THE ORIGIN OF THE SCENERY OF THE BRITISH ISLANDS[1]

THE insular position of Britain, which we are accustomed to regard as an essential and aboriginal feature of the country, is merely accidental, and has not always been maintained. The intimate relation of Britain with the Continent is well shown by the Admiralty charts. If the west of Europe were elevated 200ft.—that is, the height of the London Monument—the Straits of Dover, half of the North Sea, and a large part of the English Channel would be turned into dry land. If the elevation extended to 600ft.—that is, merely the united heights of St. Paul's and the Monument—the whole of the North Sea, the Baltic, and the English Channel would become land. There would likewise be added to the European area a belt of territory from 100 to 150 miles broad, stretching to the west of Ireland and Scotland. A vast plain would unite Britain to Denmark, Holland, and Belgium, and would present two platforms, of which the more southerly would stretch from what are now the Straits of Dover northward to the northern edge of the Dogger Bank. The steep declivity separating the two plateaux is doubtless a prolongation of the Jurassic and Cretaceous escarpments of Yorkshire. It is trenched at either end by marked depressions, of which the western is a magnificent valley through which the united waters of the Rhine and Thames would flow between the Dogger Bank and the Yorkshire cliffs. The eastern gap would allow the combined Elbe and Weser to escape into the northern plain. Possibly all those rivers would unite on that plain, but, in any case, they would fall into a noble fjord which would then be revealed following the southern coast line of Norway. Altogether an area more than thrice that of Britain would be added to Europe. By a total rise of 1,800 feet, Britain would be united to the Faroe Islands and Iceland; while the Arctic and Atlantic Oceans would be separated. From its position on the oceanic border of a continent, Britain has been exposed to a great variety of geological change. In such a position marine erosion and deposit are most active, and a slight upheaval or depression, which would have no sensible effect in the interior of a continent, makes all the difference between land and water. Moreover, there appears to be a tendency to special disturbance along the edge of an ocean. America affords the most marked proofs of this tendency, but in the structure of Scandinavia and its prolongation into Scotland and Ireland there appear to be traces of similar ancient ridging up of the oceanic border of Europe.

There is a remarkable convergence of geological formations in Britain, each carrying with it its characteristic scenery. The rugged crystalline rocks of Norway reappear in the Scottish Highlands; the fertile Chalk, with its smooth downs and gentle escarpment, stretches across to us from the north of France; the great plains of North Germany, strewn with the debris of the northern hills, extends into our eastern lowlands; even the volcanic plateaux of Iceland and Faroe are prolonged into the Inner Hebrides and the north of Ireland.

The present surface of Britain is the result of a long, complicated process in which underground movements, though sometimes potent, have only operated occasionally, while superficial erosion has been continuous, so long as any land has remained above the sea. The order of appearance of the existing features is not necessarily that of the chronological sequence of the rocks. The oldest formations have all been buried under later accumulations, and their re-emergence at the surface has only been brought about after enormous denudation. In its general growth, Britain like the rest of Europe has, on the whole, increased from the north by successive additions along its southern border. The oldest upheavals ridged up the Palæozoic rocks into folds running north-north-east and south-south-west, as may yet be seen in Scotland, in the Lake Country, and in Wales. By a later series of folds the younger Palæozoic rocks were thrown into north and south and east and west ridges, the latter of which still powerfully affect the topography in southern Ireland, and thence through South Wales and Belgium. An east and west direction was followed by the more important subsequent European disturbances, such as those that upheaved the Pyrenees, Jura, and Alps. Some of the latest movements that have powerfully affected the development of our scenery were those that gave the Secondary rocks their general tilt to south-east. It is very doubtful if any part of the existing topography can be satisfactorily traced back beyond middle or older Tertiary time. The amount of erosion of some of the hardest rocks of the country since that date has been prodigious, as may be seen in the fragmentary condition of the volcanic plateaux of the Inner Hebrides.

