THURSDAY, DECEMBER 6, 1888.

PRJEVALSKY'S FOURTH JOURNEY TO CENTRAL ASIA.

From Kiakhta to the Sources of the Yellow River, the Exploration of the Northern Borders of Tibet, and the Journey viâ *the Lob-nor and the Basin of the Tarim.* By N. M. Prjevalsky. (In Russian.) With 3 Maps, 29 Phototypes, and 3 Woodcuts. (St. Petersburg: Published by the Russian Geographical Society, 1888.)

IN this large quarto volume, which the indefatigable traveller brought out before leaving St. Petersburg for his proposed fifth journey to Central Asia, we have a general account of the journey he began at Kiakhta on November 20, 1883, and ended two years later at Lake Issyk-kul, in Russian Turkestan, after having visited the upper parts of both the Yellow and the Blue Rivers. As to the purely scientific description of the invaluable collections which were brought in by the Expedition, it has been undertaken by specialists and will be published separately.

Prjevalsky's aim during his fourth journey was to reach Lhassa, in Tibet; and it was in the hope that he might more easily make his way to that city that he started from Kiakhta, instead of taking the shorter route *viâ* Turkestan. His plan was to be at Lake Kuku-nor early in the spring; to buy provisions there, and to have them stored somewhere in South Tsaidam; and thence to proceed southwards, and to cross the north-eastern border-ridges of Tibet. The third part of the scheme could not be accomplished; and, after having visited the Upper Hoang-ho and the Upper Yang-tzse-Kiang (the Dy-tchu), Prjevalsky was compelled to return to his store-house, and thence he proceeded home *viâ* Lob-nor and East Turkestan. But the Expedition has thrown so much light upon the orography, the flora, the fauna, and the inhabitants of the outer terraces of Tibet, as well as of Eastern Turkestan, that one can hardly regret that the Russian traveller did not succeed in crossing the highlands to the north of the holy city of Buddhism.

The chapters devoted to the journey to the west of Kuku-nor will certainly be the first to attract the geographer, for only very brief accounts of that part of Prjevalsky's journey have hitherto been published. But the physical geographer and naturalist will also read with interest the pages devoted to the winter journey across the Gobi, to its terrible sand-storms, and the geological work of these storms, and still more the remarks upon the flora and fauna of the Nian-shan plateaus and the spring migrations of birds about Kuku-nor. It was in the Nian-shan that a new species of antelope, the *A. cuvieri*, was discovered. As seen from the drawing given by Prjevalsky, it differs widely from the next kindred species, the *A. gutturosa*.

It was only on May 13, 1884, that the Expedition reached the spot, Dzun-zasak, in South Tsaidam, where a store-house had to be erected. After having overcome considerable difficulties in getting camels and provisions, it started southwards in order to reach Lhassa. It crossed, first, the Burkhan-buda ridge, which rises like a wall from 7000 to 7500 feet high over the plateau of Tsaidam, and reaches the height of nearly 17,000 feet, without, however, attaining the limits of perennial snow. The Burkhan-buda is a border-ridge; it fringes the next and higher terrace of Northern Tibet, the lowest parts of which are from 3000 to 4000 feet higher than the Tsaidam plateau; and therefore it has but a gentle and short slope towards the south. At its southern foot, Prjevalsky found a broad valley, 13,400 feet above the sea, where flocks of wild *yaks* (*Poëphagus mutus*, a new species discovered by Prjevalsky) and *kuku-yamans* (*Pseudois nahoor*) live on the few grazing-grounds which can be found at such a height. A low range of hills separates this valley from the broad depression of Garmatyn, or Odon-tala, where the Expedition reached, on May 29, the upper part of the Hoang-ho and its two lakes, Jirin and Orin, so well known from Chinese sources, but never before visited by a European. "Now we saw the birth-place of the great river, we drank its water, and there were no bounds to our rejoicing," wrote the traveller in his note-book. He tried, of course, to explore the lakes, but a terrible snowstorm overtook the exploring party. Next day the ground was covered with two feet of snow, and the thermometer showed a frost of – 23° C., on June 1, under the 35th degree of latitude! The difficulty of moving on camels under such conditions may be easily imagined. But hunting was excellent, and Prjevalsky's companions killed numbers of the Tibetan bear (*Ursus lagomyiarius*). Alpine meadows, 16,000 feet above the sea, spread towards the south, but high mountain-ridges separate them from the Dy-tchu (the Upper Yang-tzse-Kiang), and it was only on June 22 that the party reached the Dy-tchu, in 33° 47′ N. lat., and 95° 54′ E. long. It flows in a narrow valley, at a height of 13,100 feet above the sea, and soon enters a narrow gorge between high mountains. The camels were in very bad condition, and there were no means of moving down the Dy-tchu, as it entered a narrow stony gorge. Neither was it possible to cross the rapid river, so that Prjevalsky was compelled to return. On the return journey the Expedition explored both the lakes of the Upper Hoang-ho, but it had to carry on regular fighting with several hundreds of Tangutes. It was thus obliged to abandon the exploration of the northern shores of the lakes, and to return to the store-house.

The attempt to reach Lhassa by this route thus proved a failure; and, in our opinion, a worse route could not have been chosen. True, while going due south from Dzun-zasak, Prjevalsky reached the lakes of the Upper Hoang-ho, and solved a great geographical problem; but then he had before him a mountainous region which he would have had to cross in an oblique direction—the series of ridges which accompany the great border-ridge of Eastern Tibet undoubtedly having a direction from the south-west to the north-east. Even if he had had horses, instead of camels, he would have met with insuperable difficulties. The fact is, that, having no knowledge of the orography of the highlands of Eastern Tibet, geographers draw on our maps the mountains of the Amdo as running *between* the problematic courses of the rivers which flow from Central Asia to Burmah and China; the ridges thus have on our maps a south-eastern direction, while in reality there is the greatest probability in favour of the mountain-ridges having a north-eastern direction, and being *pierced* by those rivers. The great border-ridges of the great Central Asian plateau, which are known under the name of Great Khingan in the north, cannot terminate in the latitude of 35°. Probably they continue south-west as far as the Himalayas, and so it is most likely that the region of the Upper Yang-tze-Kiang is filled with mountains running from the south-west to the north-east.

This view is supported by the results of Prjevalsky's exploration. In 1880, when he took from Dzun-zasak a south-western direction, and thus followed the foot of the highlands, he reached the Khara-usu with comparative ease. But when he went southwards and reached the Dy-tchu under the 96th degree of longitude, he could move neither east nor south. In the east he saw the gorges by which the Dy-tchu, which flows south-east, pierces the first of the series of the mountains that accompany the border-ridge. And further south he saw before him the continuation of the same ridge, and obviously could not cross it in an oblique direction.

All this becomes obvious when one attentively examines the map which accompanies Prjevalsky's last work. In fact, we see on that map that the two great lines of upheavals—south-west to north-east, and north-west to south-east—which so distinctly appear in Turkestan, the Caucasus, and Siberia (the chains running south-west to north-east being more ancient than those which run in the other direction) are as well pronounced in the southern parts of the great Central Asian plateau as they are in its northern and eastern parts. The whole of Central Asia appears, in fact, as a series of plateaus of various heights, which—very much like Bohemia in Europe—are bordered by chains having a direction from either south-west to north-east, or north-west to south-east.[1]

Although the Expedition failed to reach Lhassa, its observations on the climate, flora, and fauna of Northern Tibet are invaluable. The climate of the region; its poor vegetation, which has every year only a few days for developing its flowers and seeds, and nevertheless is strikingly rich in the numbers of its species; the mixture of Chinese, Himalayan, Tibetan, and Central Asian species which one finds in these highlands,—all this renders the borderlands of Tibet in Prjevalsky's description almost more interesting than the plateau itself.

We shall only refer to that part of the journey during which the Expedition moved north-westwards from the Dzun-zasak store-house to the small lake Gas, at the foot of the ridges Tsaidam, Garynga, Torai, Columbus, and Marco Polo's, which connect the Altyn-tagh with the yet unnamed highlands of the Upper Hoang-ho. Most interesting facts as to the nature of Tsaidam will be found in the chapter devoted to that part of the journey. Prjevalsky's winter excursion from Lake Gas enabled him to obtain an insight into the structure of the border-ridges which separate Northern Tibet from the lower terrace of Tsaidam (9000 feet above the sea). No less than three parallel ridges constitute that border-region. The outer ones are known under the names of Tsaidam, Garynga, and Torai; but these are not the highest of the series. The highest summits are gathered in the next row of mountains—the Columbus, Marco Polo's, and Prjevalsky's ridges (this last name has been given to it by the Russian Geographical Society). Behind them there seems to be a third series of ridges, and then begins the plateau (also intersected by several snow-clad ridges), which is not less than 3000 feet higher than the Tsaidam plateau, and thus reaches about 12,000 feet in its lowest depressions. Much remains, however, to be explored before we can have a clear idea as to the structure of the mountains which separate Northern Tibet from the Lob-nor depression. Mr. Carey has already cleared up some points, and we may hope that this part of Central Asia—relatively easy to explore—will be well mapped before very long. Let us mention also that on the high plateaus which Prjevalsky visited from Lake Gas he discovered a new species of *Ovis*, which he named *Ovis dalai-lamæ*; it slightly differs by its horns and coloration from all known species of the same genus.

Less than 150 miles separate Lake Gas from the Lob-nor, and so the Expedition went to that lake, which was reached early in February 1885. There the Expedition stayed fifty days; and two chapters of the work which we have before us are given to the description of the Lower Tarim and the Lob-nor (which rapidly dries up and becomes a mere marsh), its flora, fauna, and inhabitants. Many photographs illustrate these chapters, so that now we have an accurate idea of the nature and inhabitants of the great depression which ten years ago was quite unknown. From Lob-nor the Expedition went south-westwards to Khotan, and thus followed the foot of the Altyn-tagh, the Toguz-daban, and the "Russian" ridge, which border the Northern Tibetan terrace on the north-west. The Turkestan oases of Tchertchen, Keria, Niya, and Khotan were thus visited, and again we find much valuable information as to the nature and inhabitants of the country in the chapters dealing with that part of the journey, as also excellent photographs of the inhabitants. Especially interesting are the photographs of the moving sands with their "ripple-marks" made by the wind, of the gigantic holy willows around a spring in the oasis of Niya, and of mulberry-trees in Yasulgun. It would be impossible to give in a few lines an adequate impression of the information gathered by Prjevalsky during his journey on a relatively beaten tract in Eastern Turkestan. To take one instance, we have hitherto had a general idea of the oasis of Keria and the high border-ridge which separates it in the south from the high plateaus. Although Prjevalsky made only a short excursion in these highlands, he supplies us with a most vivid description of the ridge (nearly 20,000 feet high) and its outer spurs, its flora and fauna, its inhabitants—the mountaineer Matchins who dig their dwellings in the loess which fringes the highlands (a group of such dwellings is represented by a photograph)—and their manners and customs. One feature of the highlands of Keria is especially worthy of note—the great amount of rain which falls on them in June and July. During the twenty-five days (July 10 to August 5) which Prjevalsky spent on the outspurs of the Keria Mountains, at a height of from 12,000 to 13,000 feet, it rained and snowed nearly all the time; the clouds coming from Tibet being condensed as they reached the high Keria ridge. The water which falls on the loess soil is immediately evaporated

[1] See Mushketoff's "Turkestan"; also the articles "Siberia," "Turkestan," "Transcaspian," "Transcaucasia," and "Ural," in the "Encyclopædia Britannica," and "Asia" in "Chambers' Encyclopædia."

and re-condensed by the cold air of the snow-clad summits. The great amount of rain in the border-ridges is the more striking as in East Turkestan rain is exceedingly scarce, and there is but very little rain at a level below 6000 feet. Prjevalsky concludes that the heavy summer rains which fall in the Keria Mountains every year are due to the south-western winds coming from the Indian Ocean, and he maintains that the effects of the monsoon winds are felt even in the upper parts of the Hoang-ho.

