 8*s*. and 12*s*., to students obtaining the mark "excellent" in the 2nd and 3rd Grade Examinations, respectively; and Gold, Silver, and Bronze Medals, and other prizes of Books, for the best works submitted in the National Competition of works of all the Schools of Art and Art Classes.

3. Science and Art Scholarships for Students of the Industrial Class, held locally, £4, £7, and £10, for the 1st, 2nd, and 3rd year respectively, on condition that a local contribution of £5 a year is made.

4. Local Exhibitions, to be held by Students of the Industrial Classes at the Normal School of Science and Royal School of Mines, London, the Royal College of Science, Dublin, or at an approved Provincial Science College, £25 to meet an equal sum locally raised.

5. Grants for Buildings, Fittings, and Apparatus.

Science.	Art.
(*a*) Not exceeding 2*s*. 6*d*. per square foot of internal area up to a maximum of £500 for buildings. (*b*) Grants towards the purchase of fittings, apparatus, examples, &c., not exceeding 50 per cent. of their cost within certain limits.	(*a*) Not exceeding 2*s*. 6*d*. per square foot of internal area up to a maximum of £500 for buildings. (*b*) Grants towards the purchase of fittings, apparatus, examples, &c., not exceeding 50 per cent. of their cost and within certain limits.

6. Special Grants to Organized Science Schools in addition to the foregoing. 10*s*. and 5*s*. respectively for each student who attends a day or an evening school not less than 250 or 75 times in the year.

7. Aid to Students in attending the Normal School of Science and Royal School of Mines, London, the National Art Training School, London, and the Royal College of Science, Dublin.

Science.	Art.
(*a*) 21 Royal Exhibitions (seven awarded each year) with maintenance allowance of £50 a year tenable for three years. (*b*) 36 National Scholarships (twelve awarded each year) with maintenance allowance of 30*s*. a week for 40 weeks in the year tenable for three years. (*c*) 18 Free Studentships (six awarded each year) tenable for three years, at Normal School of Science and Royal School of Mines, London.	(*a*) National Scholarships tenable for not more than three years at National Art Training School with maintenance allowance of 20*s*. a week. (*b*) Free Studentships in National Art Training School.

8. Aid to teachers and persons preparing to become teachers in attending the Normal School of Science and Royal School of Mines, London, the National Art Training School, London, the Royal College of Science, Dublin, and Provincial Colleges at which advanced instruction in Science is given.

Science.	Art.
(*a*) Grants of £2 each with travelling expenses to local teachers selected to attend short courses of instruction at Normal School of Science and Royal School of Mines. (*b*) Grants of 21*s*. a week each with travelling expenses to teachers in training selected to attend the sessional courses of the Normal School of Science and Royal School of Mines. (*c*) Grants in aid of fees to local teachers selected to attend Provincial Science Colleges. (*d*) Free admission (subject to payment of examination fee) to courses of lectures at Normal School of Science and Royal School of Mines and Royal College of Science, to Science teachers.	(*a*) Grants to enable masters and students to visit various metropolitan Art Institutions, and, in special cases, foreign towns, schools, and galleries. (*b*) Grants of from 10*s*. to 35*s*. a week with travelling expenses to teachers in training selected to attend the National Art Training School.

9. Grants to Local Museums and Loans of works of Science and Art, Books, and specimen sets of teaching Apparatus, to Science and Art Schools.

10. Aid to Training Colleges for Instruction in Science and Art.

Science.	Art.
(*a*) Grants of £3 and £1 10*s*. respectively for each 1st and 2nd Class obtained at the Annual Examination. In Practical Chemistry £3 and £2. (*b*) Grants not exceeding 50 per cent. of the cost for apparatus and fittings.	(*a*) Grants of 10*s*. in respect of each subject of examination in which a resident student passes. (*b*) Grants of 50 per cent. towards the cost of examples.

11. Aid to Elementary Schools for Instruction in Drawing.

Science.	Art.
	(*a*) Grants of 1*s*., 1*s*. 6*d*., or 2*s*. on average attendance of Schools examined in Drawing. (*b*) Grants of 10*s*. for each pass in 2nd Grade Examinations.

12. Aid towards expenses of Examinations.

(*a*) Grants of 50 per cent. towards the fees of Special Local Secretaries and their Assistants for conducting annual examinations of Science and Art Schools and Classes.

SCIENTIFIC SERIALS.

American Journal of Science, July.—The viscosity of steel and its relations to temperature, by Carl Barus. In this paper the author's studies are mainly restricted to a discussion of the relation between torsional viscosity and temperature as observed with steel in different states of hardness. Reference is also made to the effect of stress on the amount of viscous motion in solids, and to a more general method by which the instantaneous deformation and the gradual deformation produced by stress may be co-ordinated. It is shown that imperceptible gradations lead from the purely viscous deformation which follows strains within the elastic limits to the sudden permanent set which follows strains beyond those limits.—Kilauea in 1880, by William T. Brigham. A detailed account is given of the results of the outbreak of May 1, 1880, with a description of the changes that had taken place since the author's previous visit in 1865. The trigonometrical survey then made was found to be already antiquated, the whole boundary perceptibly changed, and Kilauea apparently 5 per cent. larger than eighteen years previously.—Recent explorations in the Wappinger Valley limestone of Dutchess County, New York (continued), by W. B.