The main topographical features of Britain may be arranged as mountains, tablelands, valleys, and plains. All our mountains are the effect of erosion on areas of land successively upheaved above the sea. In the development of their forms, the general outlines have been mainly determined by erosion independent of geological structure; while the details have been chiefly guided by structure, but partially also by the rate and kind of erosion. Ruggedness, for example, has resulted primarily from structure, but has been aggravated by greater activity of erosion. The mountainous west, with a greater rainfall and steeper slopes, is more rugged than the mountainous east. The tablelands of Britain are of two orders—1, those of deposit, which may be either (*a*) of sedimentary rocks, horizontal or nearly so, as in the millstone grit and Jurassic plateaux of Yorkshire, or (*b*) of volcanic rocks, as in the wide plateaux of Antrim, Mull, and Skye; 2, those of erosion, where, as the result of long-continued degradation, a series of plicated rocks has been cut down into a more or less uniformly level surface, as in South Wales. By the elevation of such a surface into a high plateau, erosion begins anew, and the plateau is eventually trenched into a system of ridges and isolated hills, as has happened in the Highlands. The valleys of Britain are the result of erosion either (*a*) guided by geological structure, as in what are called longitudinal valleys, that is, valleys which run along the strike or outcrop of formations, as the Great Glen and Glen Spey in Scotland and the valleys of the Trent and Avon in England; or (*b*) independent of geological structure, as in the transverse valleys which embrace the great majority of British examples. Our plains have been produced by the spreading out of *detritus* by the operation of rain and rivers, as in river terraces and alluvial plains; by the sea, as in raised beaches; or by land-ice and floating-ice, as in the glacial drifts of the Lowlands. The existing watershed of Britain is profoundly significant, affording a kind of epitome of the geological revolutions through which the surface of the country has passed. It lies nearer the west than the east coast. The western slope being thus the steeper, as well as the more rainy, erosion must be greater on that side, and consequently the watershed must be slowly moving eastward. Probably the oldest part of the watershed is to be found in the Highlands, where its trend from north-north-east to south-south-west was determined by the older Palæozoic upheaval. Its continuity has been interrupted by the dislocation of the Great Glen. After quitting the Highlands it wanders across the Scottish Lowlands and Southern Uplands, with no regard to the dominant geological structure of these districts, as if, when its course was originally determined, they had been buried under so vast a mass of superincumbent rock that their structure did not affect the surface. Running down the Pennine Chain the watershed traverses a region of enormous erosion, yet from its general coincidence with the line of the axis of elevation, we may perhaps infer that the anticline of the Pennine Chain has never been lost under an overlying sheet of later undisturbed rocks. The remarkable change in the character of the watershed south of the Pennine Chain carries us back to the time when the great plain of the Secondary rocks of England was upraised with a gentle inclination to east and south-east. The softer strata between the harder escarpment-forming members of the Jurassic series and the Palæozoic rocks of the Pennine Chain were worn away, and two rivers carrying off the drainage of the southern end of that chain flowed in opposite directions, the Avon turning south-west and the Trent northwards. By degrees these streams moved away across the broadening plain of softer strata as the escarpments emerged and retreated. At the same time streams collected the drainage from the uprising slope of Secondary rocks and flowed south-eastward. Successive lines of escarpment have since been developed, and many minor watersheds have arisen, while the early watershed has undergone much modification, these various changes pointing to the continuous operation of running water.

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[1] Abstract of the first of five lectures by Archibald Geikie, F.R.S., Director-General of the Geological Survey, given at the Royal Institution, January 29.