From Khotan the Expedition went northwards, across the desert. It crossed the Tarim at the confluence of the Yarkand-daria and the Aksu-daria, at a height of 3100 feet above the sea. The river has there a width of 185 yards, and an average depth of from 3 to 4 feet at low water. The velocity of the current was 160 feet in a minute. From these facts, as well as from what he saw of the Lower Tarim, Prjevalsky concludes that the river can be navigated by small steamers from Lob-nor up to the confluence of the Yarkand and Aksu Rivers, and that the two latter can also be navigated to some extent.

The last chapter of the work is devoted to a general sketch of the political condition of Central Asia; but those who are acquainted with the recent literature of the subject will find little new in it. Geographers who may propose to explore Central Asia will find more to interest them in the introductory chapter devoted to the ways and means of travelling in Central Asia, with minute instructions as to how to organize expeditions. This chapter is full of practical hints. As to the scientific problems, Prjevalsky remarks that the present period of great discoveries in Central Asia is rapidly coming to an end. Few parts of what was formerly the great *terra incognita* remain to be explored; so that we approach a time when regular scientific expeditions will be necessary. There remain for investigation by means of "scientific reconnoitrings" the plateaus of Northern Tibet, the highlands of Eastern Tibet and Amdo, and Southern Tibet from Lhassa to Gartok. Three expeditions, lasting two or three years each, would suffice for the exploration of these three regions. The Pamir, with the Hindu-Kush and the Karakorum Mountains, the Eastern Tian-shan, the Altyn-tagh and the Nian-shan, the border-ridges of South-East Mongolia, the whole of the great Khingan, and North-Western Mongolia, close to the Siberian frontier, come next. Dealing with the subject of special scientific explorations, he recommends the Karashar and Si-nin for zoologists; the Tchertchen oasis for archæologists; Si-nin for ethnographers; Kashgar and Khotan, and Si-nin and Urga, for meteorologists; and the whole of Central Asia for geologists.

The present volume has three maps. One of them, on the scale of 67 miles to the inch, embodies the results of the four journeys of Prjevalsky, and is an excellent map of the eastern parts of Central Asia. Two maps, on the scale of 33 miles to the inch, embody the original surveys of the Expedition at the sources of the Yellow River and in East Turkestan. Numbers of excellent photo-lithographs, and three drawings representing new species of *Antelope* and *Ovis*, are inserted in the work.

Many years will elapse before the complete descriptions of Prjevalsky's rich collections will be published. All that can now be said is that they are in excellent hands. K. I. Maximowicz, A. A. Strauch, S. M. Hertzenstein E. A. Büchner, A. S. Woeikoff, and A. A. Inostrantseff are busily occupied with them, and the first parts of their common work are already in print. The first instalment of the first volume, containing the "Mammals," by E. Büchner, was issued at St. Petersburg a few days ago.

P. K.

FLOWERING PLANTS OF WILTS.

Flowering Plants of Wilts; with Sketches of the Physical Geography and Climate of the County. By the Rev. T. A. Preston, M.A. 500 pp. With a Map. (Published by the Wiltshire Archæological and Natural History Society, 1888.).

IN Wiltshire, the chalk downs which form so characteristic a feature of the geology and physical geography of the South of England reach their western limits. The area of the county is about 1300 square miles. It does not anywhere reach the coast, and forms a watershed from which small streams run in three directions, to the Severn, Thames, and English Channel. An elevated plateau of chalk on the south-east occupies more than half the area of the county. This is divided into two unequal halves by a natural depression, called the Vale of Pewsey, which runs almost due east and west, from Devizes to Hungerford. Along this hollow runs the Kennet and Avon Canal, of which the highest point, near Savernake, reaches an altitude of 500 feet. The northern portion of this chalk plateau is called Marlborough Downs, and the town of Marlborough stands nearly in the centre of it. The southern part is Salisbury Plain, the word plain as here applied conveying a delusive notion. Salisbury is at the south, and Stonehenge near the centre of this southern chalk tract. The highest points of these chalk downs reach a height of from 800 to 950 feet. The third section of the county, lying west and north of the chalk, is the fertile plain, underlain by greensand and oolite, along which the Great Western Railway runs between Swindon and Bath. The following extract from the introductory essay contributed to this flora by the Rev. J. Sowerby gives, in a few words, an excellent idea of the general characteristics of these different districts:—

"The great characteristic of the chalk plateau is its vast extent of grass-land, where sheep are extensively pastured. This space is more broken up each year for cultivation, but often exhibits great tracts of grass, with only occasional patches of furze. Only on the small patches of Tertiary scattered here and there, especially in the northern part, do we find wood (generally only underwood), excepting the grand forest of Savernake, twenty square miles in area, which can show timber of an age and size unrivalled in any part of England. The upper chalk hills were once, it is probable, covered with extensive copses, chiefly thorns. Remains of these still occur here and there; and individual trees of great size, some yet extant, others only traditional or historical, attest the former existence of a primæval wood. In the hollows of the downs, especially near the villages, there are spaces, often finely timbered, especially with elms. Monotonous as the surface of the downs may seem to be, the changes that present themselves are often singularly picturesque and varied. After passing, it may be for hours, over the gently sloping grass plains, all blue above, all green below, the traveller suddenly sees below him a village embosomed in woods, with its picturesque church tower, surrounded by fertile and well-tilled land. Such an experience is obtained by the traveller who passes over the downs from Marlborough to Avebury or Wooton Basset, from Heytesbury to Chittern or Imber, from Warminster over Battlesbury, and the projecting spur of Bratton Castle to Steeple and Prood Ashton, on their picturesque hills.

"The part of the county lying north and west of the chalk plateau is of a different character. It is the plain country, as the other is the hill country of Wiltshire. They have been called 'the cheese' and 'the chalk.' This part includes, in the north, the country drained by the Thames and its affluent the Cole, and on the west that drained by the Bristol Avon. It consists of various geological strata, but chiefly of Oxford clay, a band of which, with an average breadth of nearly five miles, traverses this part of the county from north-east to south-west. Viewed from the outer edge of the chalk escarpment, this region presents the appearance of a vast, well-wooded, and fertile plain, bounded in the far distance by the hill-ranges of the adjoining counties of Gloucester and Somerset. The outer slope of the chalk plateau descends a hundred feet or so, its steep sides covered with turf or clothed with hanging wood, and then slopes gently down to the level. Here is a land of pasture-fields and hedges, overshadowed everywhere by elms, growing mostly in the stiff clay soil that overlies the Kimmeridge clay and Coral Rag. Beyond the level, in front, rises a line of hills of the Coral Rag formation. These hills again descend, with an abrupt slope, into the valley (or plain) through which the Avon flows. The most picturesque scenery is found on the outer slopes of the hills. The plain, though often finely wooded, is somewhat tame, though its gentle hills and dales are not wanting in a beauty of their own."

What is said in the introductory chapter about the climate of the county is not satisfactory. Mr. Sowerby sums it up as follows :—

"On the whole, Wiltshire has probably the most elevated surface of any English county. This gives it certain peculiarities of climate. Its average mean summer temperature is higher, its mean winter temperature lower, than those of any other English county."

In the Report issued by the Royal Horticultural Society, edited by the Rev. George Henslow, on the effect on garden plants of the severe winters of 1879-80 and 1880-81, full details are given for the county of the plants that were injured and uninjured. Taking what is there stated in connection with the full details about the native vegetation of the county which are given in the body of the present work, it is quite clear that the whole of the county belongs to the warmest of Watson's six climatic zones, the Inferagrarian, of which *Clematis Vitalba*, *Viburnum Lantana*, and *Ruscus aculeatus*, are three out of many characteristic plants. The Inferagrarian and Midagrarian zones are represented in England at sea-level ; and two others, the Superagrarian and Inferarctic, in the hill-country of the North of England ; the two coldest of the six, the Midarctic and Superarctic, being reached only amongst the higher mountains of the Scotch Highlands. So far as one can judge from the botanical point of view, Kent, Sussex, Surrey, Hampshire, and Wilts stand substantially on the same level as regards climate, and cover the whole extent of Watson's Inferagrarian zone, without reaching into the Midagrarian. Mr. Preston is an experienced climatologist and phenologist, and no doubt is quite aware that such is the case ; but nowhere in the present work can we find a clear explanation of the true state of the case, which from the point of view of botanical geography is all-important.

Besides the introductory sketch of the physical geography of the county by Mr. Sowerby, and the chapter on its temperature and rainfall, there is one on its geology, with a table of the twenty strata represented in the county twelve of which belong to the Oolitic series, four to the Cretaceous, and four to the Tertiary. Mr. G. S. Boulger contributes a sketch of its drainage, on which Mr. Preston founds eleven districts, under which he classifies the localities of the rarer plants. Two of these drain into the Severn, two into the Thames, and the other seven into the English Channel. Out of the 500 pages, 430 are occupied with a catalogue of the flowering plants of the county, with such detailed localities for the rarities as have been noted. Great pains seems to have been taken to identify the species, and to trace out their dispersion through the different districts. The eighth edition of the "London Catalogue" is followed as a standard of nomenclature ; and out of the 1760 species there registered for the whole of Britain, 849 have been found in Wiltshire. Of these about 50 are marked as introduced, and at least 50 more are reckoned as varieties in Watson's "Cybele," where the number of wild British plants, including ferns, is estimated at 1425. Of these 1425 species, 530 are spread over the whole of Britain, 600 scarcely reach into Scotland, 200 are characteristically boreal types, and 77 too local to be classified. Wiltshire yields two plants which are not known elsewhere in Britain —*Cnicus tuberosus* and *Carex tomentosa*—both widely spread on the Continent. Out of 600 austral types, 127 are characteristically eastern in England. These are mostly plants that prefer chalk and limestone, and are well represented in the county. Add 30 for ferns, and 780 species for Wiltshire will be about the number on Watson's scale of reckoning, and compares properly with the figures as given in tables on pp. 371-81, and elsewhere in the fourth volume of the "Cybele." This is a smaller number than the plants of Kent, Surrey, and Hants, and about on a par with Dorsetshire and Hertfordshire. In all these counties the boreal element of the British flora is substantially eliminated. The special deficiency or unusual rarity in Wilts is of the plants of sandy heatherland, such as the foxglove, *Ulex europæus*, the fruticose Rubi, and many of the Trifolia, and such grasses as *Aira præcox*, *Deschampsia flexuosa*, and *Nardus stricta*. Altogether the book is one which no one who is interested in the distribution of British plants can afford to neglect.