Dwight. In this paper (No. 6 of the series) the author deals with the discovery of additional fossiliferous Potsdam strata and pre-Potsdam strata of the Olenellus group near Poughkeepsie. This review of the latest palæontological facts makes it evident that the strata in Dutchess County are simply the continuation of the strata characterizing the Taconic and adjoining series lying northward. But while proving a grand unity, they indicate also an interesting and unexpected variety of rock structure.—Image transference, by M. Carey Lea. By image transference are here denoted curious effects produced on sensitive films, and specially interesting in connexion with the subjects of papers which appeared in the May and June numbers of the journal. In supplement to those papers the possibility is here shown of developing on a film of silver haloid a complete image, a print from a negative for example, without either exposing the silver haloid to light, or to the action of hypophosphite, or subjecting it to any treatment whatever, between the moment of its formation and that of its development. The film of silver haloid comes into existence with the image already impressed upon it.—The theory of the wind vane, by George E. Curtis. The author's theoretical studies lead to the inference that the oscillations of both spread and straight vanes are smaller as the vanes are longer and larger; that the spread is always more stable than the straight vane; and that this advantage in stability is greater for long than for short vanes, and is independent of the wind velocity.—On the manner of deposit of the glacial drift, by O. P. Hay. The author's studies of this great geological problem lead to the following conclusions: (1) an ice-sheet moving over a nearly level surface would possess far less abrading power than it would have while descending at a higher angle; (2) through subsidence of the glacial mass by the earth's heat and other causes a constantly increasing proportion of inert matter would collect in the lower layers of the moving ice; (3) this accumulated material would tend to retard and finally arrest the motion of the lower portions of the glacier, and a permanent deposit would then be gradually made; (4) other detritus might accumulate at the foot of the glacier as a terminal moraine, and still other masses on the top of the already formed deposit when the glacier finally melted.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 5.—M. Hervé Mangon in the chair.—Photochronography applied to the dynamic problem of the flight of birds, by M. Marey. Having in a previous note shown that the kinematics of flight may be completely illustrated by photochronography, the author here proves that the same process contains all the elements necessary for solving the dynamic problem of flight; that is to say, for measuring the muscular forces and the work performed by the bird. Here is applied the mechanical principle that, if the mass of a body and the movements animating it be known, it is possible to deduce the value of the forces by which those movements are produced. On the photochronograph are measured all the displacements of the mass of the bird on the wing, together with the velocities of these movements. On the other hand the weight, that is, one of the forces to which the mass is submitted, is also known, while the resistance of the air, another of these forces, may be determined experimentally. Consequently the unknown quantity to be eliminated will be the muscular force of the bird with its momentum of action, and the value of its two components, one acting vertically against the weight, the other horizontally against the inert resistance of the mass and of the air. In these experiments the displacements of the bird are successively measured according to these two vertical and horizontal elements.—Measurement of luminous sensations in function of the quantities of light, by M. Ph. Breton. Since the invention of Bouguer's photometer it is known that if a dull white surface be disposed in contiguous zones receiving equi-different quantities of light, the perceptible contrasts between such zones are very far from being equal. To explain this phenomenon it has been suggested that the eye perceives the *relation* between two contiguous lighted surfaces. But the law (attributed to Fechner and Weber) based on this assumption—to the effect that, if several contiguous luminous surfaces are in geometrical progression, the sensations of the contrasts are equal—is shown to be incorrect by the experiment here described.—Observations of Brooks's new comet, made at the Observatory of Algiers with the 0·50-metre telescope, by MM. Trépied, Rambaud, and Sy.—Observations of the same comet made at the Observatory of Lyons with the 6-inch Brunner equatorial, by M. Le Cadet. The positions of this comet for August 29 and 30 and September 1 are also given from measurements taken by M. Gruey at the Observatory of Besançon. Its brightness is that of a star of the tenth magnitude.—Differential formulas for the variation of the elements of an orbit, by M. R. Radau. To correct a provisional system of elements it is often preferable to have recourse to the equations supplied by the ephemerides, rather than repeat the direct calculation of the elements. But the method is somewhat laborious, as the equations generally include six unknown quantities. The author, however, here shows that it is possible to give them a form in which the number of unknown quantities will be diminished without causing any complication in the calculation of the coefficients.—Note on M. Bertrand's problem, by M. Désiré André. A direct solution is given of this problem, followed by some remarks by M. Bertrand himself, pointing out its application to the question of chances in games of hazard as treated by Huygens, Moivre, Laplace, Lagrange, and Ampère. He offers a fresh solution of the problem: if a player stake the *n*th part of his fortune and continue the game indefinitely, what is the probability of his being ruined within a given number of rounds?

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Revised Currency System: H. Bull (Hamilton).—Laws and Definitions connected with Chemistry and Heat: R. G. Durrant (Rivingtons).—Educational Ends: S. Bryant (Longmans).—*Challenger* Report, Zoology, vol. xx. (Eyre and Spottiswoode).—A Short Introduction to the Study of Logic: L. Johnstone (Longmans).—The Instability of Gold as a Standard of Value: H. Bull (Hamilton).—The Eruption of Tarawera, N.Z.: S. P. Smith (Wellington).—The Icerya or Fluted Scale (Washington).—U.S. Department of Agriculture, Division of Entomology, Bulletins No. 13 and 14 (Washington).—Kryptogamen-Flora von Schlesien, iii. Band, 3 Liefg. (Kern, Breslau).—Beiblätter zu den Annalen der Physik und Chemie, 1887, No. 8 (Barth, Leipzig).

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