SOCIETIES AND ACADEMIES

LONDON

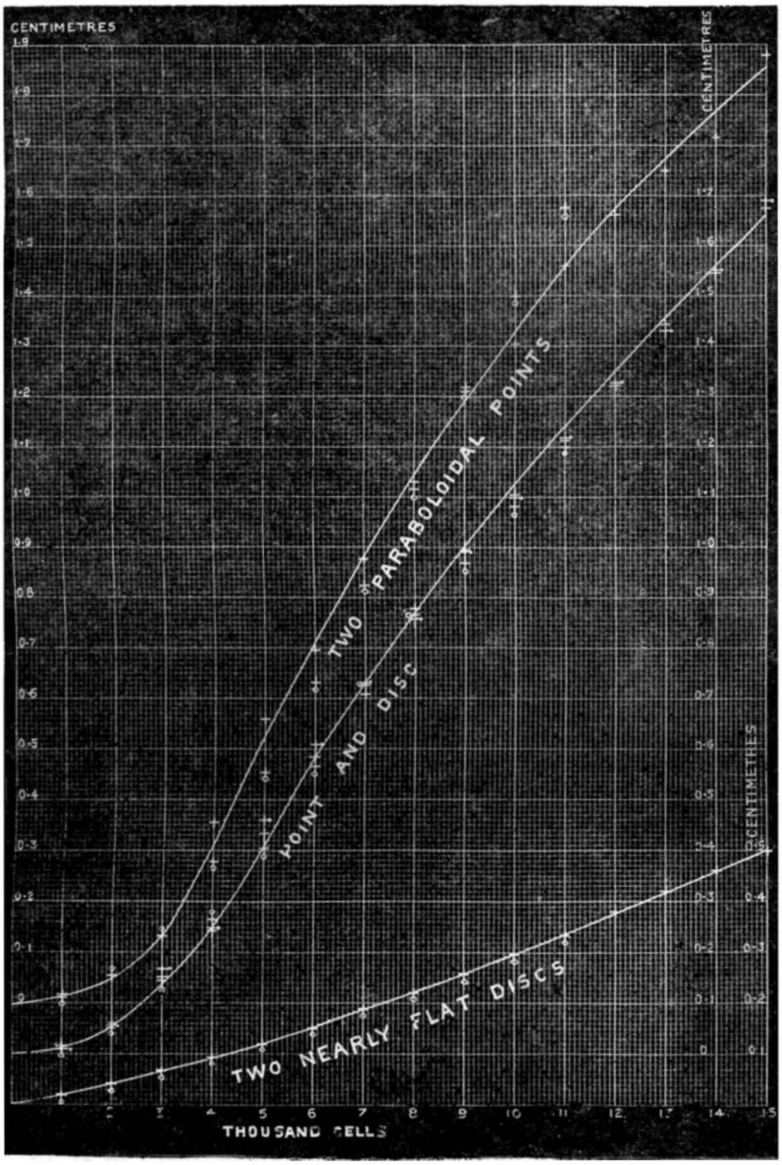
Royal Society, December 13, 1883.—"Experimental Researches on the Electric Discharge with the Chloride of Silver Battery." By Warren De La Rue, M.A., D.C.L., Ph.D., F.R.S., and Hugo W. Müller, Ph.D., F.R.S.

SECOND POSTCRIPT TO PART IV. "PHIL. TRANS.," PART II., VOL. CLXXIV.

Striking Distance.—In a postscript to Part IV. of our researches,[1] we stated that, with 14,400 cells, partly of the rod form, partly of the chloride-in-powder form, the length of the spark between paraboloidal points was 0·7 inch (17·8 mm.), and between a point and disk 0·62 inch (15·7 mm.), and that it does not appear, therefore, that the law of the spark being as the square of the number of cells holds good beyond a certain number.

These results were obtained at the Royal Institution; since the removal of the battery to our laboratory we had not, at the date of the postscript to Part IV. of our researches, charged up the whole of it. Recently, however, we have put the battery in thorough order, by scraping the zinc rods[1] of the cells already charged up and added newly made up cells to bring up the total to 15,000 cells, all of the rod form.

Having the whole 15,000 cells in perfect order, we thought that it would be desirable to make fresh determinations of the striking distance, increasing the potential a thousand cells at a time, between two very slightly convex disks (planes), a point and disk, and two paraboloidal points. These points are one-eighth of an inch (3·175 mm.) in diameter, and three-eighths of an inch (9·525 mm.) long. In the case of a point and disk, the point was like one of those used for two points, and the disk was $1\frac{5}{16}$ inch [3·334 cm.] in diameter. The two planes used were $1\frac{5}{16}$ inch [3·334 cm.] in diameter.



As the points, particularly the negative, are deformed by the discharge, the precaution was taken to touch up the point after each discharge in the shaping-tool, screwed to the mandril of the lathe, mentioned in Part I. of our researches,[2] and thus to restore them to a true paraboloidal form.

Results were obtained which are plotted down in the diagram.

The several results, the different sets being distinguished by plain crosses or crosses with a dot, are laid down on the diagram, Fig. 1, to which are also added other results already published from former experiments; these latter have a ring on one of the members of the cross.

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[1] *Phil. Trans.*, part ii. vol. clxxiv. p. 477, separate copy p. 249.

[1] We are at present making experiments in order to prevent the deposit of oxychloride of zinc on the zinc rods by covering the charging fluid with a layer of paraffin oil.

[2] *Phil. Trans.*, part i. vol. clxix. p. 79, separate copy p. 25.

From these curves were deduced the numbers given in Table I., II., III. in C.G.S. units.