J. G. BAKER.

MR. DODGSON ON PARALLELS.

Curiosa Mathematica. Part I. A New Theory of Parallels. By Charles L. Dodgson, M.A. (London : Macmillan and Co., 1888.)

THIS small book came into the world a little too soon or a little too late for our comfort. It was offered to us for notice in mid-vacation, and thinking we should find something amusing, we incontinently accepted the offer. We found some amusement, for, contrary to the author's experience, we read the preface, which is rather drawn out, but here and there is brightened by a quaint fancy or an odd quotation. We read also the appendixes, which are of a similar character with the preface; but then there remained the inner layer of the sandwich, which called for a most careful overhauling. Anyone who has read Mr. Dodgson's "Euclid and his Modern Rivals" (cited in our present notice as "E. and R."), is prepared to find close logical reasoning and acute remarks in any work he undertakes, and the reader of this booklet will not be disappointed in these particulars.

Euclid's Twelfth Axiom the author asserts to be *not* axiomatic, *i.e.* he has not met with any "bimanous biped" who accepts it as *intuitive* truth. His quest is to find a better axiom. At first sight—and the illustrative figure meets us on the cover and in other places—one is disposed to grant the truth of the Dodgsonian axiom, viz. that "in any circle, the inscribed regular hexagon is greater than any one of the segments that lie outside it." But the author is not restricted to a paltry *once*; he can equally well grapple with the problem, if his reader will grant that twice, four times, eight times, or, in mathematical parlance, 2^n times, the hexagon is greater than any one of the above-named segments. The principal part of the text consists of five definitions, six axioms, and seventeen propositions. Appendix I. contains alternative proofs of certain propositions consequent upon the general form of the author's axiom. The "distance" between two points figures as a definition ("the length of the shortest path between them") and as an axiom ("the length of the straight line joining them"). Prop. IV. is headed a "Theorem"; we should have thought it was a "Problem." It is:—"Given a triangle: to describe an equilateral triangle which shall "enclose it" (third line from end—for AE read DE). Prop. V. is an important one; it runs thus:—"Given a certain angle; and given that every isosceles triangle, whose vertical angle is not greater than the given angle, has its base not greater than either of its sides; to describe, on a given base, an isosceles triangle having each base-angle equal to the given angle" (line 5 from end, for "DE produced" read "BE produced"). In the corollary to this, the argument seems to us to be scamped: a hasty reader might think that Mr. Dodgson had *assumed* Euc. I. 32. We would close thus:—"Angle AFB is greater than angle ACB, ∴ greater than angle ABC, and *a fortiori* greater than angle ABF." Prop. VI. is all right, but how are the figures to be constructed if $n > 2$? The sum of the angles of a triangle is called, by Mr. Dodgson, its "amount." In Prop. VII. (interchange E and F in dexter figure) he shows that, "if α, β be two 'possible amounts'—that is, 'amounts' belonging to existing triangles—then every 'amount' intermediate to α and β is also 'possible.'" Prop. VIII. shows that there is a triangle whose angles are together not greater than two right angles (line 7 up, p. 17, for "=" read ">"; line 1 up, p. 18, for "ABD" read "ADB"). At this point comes the axiom, and Prop. IX. follows:—"An isosceles triangle, whose vertical angle is one-twelfth of a right angle, has its base less than either of its sides" (the corollary applies Prop. V. above). Prop. X. shows that "the angles of every equilateral triangle are together not less than one-fourth of a right angle." Prop. XI. establishes that "there is a triangle whose angles are together not less than two right angles." This is a long proposition. Props. VIII. and XI. are sound on the hypothesis which Mr. Dodgson seems tacitly to have adopted, viz. that the "amounts" of triangles are all in the same boat, either *all* greater than two right angles or *all* less than the same quantity. Surely it is, *a priori*, conceivable that the "amounts" may be variable, and then how will his proofs hold? Prop. XII. readily deduces, from the *previous reasoning*, that "there is a triangle whose angles are together equal to two right angles." Prop. XIII. proves that there is a quadrilateral figure with all its angles right angles (*i.e.* a rectangle); and Prop. XIV. shows that the opposite sides of such a figure are equal. But, "tell it not in Gath," Mr. Dodgson *takes up the rectangle*—we repeat it, takes up the rectangle—and *reverses* it, "so that A, B, may change places." We do not object, but how about the Irish bull (E. and R., p. 47)? But this is not the only surprise in store, for in Prop. XV., to prove that "there is a pair of lines, each of which is 'equidistant' from the other—that is, is such that all points on it are equally distant from the other line"—he makes a rectangle slide along on a straight line! Prop. XVI. proves that "the angles of every triangle are together equal to two right angles"; and Prop. XVII. winds up the story with showing "that a pair of lines, which are equally inclined to a certain transversal, are so to any transversal."

The appendixes repay perusal. Appendix II. discusses Euclid's axiom, and argues that, "though true in the sense in which *Euclid meant it*, it is *not* true in the sense in which *we take it*." In fact, Mr. Dodgson contends that Euclid "excludes from his view both infinities and infinitesimals, and considers *finite magnitudes* only." This is rightly founded on Euclid's Book X. Prop. I. We cannot go into the matter further here, but commend this and Appendix III. ("How should Parallels be Defined?") and Appendix IV. ("How the Question stands To-day") to any reader who is interested in this crucial question. We can quite sympathize with the author, as in times past we have more than once done our little best in the same direction, when he recounts how, more than once, he, too, has "with clasped hands gazed after the retreating meteor, and murmured, 'Beautiful star, that art so near and yet so far.'" To conclude, Mr. Dodgson is "inclined to believe that, if ever Euc. I. 32 is proved without a new axiom, it will be by some new and ampler definition of *the right line*—some definition which shall connote that peculiar and mysterious property, which it must somehow possess, which causes Euc. I. 32 to be true. Try *that* track, my gentle reader; it is not much trodden as yet; and may success attend your search!"

OUR BOOK SHELF.

Primer of Micro-Petrology. By W. Mawer, F.G.S. (London: Office of *Life-Lore*, 1888.)

THE task of introducing the student to any particular branch of science requires such selective judgment, such tact both in saying and in leaving things unsaid, that it is not surprising if many so-called "primers" fall short of the good intentions of their authors. Mr. Mawer, in this little book, presupposes "an acquaintance with the phenomena of pleochroism and the polarization of light," and hence refers only in the briefest manner to the methods employed in the examination of thin mineral sections. He also, in his desire to be abreast of current literature, uses such terms as "allotriomorphic," "micro-felsitic," "magma-basalt," without adequate definition or discussion; and in speaking of a "porphyritic ground-mass" he will throw many beginners into confusion. If the student is to seek elsewhere for instruction both in the manipulation of the polariscope and in the use of technical terms, the book must be held to fail in its fundamental object as a primer. It will probably serve well, however, to remind the learner of the broader features that mark out one rock-forming mineral from another. The author, moreover, insists, as befits a geologist, on the purely supplementary character of microscopic study—a warning that seems more than ever needed when micro-petro-*graphy*, by the change of a few letters, has been exalted to the level of a science.

The statements in this book are essentially accurate, and the illustrations, excepting that of ophitic structure, may be useful in recalling diagrammatically what has been seen in actual sections. On p. 32, however, there is an incorrect account of the pleochroism of muscovite, which probably has arisen from a blending of two totally independent notes. On p. 36 the sections of augite should be described as having, not six, but eight sides; and talc reappears on p. 50 as a constituent of protogine granite. The cleavages in drawings on pp. 33 and 36 are not in every case consistent with the descriptions.

G. C.

Theoretical Mechanics. By J. E. Taylor, M.A. (London: Longmans, Green, and Co., 1888.)

So long as examinations on prescribed courses are in vogue, so long, we suppose, will text-books be written for them. The book before us has been prepared chiefly to help those who are studying for the elementary stage of the Science and Art Department's examination in the subject, but it also covers the requirements for London matriculation. There is not much scope for originality in a work of this description, and in looking through it we find ourselves in familiar, well-worn paths.

In his preface, Mr. Taylor states that he has endeavoured to make the subject comprehensible to the beginner, but we are afraid that his efforts to explain the difference between mass and weight will be far from successful. This is always a delicate point to touch upon, but we venture to say that few beginners will be likely to understand the explanation given on page 8. This is as follows:—"Whilst mass is always measured by weight, yet the two terms must be kept distinct, the weight being the amount of force which the attraction of the earth exerts on the mass. If g represent this attraction, W, weight of the body, m, mass, we have $W = mg$." Most beginners are likely to imagine from this that W should be equal to g, instead of to mg.

The book is well illustrated throughout with many new diagrams and several old ones from well-known text-books. Numerous examples, worked and unworked, are also given.

With the exception referred to, the book is on the whole well written, and completely covers the Syllabus. The admirable style in which it has been issued, and its comparative cheapness, will commend it to many teachers.

Instructions for Observing Clouds on Land and Sea. By the Hon. R. Abercromby. With Photographs and Engravings. 22 pp. (London: Stanford, 1888.)

The phrase *Nascitur non fit* may be applied to cloud observers with almost the same confidence as to poets; at least, such is the experience of most persons who have attempted to teach an ordinary observer to record cloud phenomena.

Mr. Abercromby's pamphlet, however, contains a valuable stock of instruction which may be placed in the hands of intending observers, and will at least indicate to them what they have to observe.

The actual nomenclature of cloud forms used by Mr. Abercromby is that which has been, for the time at least, rejected by the International Committee at the recent meeting at Zürich (NATURE, vol. xxxviii. p. 491), but this is a minor matter. The illustrations of cloud perspective and cloud motion are new and good, while the difference between the motion of advance, the "propagation" of a cloud bank, and the rotation of the clouds within that bank is, for the first time, clearly stated. The importance of the R. point (radiation point), the point towards which the stripes of cirrus converge, is explained.