TABLE I.—*Two Disks*

E.M.F. in volts	Striking distance in centimetres	Difference of potential per centimetre. Volts	Intensity of force	
			Electro-magnetic	Electro-static
1,000	0·0205	48,770	4·88 × 10^{12}	163
2,000	0·0430	46,500	4·65 ,,	155
3,000	0·0660	45,450	4·55 ,,	152
4,000	0·0914	43,770	4·38 ,,	146
5,000	0·1176	42,510	4·25 ,,	142
6,000	0·1473	40,740	4·07 ,,	136
7,000	0·1800	38,890	3·89 ,,	130
8,000	0·2146	37,280	3·73 ,,	124
9,000	0·2495	36,070	3·61 ,,	120
10,000	0·2863	34,920	3·49 ,,	116
11,000	0·3245	33,900	3·39 ,,	113
12,000	0·3566	33,652	3·37 ,,	112
13,000	0·4068	31,957	3·20 ,,	107
14,000	0·4463	31,369	3·14 ,,	105
15,000	0·4882	30,725	3·07 ,,	102
15,450	0·5029	30,722	3·07 ,,	102

TABLE II.—*A Paraboloidal Point and a Disk*

E.M.F. in volts	Striking distance in centimetres	Difference of potential per centimetre. Volts	Intensity of force	
			Electro-magnetic	Electro-static
1,000	0·0123	81,103	8·11 × 10^{12}	270
2,000	0·0567	35,274	3·53 ,,	118
3,000	0·1379	21,755	2·18 ,,	73
4,000	0·2447	16,347	1·63 ,,	54
5,000	0·4029	12,410	1·24 ,,	41
6,000	0·5631	10,655	1·07 ,,	36
7,000	0·7039	9,945	0·99 ,,	33
8,000	0·8447	9,471	0·95 ,,	32
9,000	0·9709	9,270	0·93 ,,	31
10,000	1·0874	9,196	0·92 ,,	31
11,000	1·1990	9,174	0·92 ,,	31
12,000	1·3058	9,190	0·92 ,,	31
13,000	1·4078	9,234	0·92 ,,	31
14,000	1·5145	9,244	0·92 ,,	31
15,000	1·6116	9,307	0·93 ,,	31
15,450	1·6600	9,307	0·93 ,,	31

TABLE III.—*Two Paraboloidal Points*

E.M.F. in volts	Striking distance in centimetres	Difference of potential per centimetre. Volts	Intensity of force	
			Electro-magnetic	Electro-static
1,000	0·0173	57,866	5·79 × 10^{12}	193
2,000	0·0493	40,568	4·06 ,,	135
3,000	0·1282	23,409	2·34 ,,	78
4,000	0·3078	12,996	1·30 ,,	43
5,000	0·5107	9,790	0·98 ,,	33
6,000	0·6845	8,766	0·88 ,,	29
7,000	0·8496	8,239	0·82 ,,	27
8,000	1·0117	7,908	0·79 ,,	26
9,000	1·1602	7,757	0·78 ,,	26
10,000	1·2913	7,744	0·77 ,,	26
11,000	1·3130	7,785	0·78 ,,	26
12,000	1·5243	7,873	0·79 ,,	26
13,000	1·6271	7,990	0·80 ,,	27
14,000	1·7146	8,165	0·82 ,,	27
15,000	1·7961	8,351	0·84 ,,	28
15,450	1·8500	8,351	0·84 ,,	28

An inspection of the diagram, drawn on a reduced scale from the curves as originally laid down, shows that the curve for approximate planes (slightly convex, to insure the centres being the most prominent) is continuously concave, whereas those for both point and disk and two points are concave only for a certain distance, and then turn off and become convex. Moreover, it is seen that the intensity of force per centimetre decreases continuously up to 15,450 volts in the case of planes; but that, in the case of a point and disk, and also in that of two points, the decrease ceases after a certain potential has been reached, and that then it increases so as to become nearly a constant quantity. Between a point and a disk the potential per centimetre at 9,000 volts and beyond is very nearly 9,200; consequently, if the law holds good, to produce a spark 1 decimetre (3·94 inches) long, 92,000 volts, one 1 metre (39·37 inches) long, 920,000 volts,[1] and a flash of lightning 1 kilometre (0·621 mile) in length, a potential of 920,000,000 volts would be required, but this potential would be lessened by the diminution of the atmospheric pressure at the height of a kilometre, namely 607·4 mm. (799,210 M), or a mean pressure of 713·8 mm. (939,211 M) between 1 kilometre and the earth. Taking the mean pressure 939,211 M, it would require 864,000,000 volts to produce a discharge between a cloud (regarded as a point) 1 kilometre high and the earth.