Mr. Abercromby concludes as follows:—

"It (cloud observing) cannot be learnt in a day, but with a little attention and practice the knowledge is soon acquired. The observer, who begins by taking simple cases of low, fast-moving clouds, till he has fully realized the meaning and importance of R. points, will soon attain such proficiency as will enable him to make valuable observations in the most recent branches of modern cloud science."

Laboratory Manual of General Chemistry. By R. P. Williams, A.M. (Boston: Ginn and Company, 1888.)

After a few preliminary matters, including some good rules for students in the laboratory, each two pages of this book has in large type consecutive directions for performing an experiment or exercise. The rest of the two pages is left blank for written notes. One hundred exercises are given, and they are of a quite elementary character. It is a pity that contractions are so frequently used, especially when there is a large amount of vacant space and so small an amount of matter. "Ap.: p.t., 4 rec., t.t., d.t., r.s." indicates to the student the apparatus he needs for the purpose of preparing hydrogen. It would have been better to adopt a recognized system of shorthand throughout, for that would have rendered the book more useful to some and quite useless to others, instead of troublesome to all.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mr. Romanes on the Origin of Species.

What the *Times* said is substantially the same as what Mr. Romanes himself says on p. 366 of his paper: "The theory of natural selection is not, properly speaking, a theory of the origin of species: it is a theory of the development of adaptive structures. Only if species always differed from one another in respect of adaptive structures, would natural selection be a theory of the origin of species. But, as we have already seen, species do not always, or even generally, thus differ from one another." Very well then, I say, if this be true, it shrivels up the part played by natural selection to very small dimensions.

The second part of Mr. Romanes's reply consists of a complaint that when I quoted from his paper the words "natural selection not a theory of the origin of species," I did not see that they were "flatly falsified" by the section at the head of which they stood. I do not see it even now, because the section finishes with what Mr. Romanes oddly calls an "insinuation" "that Mr. Darwin's great work on the 'Origin of Species' has been misnamed." If this insinuation be just, then I further do not understand how Mr. Darwin's reputation for candour is to be saved except at the expense of his intelligence.

In the third part of his reply, Mr. Romanes says "he [Mr. Dyer] must surely be aware that other botanists who have more thoroughly considered the subject are dead against him in his general conclusion." I have perhaps as many opportunities as most men of knowing the opinions of botanists, and I cannot say I am aware of anything of the kind. The "late Prof. Nägeli" may be dead against me possibly; but I was not aware that he was dead in any other sense. Nor do I see that as he insists (quite correctly as I think) on the inutility of family characters he can afford much comfort to Mr. Romanes, who regards them as generally adaptive.

I have devoted a good deal of time to the study of Mr. Romanes's paper published by the Linnean Society. I believe I have stated the conclusions to be drawn from that paper with tolerable accuracy. If I have not done so, I undoubtedly owe him a sincere apology. But I am bound to confess that, the more I study his views, the more I find myself in disagreement with him as to the inutility of specific characters; as to the utility and mode of origin of generic characters and those of higher grade; as to sterility as a primary specific difference; and as to the value of so-called physiological selection. In all these matters he is, I am satisfied, contradicted by botanical experience. I think if he had imitated the example of Mr. Darwin, and had carefully collected a large body of evidence on each of these points with a perfectly open mind, he would have found this out for himself. What, however, I view with less patience than his unsustained generalizations, is his persistent attempt to place them on the shoulders of the Darwinian theory. I have reluctantly arrived at the conviction that his only excuse for so doing is that he has fundamentally misunderstood that theory. At any rate, I cannot in any other way account for the strained interpretation which he has put on passages from Mr. Darwin's writings. I may give, as an example, the passage he quotes "to justify the insinuation" that the "Origin of Species" has been misnamed; the obvious drift of this does not relate to specific differences at all, but to those which are characteristic of families. It is easy to see, in fact, by a comparison of pp. 170 and 176 of the sixth edition, that the passage cited by Mr. Romanes was inserted by Mr. Darwin to meet the point raised by Nägeli to which I have referred above. Certainly I think that no one would have been more surprised than Mr. Darwin when he wrote the words could he have foreseen that they would be used to impugn the validity of the title of his theory and of his book. Everyone knows that Mr. Darwin was the fairest and most generous-minded of men. He constantly admits the possibility of explanations to which he really, however, did not attach much importance. Such admissions Mr. Romanes appears to me to treat as if wrung from a hostile witness. In my judgment this is entirely to misapprehend their significance or the spirit in which they were made.

W. T. THISELTON-DYER.

Royal Gardens, Kew, December 1.

Natural Selection and Useless Structures.

IN his letter on "Mr. Romanes's Paradox" (NATURE, November 1, p. 7), Mr. Thiselton Dyer questions the existence of indifferent or slightly disadvantageous specific characters. That letter referred, in a highly laudatory yet somewhat deprecating manner, to a lately published (Proc. Roy. Soc., No. 269) obituary notice of Mr. Darwin; and it implied that Mr. G. J. Romanes, from his unfamiliarity with the study of species, did not quite know what he was talking about when he asserted that such indifferent characters do in fact exist. I, who claim to have had some slight experience in the practical discrimination of species, ask permission to make a few observations in your columns on the subject.

Everyone would, I suppose, regard the frequent absence of the toe-nail on the hallux of the orang as an indifferent matter, but I am inclined to consider the feeble development of that digit itself as a slightly disadvantageous one. However that may be, I am strongly of opinion that the abortion of the index in the Potto can never have saved the lives of the earliest individuals so distinguished. I have, as yet, heard no reason assigned for the life-saving action of the thumbless hands of *Colobus* and *Ateles*, or of the tail of the one chameleon in which alone (so far as I know) that organ is not prehensile. The metallic lustre of the peritoneum of some fishes is hard to explain by either "natural" or "sexual" selection; as also are such specific characters as the extension, or non-extension, of the premaxillæ to the frontals, or the pattern of the foldings of enamel and cement in various Rodents. The complexity of the teeth of *Labyrinthodon*, or the similar multiplicity co-existing in those of *Orycteropus* and *Myliobatis* (which can hardly have been derived from a common ancestor, though their resemblance extends even to microscopic structure), are unquestionably good taxidermic characters; yet they can hardly have been due to the action of natural selection, as I pointed out in my "Genesis of Species" in 1870. But if such "selection" cannot originate characters which form the diagnosis of a species, then it cannot possibly be the origin of such species. To say that the rudimentary index of the Potto is a character which, though itself useless, has been carried on the back, as it were, of some possible but unknown useful simultaneous variation which co exists with it or did co-exist with it in some unknown ancestor is a purely gratuitous assertion. Such assertions are the less warranted because we have evidence that the energy of Nature's destructive forces has been exaggerated. Prof. Dyer tells us that natural selection is a hard taskmaster; but it is not, I think, so hard a one as some persons suppose. This seems to me clear from such facts as the finding of hares and rabbits in which an incisor tooth has grown so as to complete the circle it always tends to form—a condition which shows a remarkable preservation of life under extremely disadvantageous circumstances. A stoat, three of whose feet had been cut off at different times by traps, has nevertheless (I am informed) lived long enough for its injured limbs to heal so thoroughly that the beast could get a living on its one foot and three stumps. Cases of prolonged life under trying circumstances are not so rare. I recollect the skeleton of a monkey which must have long suffered from acute rheumatism in its native forests.

Prof. Dyer deprecates the admission, by the author of the obituary notice, that indifferent or slightly disadvantageous characters may be evolved in spite of "natural selection." But the obituary notice admits *much more than that*, since, according to its author, a maintainer of "natural selection" is free to affirm the genesis of species by sudden, considerable, definite variations, directly produced by the reaction of the innermost nature of an organism on the stimulus of its environment, according to precise innate laws of its being. This certainly is not "natural selection," as understood and taught by Mr. Darwin, and the inventor of a new term has alone the right to fix what its meaning shall be.

The statement of the obituary notice seems equivalent to an unintentional but virtual abandonment of "natural selection," while still retaining the name—reducing it, in effect, to that merely subordinate *rôle* we all admit that it plays. To call such a mode of origin "origin by natural selection" seems much the same thing as declaring an elaborately prepared theatrical transformation scene to be brought about by the chains and cords which prevent its moving pieces from passing beyond their assigned limits. The true meaning of "natural selection" is frankly declared by that distinguished biologist upon whose shoulders the mantle of the deceased prophet seems to have fallen. Prof. Lankester, in his article "Zoology" (in the last volume of the "Encyclopædia Britannica") has just given a most straightforward, lucid, and forcible representation of Darwinism. Nevertheless, the article (in the same volume) on "Variation" by Prof. Geddes, appears to me to be more in harmony with the facts of biology. It is, of course, open to anyone to say: "All species which succeed do so from some cause, and this may be metaphorically said to 'select' them." Therefore, since all causes are "natural" causes, every species which does succeed must succeed through "natural selection." This is equivalent to saying: "Nature is so conditioned as to produce the results it does produce"—an assertion most true, but somewhat trivial. When a term is so stretched as to mean "anything," it thereby comes to mean "nothing," and its use can serve no purpose save the preservation of a phrase it may be desired, for some reason, not to discard.

ST. GEORGE MIVART.

Hurstcote, Chilworth, Surrey, November 28.

A Mussel living in the Branchiæ of a Crab.

LATE this autumn, while searching for Crustacea at Amroth, in South Wales, I found rather an exceptionally good specimen of the common shore crab (*Carcinus mænas*), which I took back to the hotel to clean and preserve. On removing the carapace, I found a mussel living among the branchiæ, and fastened to them by means of its byssus. It was in good condition, and measured ⅜ of an inch in length. The carapace of the crab measured 2¼ inches wide by 1⅝ inches long. I could find no signs on the exterior of the crab of anything remarkable within, nor was there any damage to the shell, or hole through which the mussel could have passed. It seems that the mussel, while yet minute, or in a larval condition, must have been carried into the branchiæ, along the ordinary passages, by the flow of water the crab urges through them; it must there have become entangled in the feathery branches, and lived in this unwonted habitat long enough to have grown to its present size, having its food carried to it by the same water that served to oxygenate the lungs of its host. W. R. PIDGEON.

42 Porchester Square, W.

The Pasteur Institute.

IN the article in NATURE under the above title the writer says (p. 74):—"The probability of rabies following the bite of a rabid dog is now definitely ascertained to be from 15 to 16 per cent. of those attacked." It would greatly assist all who desire to form an impartial estimate of the value of Pasteur's researches on rabies as far as they are deducible from a comparison of statistics, if the writer would state the facts and figures on which the above computation of 15 to 16 per cent. rests. The statement is repeatedly made, but the proof is never given along with it. It is obvious that, unless this percentage is proved beyond dispute, the statistical argument will be lacking in cogency and force, and leaves a loophole for attack by those who are ever ready to depreciate and oppose the brilliant investigations of M. Pasteur. ERNEST ALBERT PARKYER.