It is extremely difficult to conjecture how a cloud can become charged to such an enormous potential, unless the charged molecules balance each other (as those of a stratum in a vacuum tube may be conceived to do) until a disturbing cause breaks up the arrangement; and then the whole of them are discharged in one direction with their aggregate potential.

We may add that less than 15,000 cells would not have sufficed to make out the fact that the intensity of force to produce a discharge between a point and disk or two points becomes a constant after 9,000 to 11,000 cells has been reached.

The following table gives the ratios of the striking distances between a point and a disk and two points respectively, taking those between two disks as unity. And also the relation between the striking distances between a point and a disk and between two points, taking those between a point and a disk as unity.

Cells	Ratio between point and disk to that between two disks	Ratio between two points and that between two disks	Ratio between two points and that between a point and disk
With 1,000	0·60	0·84	1·40
,, 2,000	1·32	1·15	0·87
,, 3,000	2·09	1·94	0·93
,, 4,000	2·68	3·37	1·26
,, 5,000	3·42	4·34	1·27
,, 6,000	3·82	4·65	1·22
,, 7,000	3·91	4·72	1·21
,, 8,000	3·94	4·71	1·20
,, 9,000	3·89	4·65	1·20
,, 10,000	3·80	4·51	1·19
,, 11,000	3·69	4·35	1·18
,, 12,000	3·58	4·18	1·17
,, 13,000	3·46	4·00	1·16
,, 14,000	3·39	3·84	1·13
,, 15,000	3·30	3·68	1·12
			Mean 1·16

The striking distances from which the above ratios are calculated are those obtained from the smoothed curves.

January 17.—"Evidence of a Large Extinct Australian Lizard (*Notiosaurus dentatus*, Ow.)," by Sir Richard Owen, K.C.B., F.R.S., &c.

This evidence is based on a small fragment, seemingly of coal, with roots of two teeth adherent thereto, transmitted to the author from the Department of Mines, Sydney, New South Wales; but stated to be from a Pleistocene deposit. The author had

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[1] To produce a spark between a point and a disk used for example as the dischargers of an induction coil—

In length	It would require in E.M.F. volts
1 inch	23.367
1 foot	280,400
1 yard	841,230

noted that vegetable fossils from the same formation and locality presented a similar jet-black colour, and glistening petrified fracture. The paper details a series of comparisons with known recent and fossil Saurians. The size and striated exterior of the teeth suggested, at first, crocodilian affinity. But closer comparisons, aided by application of the microscopic test to the tissues of both the bone and tooth, led to a conclusion of the affinities of the fossil reptile represented by the fragment of mandible and attached parts of teeth. It was equal in size to the extinct horned lizard *Megalania*, which had an armature of the mouth like that of a tortoise. *Notiosaurus* was a toothed and pleurodont lizard, like the large existing *Hydrosaurus* of Australia, but of more than twice its size.