Blackburn, December 3.

The Zodiacal Light.

IN your issue of October 25 (vol. xxxviii. p. 618), Dr. Muirhead quotes a remark of Cassini's in contradistinction to the relation indicated in your issue of the previous week (October 18, p. 594). The remark has not escaped notice, but is, I think, directed to a variation of shorter period, abundantly exemplified in Weber's observations, and in no wise invalidating the relation in the note of October 18. As far as Cassini's numerical observations go, the relation of the 18th is fairly exemplified, as will be shown by the following figures:—

Year.	Number of Observations.	Mean Elongation, referring to March.
1683	4	51·3
1684	2	67·10
1685 (max.)	33	52·35
1686	26	56·28
1687	16	68·82
1688	2	51·53

There are also observations indicating that the appearance did not pass away in 1688. Missionaries report brilliant appearances in 1690.

Any statement beyond the existence of this shorter variation would be at present premature.

The number of observations do not permit of a sufficiently sharp determination of the critical epoch to assert the amount of lag. The best determination which I am at present able to make is as follows. The sun-spot maxima of 1848, 1860, 1871, and 1883, follow the minima of the zodiacal light by + 1, − 1·5, − 1·5, + 1·5 years respectfully. The sun-spot minima of 1856, 1867, and 1878, follow the maxima of the zodiacal light by + 1, − 1, + 2·5 years respectively.

As to the working hypothesis, the suggestions put forward by Huggins in the Bakerian Lecture for 1885 seem in slightly varied form to meet all the facts which I am at present able to bring to bear upon the subject. There is evidence in the variation in the light of Encke's comet, as well as in the disturbance of its motion, that approaching the time of sun-spot maximum it meets matter moving towards the sun which it does not meet at the time of sun-spot minimum. Whence this matter comes may perhaps be questioned.

Observations seem to have been very nearly dropped since Weber's death in 1883. I am sure Dr. Muirhead will join with me in calling the attention of observers to this subject, and in asking that those observatories favourably situated would give us continuous records both as regards place, spectrum, and polarization. O. T. SHERMAN.

Baltimore, Md., November 15.

The "Tamarao" of the Philippine Islands.

DANS le numéro d'"August 16" (vol. xxxviii. p. 363), vous donnez une lettre du Dr. P. L. Sclater au sujet du *Tamarao* de Mindoro. Je crois que le Musée de Dresde s'en est déjà occupé; mais, sans avoir eu connaissance de ce travail, j'ai publié une note dans le tome ii. de nos Mémoires (Trübner, London) concernant l'histoire naturelle de l'Empire Chinois (p. 90), sur le *Tamarao*. J'y constate que c'est un buffle, et je propose de le nommer *Bubalus mindorensis*. Il n'a rien de commun avec l'*Anoa* des Célébes, au moins en ce qui concerne les dents.

Je suis curieux de voir dans le prochain numéro des P.Z S. une opinion contraire à celle de 1878. En dix ans on fait du chemin.

Je vous serais reconnaissant, Monsieur le Directeur, d'insérer ce petit mot dans votre correspondance. P.-M. HEUDE, S.J.

Musée de Zikawei, près Shanghai, 15 Octobre.

THE EARLIEST RACIAL PORTRAITS.

THE earliest representations of races that are preserved to us have been strangely neglected hitherto. On the Egyptian monuments are carefully sculptured and coloured figures of the various races that fell from time to time within the reach of conquest, or that entered into relations with Egypt, dating from the third millenium B.C.; yet till last year no attempt had been made to secure copies of these, free from the inevitable errors of mere drawings. At the desire of the British Association I took up this work, and made a series of casts of 280 heads from the sculptures, besides noting the colours of all paintings of races that I could find. These casts I then photographed, and the prints of the photographs can be obtained at cost price of printing.[1] These photographs are the source of the blocks (prepared by Messrs. Harper and Brothers) used in this paper, which, therefore, are perfectly automatic copies of the original sculptures.

In a recent article (NATURE, August 2, p. 321) Prof. Sayce has already noticed some of the conclusions to be drawn regarding a fair race in Palestine, so that it is needless here to repeat his statements; the actual portraits will, however, enforce his conclusions. The Amorites, who occupied the whole of Palestine, are seen (Fig. 1) to have fine though powerful features, quite different from the Jewish-Assyrian or the Egyptian types, with dolichocephalic heads; a type of face quite in accord with the light complexion and red-brown hair which they appear with in a painting of about 1500 B.C. They differ thoroughly from the features of the surrounding races of Hittites, Philistines, and Bedawin, as sculptured by the same artists, so that we are clear of the influence of mere conventionality. The Thahennu of Northern Africa, the Kabyles of modern times, show (Fig. 2) closely the same features, with only a slightly different beard and the long lock of side hair characteristic of the peoples of that region. Of the very few other portraits of Aryans that appear in Egypt, one of the most interesting (Fig. 3) is the primitive Greek woman, one of the captive Hanebu, or "lords of the north" (1400 B.C.). This has a very expressive and intelligent face, and the wavy sidelock and back hair recall the archaic Greek sculptures and vase-paintings. The stone has been unfortunately injured, but this precious proto-Greek is the only one remaining of the group.

In considering the origin of the Egyptians themselves, we are met with the difficulty that they are unlike any of the well-known neighbouring races. On the monuments we find, however, the Punites, or people of the southern shores of the Red Sea; and the resemblance between their features and those of the Egyptians is strikingly close. This noble of Pun (Fig. 4), has so precisely the face of Seti II, that either might be intended for the other. The evidence of relationship is not only in feature; the Egyptians coloured themselves as the red race, in contrast to the yellow Libyan, the brown Asiatic, and the black Negro in the four great divisions of mankind: they also colour the

[1] Apply to Mr. Harman. 75 High Street, Bromley, Kent.

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FIG. 1.—Amorites.

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FIG. 2.—Thahennu.

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FIG. 3 —Hanebu.

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FIG. 4.—Pun.

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FIG. 5.—Hyksos.

Punites of the same red. In their civil relations likewise they show some signs of a community of origin: the Egyptians never made war on the Punites, while peaceful intercourse is repeatedly found, under Sankhkara (2800 B.C.), Hatasu (1600 B.C.), Ramessu III. (1200 B.C.), and others. The land of Pun was called "the divine land" by the Egyptians, and the typical form of the beard of the Egyptian gods is that of the noble of Pun above. Unfortunately we know so very little of the archæology of Somali Land and Yemen, which appear to be the ancient Pun, that it is hopeless at present to obtain clues from there; but the recent report of Colonel Haig on the extraordinary terracing of the hills on the Arabian side with stone walls to a height of 6000 feet, the great buildings mentioned by Hamdāni (tenth century A.D.), and the massive ruins, with blocks 13 feet long, at 70 miles in the interior from Aden,[1] all show that this region has been at some time a seat of civilization. It is not too much to hope that British or Italian energies there may yield some authentic and accurate accounts of the antiquities around Aden and Asab.

The source of the Hyksos, or "shepherd kings," who

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Fig. 6—North Syrians.

invaded Egypt about 2300 B.C., has been much discussed, and one special object of my work was to get a good profile of the Hyksos sphinx in the Bulak Museum (Fig. 5).

The features are quite peculiar, and unlike those of any Egyptian or other race usually represented. But on the north wall recently uncovered at the temple of Luxor, precisely the same face is found (Fig. 6), both in profile and full face, among people of Northern Syria.

The frontal projection, the horizontal eye, the precise curves of the nose, the peculiar form of slope beneath it, the lips, and the angle of the beard, are identical throughout; while the very thick bushy hair in the Syrian parallels the massive locks with which the Hyksos always represented themselves. Further evidence on the Hyksos has just come to light. On a statue found by M. Naville at Bubastis are the names and titles of a Hyksos king (*Academy*, September 1, 1888, &c.), Khian, which at once links to the Greek form Ianias of Manetho's dynastic lists, and appears to be identical with the name Khaian which occurs twice among the chiefs of North Syria, about 1000 B.C., in the Assyrian annals. Thus there is a confirmation of the view that the Hyksos were a people from Northern Syria, and further research should follow on these lines.

Of the Khita, or Hittites, there are several portraits, of which the most characteristic (Fig. 7) is that of the king (1200 B.C.). All of these are closely alike, and could not be mistaken for any other race on the monuments. The very low and retreating forehead, the large curved nose, and beardless receding chin are the essential points; and it is just these peculiarities which are most marked in the sculptures of the Hittites executed by themselves in their own cities. The general view now is that they must have been a Mongolian race, who held a military occupation of the lands around their own country, much like the Turkish rule of modern times. Their colour on the paintings is a moderate brown or browny yellow; the eye brown, and the hair black or brown. They are thus completely different from the fair Amorites, the red-brown Bedawin, or the yellow Phœnicians which surrounded them.

The value of the series of photographs lies not only in the study of one or two special races, but in the general information on the characteristics of the people of all the countries around Egypt at about 1400 B.C. What is much needed now is an equally complete and comparable series of portraits, in profile and full face, of the modern races which are supposed to be the representatives of these.

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Fig. 7.—Hittites.

Until we have the recent portraits for comparison, the full value of the information which the Egyptians have so carefully recorded cannot be made available. It is to be hoped that some amateur will take scientific photographs in Syria, North Africa, and other countries before long.

An interesting study of the mixture of races may be made from the coloured wax paintings of the Roman age which I discovered this year in the Fayum. From those we see how largely Greek and Italian blood penetrated into Egypt far inland, and how it became mixed with the native race; showing that the Copt, though pure from Arab admixture since the Muhammedan conquest, is far from being of a pure race. We have therefore in the Copts a most interesting example for study; as the effect of climate in unifying a heterogeneous mixture, and subduing elements foreign to the country, can be here observed without any admixture of fresh races for twelve hundred years. A thorough anatomical study of the average Copt in comparison with the elements of ancient Egyptian, Negro, Ethiopian, Arab, Greek, and Roman, would throw light on the great question of climate *versus* race in the causation of characteristics. We have a specimen race duly compounded, and then safely set apart for future examination, owing to the power of fanaticism, which has been an absolute barrier to further combinations. W. M. Flinders Petrie.

[1] Described to me by Colonel Johnson Pasha.

BRITISH TERTIARY VOLCANOES.[1]

DURING the last twenty-seven years, the study of the volcanic rocks of the British Isles has been a constant and favourite pursuit with Dr. A. Geikie. It is now seventeen years since he read before the Geological Society of London the most important of the numerous memoirs which he had from time to time up to that date put forth on this subject. It was the well-known paper on the Island of Eigg, and was intended to be the first of a series of papers descriptive of localities where the characteristic features of the British volcanic rocks are well displayed. But man proposes: for the promised continuation of the series geologists have waited long and anxiously, no further instalments having till now appeared. The delay however, though trying while it lasted, has been productive of good result in the end; for we have now the long-wished-for consummation, not scattered through a long string of isolated papers, but in one connected whole. Dr. Geikie has garnered his harvest, and has summed up the results of the labours of more than a quarter of a century in a memoir which may fairly be looked upon as one of the most important of the contributions to the geological history of Britain which have seen the light since the days of William Smith.

And it gives to this elaborate communication a further importance that it is controversial as well as descriptive. In January 1874, Prof. J. W. Judd read before the Geological Society a paper "On the Ancient Volcanoes of the Highlands." It is a singularly fascinating production; its story is concisely and graphically told, and hangs well together; and I shall not easily forget the interest with which I read it for the first time, and which frequent reference to it subsequently has not abated. But Dr. Geikie's study of the subject has led him to conclusions directly in the teeth of two at least of the most important of those arrived at by Prof. Judd. Both authorities are agreed that the great basaltic plateaus of the Western Islands of Scotland and the North-East of Ireland are formed of sheets of sub-aërial lava piled one above another, the products of a long series of eruptions. Prof. Judd holds that the lavas were poured out from great central volcanoes of the type of Etna and Vesuvius, and he has endeavoured to fix the sites, and form an approximate estimate of the size of these volcanoes. Dr. Geikie is unable to find evidence for the former existence of central volcanic piles, and he believes that the lavas were emitted from fissures and numerous scattered vents of inconsiderable size. Again Prof. Judd thought he had established a threefold order of events during the period of volcanic activity. The first series of eruptions was marked by the discharge of lavas belonging to the acid class. Then came an abatement or cessation of the volcanic energy, and during a quiescent interval the cones and products of this period were largely denuded. Volcanic activity was resumed during the second period, but its products were of the basic class, and now form the basaltic plateaus. During the third period the volcanic energy was dwindling down, and had so far spent itself that it was equal to the production only of sporadic cones of small size, which are paralleled with the "Puys" of Auvergne.

And Prof. Judd further maintained that the great intrusive masses of granite and gabbro, which now form some of the boldest heights of the district, are the hardened contents of the reservoirs which fed the volcanoes of the first two periods. They had originally been buried beneath the cones that were heaped over them by the eruptions, and have been bared by denudation. The granites belong to the volcanoes of the first period, and Prof. Judd maintained that a gradual passage could be traced from them into sub-aërial lavas of acid composition that were emitted during that period. Similarly the gabbros were relegated to the second period, and pass gradually into its basic lavas. Dr. Geikie on the other hand brings an overwhelming mass of evidence to show that the intrusive masses of granite and other acid rocks are younger than the plateau-basalts. He mentions nothing that can possibly correspond with the sub-aërial sheets of acid lava which Prof. Judd states were poured out during his first period; he shows, indeed, that the one solitary known instance of a true superficial stream of acid lava is that of the Scuir of Eigg, which is unquestionably considerably younger than the plateau-basalts.

Though Dr. Geikie does not express a positive opinion on the subject, it seems to me that there is nothing to forbid our looking upon some at least of the smaller vents which he describes as Puys as belonging to Prof. Judd's third period. The vent, for instance, at Faskadale (p. 106) must be later than the great acid protrusions.

It is a serious matter for one whose acquaintance with the field of dispute is but slight to endeavour to hold the balance fairly and evenly between the conflicting views of two such eminent authorities, who have both made a study of the ground itself. Nor is the delicacy of the task diminished by the fact that the disputants have been for many years among the writer's most valued brethren of the hammer, and that to their teaching and example he owes more than can be put into words. This circumstance has fortunately however a certain advantage, for in attempting to decide between the conclusions of two equally valued and equally respected friends he will at least be free from any suspicion of partiality.

Some general considerations may be noticed before coming to detailed criticism. Dr. Geikie has known the ground ever since he was a boy: he has roamed over it again and again; he has had opportunities without number of reviewing, and in some cases of correcting, his first impressions. He has had, to some extent, the assistance and co-operation of his colleagues on the Geological Survey, and has had free access to all the details of their elaborate surveys. I believe I am right in saying that Prof. Judd was able to devote to his examination of the district the summer months of not more than two or three years. Without in the least implying that his observations were hasty, it must be clear that his opportunities for going into detail were very inferior to those of Dr. Geikie.

Further I am bound to confess that, though I was fairly carried away by the charm of Prof. Judd's paper, he did not succeed in bringing conviction to my mind to the same extent as the perusal of Dr. Geikie's memoir has done. His story had on the face of it an air of reality, but his statements were broad and general, and I could not help wishing that he had interpolated among his sweeping conclusions some details of the evidence on which those conclusions were based. I should have been sorry to miss the bold and strikingly graphic sections of his folding-plate; but I should have liked to have had, in the text, woodcuts, such as those which crowd Dr. Geikie's memoir throughout, of the actual exposures out of which those generalized representations had been constructed. It is easy to imagine good reasons for the omission of these details in Prof. Judd's paper, but all those who have made it a business of their life to cultivate a healthy tone of scepticism must have regretted their absence. No such charge can be brought against Dr. Geikie; more than sixty woodcuts, most of them representing actual sections, give ample opportunity for deciding for or against the sufficiency of his evidence.

We may now examine more in detail the main points of difference between the two readings; and, first of all, as to the vents from which the lava-flows were discharged.

[1] "The History of Volcanic Action during the Tertiary Period in the British Isles." By Archibald Geikie, LL.D., F.R.S., Director-General of the Geological Survey of the United Kingdom. Transactions of the Royal Society of Edinburgh, vol. xxxv., Part 2. (Edinburgh: R. Grant and Son, 1888.)

Dr. Geikie relies on the absence of any obvious vent from which the molten matter flowed. But surely the huge orifice of Strath, in Skye, was large enough to have served such a purpose. True there are appearances which seem to show that some of the plateau-basalts once extended right across the mouth of this funnel, but Dr. Geikie himself admits with perfect candour that the relation of this neck to the plateau-basalts does not admit of satisfactory treatment, owing to the destruction of the evidence by later intrusion of masses of granophyre in its immediate neighbourhood, and likewise to enormous denudation. I see nothing unlikely in the supposition that, from this enormous funnel, basaltic lava may have flowed in a manner to be shortly described; that the chimney became afterwards choked by agglomerate, too coarse to be spread far over the neighbourhood; and that, above all, basalt emitted from some new adjoining vent may have afterwards extended itself. Dr. Geikie further lays stress on the uniformity of the plateau-basalts in petrographical character, thickness, and persistent flatness, and on the almost total absence of interbedded fragmental deposits; and he maintains that these distinctive characters lead us to seek the modern analogues of the volcanic phenomena, not in large central cones like Vesuvius and Etna, but in the vast basalt-fields of Western America, where the lavas have issued from innumerable minor, and sometimes almost imperceptible, vents. With the first part of this opinion everyone must, I think, side with Dr. Geikie; but the method of formation which he advocates is by no means the only one possible or likely. Ever since I read Captain Dutton's account of the Hawaiian volcanoes,[1] it has seemed to me that it is to them we must look, if we are to understand the machinery by which great lava-plateaus have been produced. Speaking of the enormous flow which issued from Mauna Loa in 1855, he says: "As I looked over this vast expanse of lava, I was forcibly reminded of the great volcanic fields of the western portion of the United States, where the eruptions are of such colossal proportions that they have received the name of massive eruptions." After noticing Richthofen's view that these lavas had been poured forth through great fissures, and stating that the volcanic rocks of Western America, well as they are laid open to view, would be considered relatively obscure by one who has had an opportunity of inspecting the recent lavas of Mauna Loa, he goes on thus:—"I am by no means certain that Richthofen's conclusions are wrong. But here is a lava-flow, the dimensions of which fully rival some of the grand Pliocene outbreaks of the West, which demonstrably differs in no material respect, excepting in grandeur, from the much smaller eruptions of normal volcanoes" (*loc. cit.*, p. 156). But the differences between the modes of action of volcanoes of the Vesuvian and the Hawaiian types, whether we designate them as material or not, are striking enough, and they are just those which seem to have accompanied the discharge of the plateau-basalts we are now engaged with. Captain Dutton has well described them. "Mauna Loa and Kilauea," he says, "are in many important respects abnormal volcanoes. Most notable is the singularly quiet character of their eruptions. Rarely are these portentous events attended by any of that extremely explosive action which is characteristic of nearly all other volcanoes. The lava wells forth like water from a hot, bubbling spring; but so mild are the explosive forces that the observer may stand to the windward of the grandest eruption, and so near the source that the heat will make the face tingle, yet without danger. A direct consequence of this comparatively mild and gentle behaviour is the absence of those fragmental products which form so large a portion of the products of other volcanoes" (*loc. cit.*, pp. 84, 85). Fissure-eruptions are, to say the least, hypothetical; but here we have a way in which huge lava-fields, of the type of basaltic plateaus, are being produced before our eyes. The universally adopted canons of geological reasoning leave us no alternative as to which of the two explanations we should favour.

[1] United States Geological Survey, Fourth Annual Report, 1882–83.

But if the view just expressed be correct, we ought certainly to find some indications left, even among these ruined volcanoes, of the position of the vents from which the lavas issued. And here I cannot help going a long way with Prof. Judd in thinking that the great eruptive bosses of gabbro in Skye, Rum, Ardnamurchan, and Mull, are plugs filling in some of the main orifices of discharge. Prof. Geikie lays stress on the facts that the gabbros send off intrusive sheets into the plateau-basalts, and even overlie them. But this proves merely that the plugs which now fill the vents are later than the plateau-basalts: the vents themselves may be older. There must be some reason why the great intrusive bosses cluster thickly round a few centres, and are elsewhere conspicuous by their absence, and the following seems not unlikely. It was at these spots that vents were opened early in the volcanic period; from them there flowed, in the mild undemonstrative fashion of the Hawaiian volcanoes, the lavas which now build up the basaltic plateaus; as sheet was laid down upon sheet, the chimney gradually rose in height; and when, for this reason, and perhaps also on account of a temporary abatement of volcanic energy, the lava was no longer able to flow out at the top, it solidified in the vent, and, being under pressure, hardened into gabbro instead of dolerite. And indeed, though Dr. Geikie speaks of the eruption of the gabbro bosses as an event sufficiently marked and independent to characterize a distinct epoch in the volcanic period, he at the same time expresses himself in a way that shows he shares in the view I have just put forward, for he says: "We must remember, however, that the gabbro in many places found its readiest ascent in vents belonging to the plateau-period."