Linnean Society, January 17.—Sir John Lubbock, Bart., president, in the chair.—Mr. A. S. Pennington was elected a Fellow of the Society.—Dr. R. C. A. Prior exhibited and made remarks on a series of useful timbers from British Guiana. These were all hard woods, among which may be mentioned the "greenheart" (*Nectandra rodiei*); the "ducalibolly," a rare, red wood used in the colony for furniture; "wamara," a very hard wooded tree sixty feet high, used by the natives for clubs, &c.; "letterwood" (*Brosimum aubletii*), useful for inlaying and making very choice walking sticks; "hyawabolly" (*Omphalobium lamberti*), a rare tree of twenty feet high, known commercially as zebra wood.—Mr. H. N. Ridley drew attention to a fasciated branch of holly from Herefordshire, in which certain of the leaf-branches were curiously interwoven.—A presumed portrait of Linnæus, in oil, was exhibited on behalf of Mr. F. Piercy.—A paper was read by Mr. J. G. Baker, viz. a review of the tuber-bearing species of *Solanum*. As they stand in De Candolle's "Prodromus" and other botanical works, the tuber-bearing Solanums are estimated as belonging to twenty distinct species. Mr. Baker thinks that not more than six of those are really distinct, viz. (1) *Solanum tuberosum*, a native of the dry, high regions of the Andes from Chili northwards to Venezuela, reappearing in other varieties in Mexico and the Rocky Mountains; (2) *S. maglia*, an inhabitant of the damp coasts of Chili, as far south as lat. 44° to 45°; (3) *S. commersoni*, a low-level plant of Uruguay, lately introduced as a novelty under the name of *S. ohrendii*; (4) *S. cardiophyllum*, a little-known species from the Mexican highlands; (5) *S. jamesii*, a native of Mexico and the Rocky Mountains; and (6) *S. axycarpum*, a native of Central Mexico. The two last have the tubers very small. All our cultivated races of potato belong to *S. tuberosum*; but the plants gathered by Darwin in the Chonos Archipelago, and that experimented upon by Solme at Chiswick, are both *S. maglia*. The author attributes the deterioration of the potato partly to its being cultivated in too humid climates, and partly to the tuber having been unduly stimulated at the expense of the other organs of the plant. There are many hundred species of Solanum known which do not produce any tubers, but maintain their ground in the world by their seeds alone, and he urges that, in order to extend the power of climatic adaptation of potato species, (2), (3), and (4) should be brought into cultivation and tried both as pure specific types and as hybridised with the numerous forms of *S. tuberosum*.—The next paper read was by Mr. A. D. Michael, on the "Hypopus" question or life history of certain Acarina. From a careful series of experiments and observations he concludes that true "Hypopi" are not adult animals, but only a stage, or heteromorphous nymphs of *Tyroglyphus* and allied genera. Nor do all individuals become "Hypopi," which latter stage takes place during the second nymphal ecdysis. It seems a provision of nature for the distribution of the species irrespective of adverse conditions. "Hypopi" are not truly parasitic, nor confine themselves to any particular insect. A new adult form described is called by the author *Disparipes bombi*, and he believes there are other species of the genus. Donnadieu's bee parasites are admitted to be adults, though it is uncertain if they are identical with Dufour's *Trichodactylus*.—Dr. M. C. Cooke made a communication on the structure and affinity of *Sphæria pocula*. Its position has hitherto been unquestioned, since originally described by Schweinitz in 1825. Dr. Cooke, however, shows from microscopical examination that structurally it is Hymenomycetal, and not Ascomycetal, being allied to the genus *Polyporus* or *Porothelium*. He designates it as *Polyporus* (*Mesopus*) *poculus*, Schwein., allied perhaps in habit to *P. pendulus*, but in substance to *P. rhipidium*.—A paper by Mr. W. Joshua was read, viz. notes on some Burmese Desmidieæ, in which he figures and describes new and interesting species.—Novitates Capensis was the title of a paper by Mr. Henry Bolus, and mainly confined to diagnoses of new or rare orchids from South Africa.

Institution of Civil Engineers, January 22.—Sir Frederick Bramwell, F.R.S., vice-president, in the chair.—The paper read was on the adoption of standard forms of test-pieces for bars and plates, by Mr. William Hackney, B.Sc., Assoc.M.Inst.C.E.

EDINBURGH

Royal Society, January 7.—T. Stevenson, C.E., vice-president, in the chair.—Papers were read on the approximation to the roots of cubic equations by recurring chain fractions, by Mr. E. Sang, and on the researches of M. E. de Jonquières on periodic continued fractions, by Thomas Muir, M.A. The author showed that the results which M. de Jonquières is from time to time communicating to the French Academy are merely particular cases of a more general result which he communicated to the Society some years ago.—A paper was also read on new forms of nerve-terminations in the skin of mammals, by S. Hoggan, M.B., the latter being communicated by Prof. Turner.—A second paper was laid on the table on a diagnosis of the phanerogamous plants of Socotra, by Prof. Bayley Balfour.—A communication was read on the Tunicata of the *Porcupine* Expedition by Prof. Herdman.—An arrangement of the metals in an electro-frictional series was submitted by A. Macfarlane, M.A., D.Sc. As the result of a large number of quantitative experiments, he found that the arrangement of the metals according to the amount of negative electricity produced upon them by a constant amount of friction (without abrasion) is as follows:—Gold, 181; platinum, 136; tin, 126; silver, 102; copper, 100; lead, 62; nickel, 59; brass, 59; iron, 56; aluminium, 50; zinc, 45; magnesium, 43; antimony, 38; German silver, 32; bismuth, 22.

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