So far then the views of Dr. Geikie and Prof. Judd may admit of modifications which render them less conflicting than they seem at first sight. But there is one point on which reconciliation is impossible, viz. the nature and relative date of the eruptions of acid composition. Prof. Judd recognizes not only acid eruptions of the massive type—granites and their allies—but he speaks of thick bodies of felstones, disposed in regular sheets and of amygdaloidal structure, which alternate with beds of scoriæ, lapilli, and ashes, that lie upon the skirts of the central bosses of granite. These he believes to be the remnants of a volcano formed mainly of acid lavas, which was piled up and largely ruined by denudation before the discharge of the plateau-basalts began. The existence of the granite bosses admits of no doubt; but Dr. Geikie has depicted numerous sections which leave no doubt that these rocks intrude into the basalts and gabbros, and are therefore of later date than them. Now that all these details are before us, the question of relative age can admit of only one answer, but it is evidently a point on which observers, who had not opportunities of entering minutely into details, were apt to go wrong. Both Principal J. D. Forbes and Prof. Zirkel seem to have come to the same conclusion as Prof. Judd, and Dr. Geikie has supplied the explanation. "That there should ever have been any doubt," he says, "about the relations of the two eruptive masses is possibly explicable by the facility with which their junction can be observed. Their contrasts of form and colour make their boundary over crag and ridge so clear that geologists do not seem to have taken the trouble to follow it out in detail. And as the pale rock (granophyre or granite) underlies the dark (gabbro), they have assumed this infraposition to mark its earlier appearance." All this is graphically brought out in Fig. 43 of Dr. Geikie's memoir, which is reproduced here (Fig. 1). Anyone trusting to surface-feature

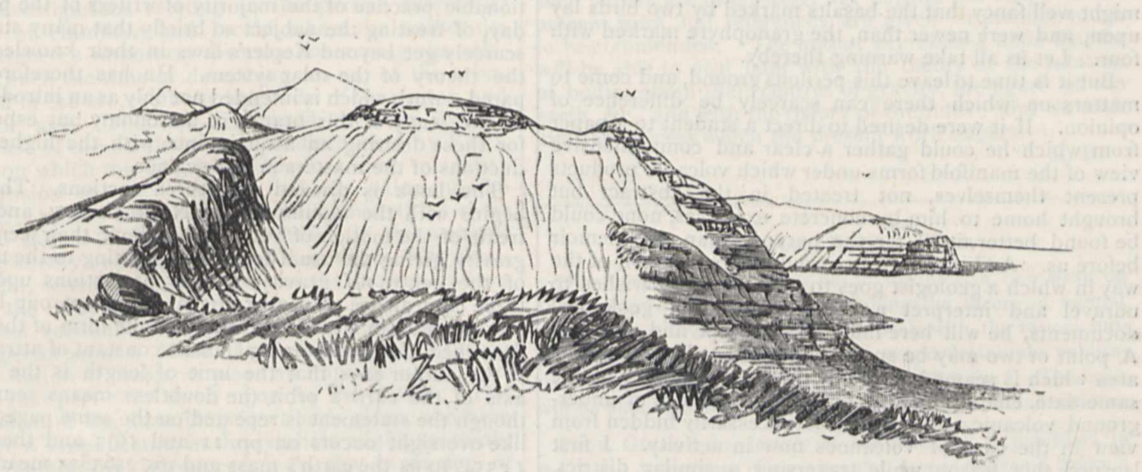

Fig. 1.—View of the hills on the south side of the head of Loch na Keal, showing the junction of the granophyre and the bedded basalts. One bird, the bedded basalts of the Gribon plateau; two birds, the bedded dolerites and basalts of Beinn a' Chraig adhering to the northern slope and capping the hill; three birds, summit of Ben More, with A'Chioch to the left and the top of Beinn Fhada appearing in the middle distance between them; four birds, the granophyre slopes of Beinn a' Chraig with the great dyke-like mass of felsite on the left.

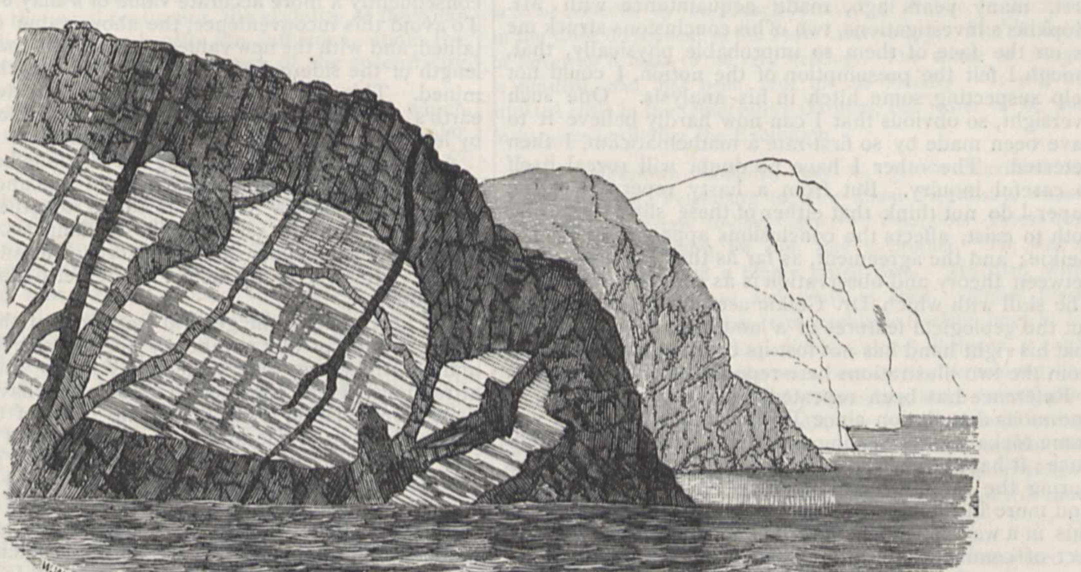

Fig. 2.—Basic veins traversing Secondary Limestone and Sandstone on the coast cliffs, Ardnamurchan.

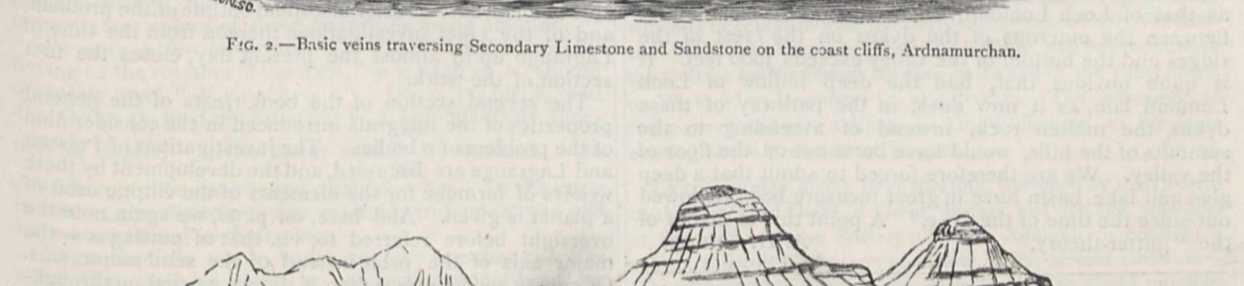

Fig. 3.—Outline of the hills of the Island of Rum, sketched from near the Isle of Eigg.

might well fancy that the basalts marked by two birds lay upon, and were newer than, the granophyre marked with four. Let us all take warning thereby.

But it is time to leave this perilous ground, and come to matters on which there can scarcely be difference of opinion. If it were desired to direct a student to a paper from which he could gather a clear and comprehensive view of the manifold forms under which volcanic products present themselves, not treated in the abstract but brought home to him by concrete examples, none could be found better fitted for the purpose than the memoir before us. And if a beginner would learn a lesson of the way in which a geologist goes to work when he wishes to unravel and interpret a complex group of geological documents, he will here find both precept and example. A point or two may be specially noticed. The enormous area which is seamed across by dykes, presumably of the same date, enables us to realize the importance of underground volcanic action, which is necessarily hidden from view in the case of volcanoes now in activity. I first learned this lesson while traversing a similar district, fully three times as large as that treated of by Dr. Geikie, in South Africa In connection with the striking parallelism of a large number of the dykes, reference is fittingly made to the classical paper of Mr. Hopkins, which he used so pathetically to complain had proved of interest neither to geologists nor mathematicians. But the mention of this paper again makes me lapse into criticism. When I first, many years ago, made acquaintance with Mr. Hopkins's investigations, two of his conclusions struck me as on the face of them so improbable physically, that, though I felt the presumption of the notion, I could not help suspecting some hitch in his analysis. One such oversight, so obvious that I can now hardly believe it to have been made by so first-rate a mathematician, I then detected. The other I have no doubt will reveal itself to careful inquiry. But from a hasty reperusal of the paper I do not think that either of these slips, supposing both to exist, affects the conclusions appealed to by Dr. Geikie; and the agreement, as far as they are concerned, between theory and observation is as complete as can be. The skill with which Dr. Geikie uses his pencil to bring out the geological features of a landscape is well known: that his right hand has not lost its cunning will be evident from the two illustrations here reproduced (Figs. 2 and 3).

Reference has been repeatedly made to the proofs of enormous denudation since Tertiary times which the volcanic rocks we are dealing with furnish in lavish abundance; it has not been so often noticed that denudation has during the same interval made its effects felt on harder and more intractable rocks. But dykes furnish proof of this in a way which I believe has not been made the subject of comment. "The evidence of this denudation," says our author, "is singularly striking in such districts as that of Loch Lomond, where the difference of level between the outcrops of the dykes on the crest of the ridges and the bottom of the valley exceeds 3000 feet. It is quite obvious that, had the deep hollow of Loch Lomond lain, as it now does, in the pathway of these dykes, the molten rock, instead of ascending to the summits of the hills, would have burst out on the floor of the valley. We are therefore forced to admit that a deep glen and lake basin have in great measure been hollowed out since the time of the dyke." A point this in favour of the "gutter-theory." A. H. GREEN.

THE THEORY OF PLANETARY MOTION.[1]

IN the work the title of which is printed below, Dr. Otto Dziobek seeks to develop the theory of the motion of bodies subject to attraction according to Newton's law. The author, in his preface, draws attention to the objectionable practice of the majority of writers of the present day, of treating the subject so briefly that many students scarcely get beyond Kepler's laws in their knowledge of the theory of the solar system. He has therefore prepared a work which is intended not only as an introduction to the study of this branch of astronomy but especially for those desiring an acquaintance with the higher productions of the masters in this science.

The book is divided into three sections. The first begins with the assumption of Newton's law, and then treats of the motion of two bodies about their centre of gravity, giving the usual deductions relating to the motion of the centre of gravity, to the projections upon the three co-ordinate planes of the areas swept out by the radius-vector in a given time, and to the form of the orbit described. In determining Gauss's constant of attraction, k, the author says that the unit of length is the major axis of the earth's orbit (he doubtless means semi-axis, though the statement is repeated on the same page, and a like oversight occurs on pp. 11 and 16); and then with 1 : 354710 as the earth's mass and 365·2563835 mean solar days as the length of the sidereal year, k is found = 0·017209895. This is the value found by Gauss, and given in his "Theoria Motus." This constant has been incorporated in many tables, and any change in its value would be attended with considerable inconvenience. But since the time of Gauss more accurate values of the earth's mass and of the length of the sidereal year have been found, and consequently a more accurate value of k may be deduced. To avoid this inconvenience, the above value of k is retained, and with the new values of the earth's mass and the length of the sidereal year the unit of length is determined. This unit of length is slightly greater than the earth's mean distance from the sun, but differs from it by less than a unit of the eighth decimal.

A collection of formulæ giving the relations between the radius-vector, the mean, eccentric, and true anomalies, as in Gauss's "Theoria Motus," is added, together with the usual expansions in series of these quantities. The expressions for the expansion of the eccentric anomaly and of the radius-vector by means of Bessel's functions are also added.

We next come to the general treatment of the problem of the motion of any number of bodies projected in any manner in space, and subjected only to their mutual attractions. Here, considering n bodies, we have the usual deductions relating to the invariable plane of the system, and to the sum of the products of the mass of each body into the area described by its radius-vector. The author then proceeds to simplify the case by discussing the motion when $n = 3$, and thus the case of the celebrated problem of the three bodies. Of this the usual outline is given, together with certain special cases of the problem, the lines of the investigations of Lagrange and of Jacobi being chiefly followed. A brief historical outline of the problem, and of the chief investigations thereon from the time of Lagrange up to almost the present day, closes the first section of the work.

The second section of the book treats of the general properties of the integrals introduced in the consideration of the problem of n bodies. The investigations of Poisson and Lagrange are discussed, and the development by these writers of formulæ for the elements of the elliptic orbit of a planet is given. And here, on p. 98, we again note the oversight before referred to, viz. that of putting $a =$ the major axis of the orbit instead of the semi-major axis. Of course such a proceeding if it were carried on throughout would have no effect upon the developments which are obtained, except on their symmetry, but the author, after mentioning that the quantity a represents the major axis, immediately proceeds to use the quantity with its usual signification, viz. the semi-major axis. The oversight occurs again on p. 112, and again in discussing the canonical constants for the elliptic motion of a planet, and again

[1] "Die mathematischen Theorien der Planeten-bewegungen." By Dr. Otto Dziobek. (Leipzig: Johann Ambrosius Barth, 1888.)

in the investigations relating to the partial differential equation of Hamilton and Jacobi, where the author deduces Lambert's important theorem concerning the relations between the time of describing an arc of the orbit, the chord of the arc, the bounding radii of the sector, and the major axis. This last-mentioned theorem for the special case of the parabola was first discovered by Euler, a point on which the late Prof. Oppolzer used to insist; the extension of the theorem for any value of the eccentricity of the orbit being due to Lambert. A short historical sketch of the matter contained in this section, referring chiefly to the labours of Lagrange, Hamilton, and Jacobi, concludes this portion of the subject, and we come to the third section of the book.

This last section of the work treats of the theory of general perturbations. Here, of course, Lagrange's theory of the variation of constants plays an important part, and we have that part fully dwelt upon by the author. The development of the disturbing function is given, and here and there a simplification in the symbols might, we think, with advantage be introduced. In the expansion of $(r_1^2 - 2r_1r_2\cos\theta + r_2^2)^{-\frac{s}{2}}$, we have given the simple expression for half the coefficient of $\cos m\theta$ in terms of Gauss's hypergeometric series, viz.—

$$r_1^{-s}\,\frac{s(s+2)(s+4)\ldots(s+2m-2)}{2m\,.\,m!}\,a^m F\left(\frac{s}{2}, \frac{s}{2}+m, m+1, a^2\right)$$

The secular and periodic changes in the elements of the orbit receive the usual treatment, the stability of the solar system is discussed, and also the influence upon the results of terms in the higher powers of the eccentricity and inclination.

A few pages are also devoted to a point which writers are accustomed to say never occurs in the solar system—viz. commensurability of the mean motions of two planets. The importance of the subject treated in this section induces the author to extend the limits of the historical sketch with which he has concluded the two previous sections, and to give a little more fully the history of the important theory of perturbations; and he adds, in conclusion, that the best proof of the truth of Newton's law is in the discovery of the cause "of the observed irregularities in the motion of Uranus," a cause suspected by Bouvard and by Bessel, and a problem which death prevented the latter from undertaking, but which was "von zwei anderen Astronomen Leverrier und Adams gelöst." Speaking of the latter, the author remarks that "er seine Resultate einige Monate früher dem Astronomen Airy mittheilte"; the want of a "Durchmusterung," however, placed the optical discovery of Neptune in the hands of Dr. Galle.

At the end of the book are given a few small tables chiefly Leverrier's elements of the orbits of the major planets, except for Uranus and Neptune, Newcomb's more correct values of these quantities being adopted.

We note a few misprints. On p. 5, at the bottom, referring to the rotation of the axes, "$+x$ nach $+z$" should obviously read "$+y$ nach $+z$." On p. 11, for k_2 read k^2. On p. 45, in differentiating V, a homogeneous function of degree -1, the factor z of $\frac{dV}{dz}$ is omitted. On p. 46 it might be mentioned that $M = \Sigma m$. In the copy before us, pp. 225 to 240 are omitted, and pp. 273 to 288 have been bound in their place.

Regarding the whole book, we may say that there is much that may be found in any ordinary text-book on the subject. But the author has endeavoured to do more than give a mere sketch, as writers of the present day usually do, leaving the reader to search the pages of *Crelle's Journal*, the *Comptes rendus*, or some similar publication, for important papers connected with the subject. Where these have appeared useful, they have been introduced in a modified form if necessary; and where such papers are interesting, but beyond the scope of the present work, full references are given—a practice much to be commended. The author expresses a hope that he will be able to deal later with the theory of the rotation of bodies about their centres of gravity, the figure of the earth, &c., and with the theory of the tides; and we wish him the success which the present work augurs.

R. B.

NOTES.

DR. ALFRED R. WALLACE has in the press a new work on Darwinism, which aims at establishing the theory of natural selection on a firmer basis, and also deals with the various supplementary theories which have been put forth since the publication of the sixth edition of the "Origin of Species." The book will be published early next year by Messrs. Macmillan and Co.

PROF. GIARD'S first lecture at the Sorbonne is published in the *Revue Scientifique* (December 1). It was delivered before a large audience, and many hundreds of persons had to be content to stay at the door. The Thursday lectures of M. Giard are devoted to an historical sketch of embryology in its relation to the theory of evolution. The Saturday lectures are devoted to embryological phenomena, considered generally.

ON the 19th inst. a monument of the astronomer Leverrier is to be unveiled by the French Minister of Public Instruction, in the Cour d'Honneur of the Paris Observatory. The likeness of Leverrier is said to be very striking. The statue of Arago is finished, and has been sent to the foundry. It will be situated close to the Observatory Gardens, but is not to be put in its place until after the Exhibition.

THE well-known botanist, Dr. C. J. de Maximowicz, writing from St. Petersburg to Kew about Prjevalsky, whose last book we review to-day, says:—"Yes, poor Prjevalsky is dead, and I mourn for him like a brother. He was a splendid character and a highly gifted man. He died with his Expedition fitted out and ready to start. Under these circumstances, the Russian Geographical Society intends to appoint, as head of the Expedition, Colonel Pentsow, a good topographer, who has already twice been in Northern Mongolia. Lieutenant Roborofski, Prjevalsky's associate, and a very capable officer and good collector, who did the botanical work during the two last journeys, is to go also. The plan is to remain the same, perhaps with the exception of Lhassa and the investigation of Northern Tibet. But the Society will appoint this time a geologist, which it is indeed high time to do."

WE learn that the Hon. John Collier has just completed a portrait of Dr. A. W. Williamson, For. Sec. R.S. This portrait, which is to commemorate the thirty-eight years of Dr. Williamson's professorial work at University College, will be presented to the College by Sir Henry Roscoe, on behalf of the subscribers, on Wednesday, December 12, at 4.30 p.m. The subscribers to this portrait will give a dinner to Dr. Williamson on the same evening at the Freemasons' Tavern.

LAST Saturday, a very large meeting, convened by the Council of the Teachers' Guild of Great Britain and Ireland, was held at the rooms of the Society of Arts, Adelphi, to consider a subject which is likely soon to attract much serious attention—the organization of secondary education. The Guild numbers among its Presidents some of the most eminent authorities on higher education, as Heads of Colleges, Professors of the English, Scotch, and Irish Universities, the President of the Royal Academy, Prof. Huxley, and Mr. Mundella. Sir Philip Magnus, who presided, said that at present no public body was responsible for the secondary education of the country. There was no department which was cognizant of the secondary schools, or of the character of the education which they provided. He insisted that it was necessary that some kind of machinery should be brought into existence for several specified objects, including (1) provision of a sufficient number of efficient secondary schools duly related to one another, and to the elementary schools beneath them, and to the Universities above them; (2) the adaptation of the instruction given in these schools to the wants and requirements of different towns and districts; (3) the registration of teachers employed in these schools; (4) the utilization of the present enormous secondary scholarship fund to provide free places in these schools, and to enable pupils from the elementary schools to receive a good secondary education, and, in certain cases, higher technical or University education; (5) the regulation and inspection of all schools in receipt of funds derived from public sources, and the recognition of all private schools that submit to such inspection; (6) the annual publication of reports showing the number and distribution of schools, the curriculum of studies, the qualifications of the teachers, the character of the teaching appliances, and the general and sanitary condition of the schools. The meeting almost unanimously passed a resolution, proposed by Prof. Gladstone, F.R.S., to the effect that an Educational Council should be called into existence, in whose hands the organization of the secondary education of the country should be placed.

THE yearly volume of the *Kew Bulletin* for 1888 is now ready. This most useful publication, as our readers are aware, contains notes on the economic products of plants which have been made the subject of particular study and investigation at Kew, and it serves as a means of communication to persons interested in botanical subjects and products in India and the colonies. In the December number there are papers on Inhambane Copal, the cultivation of rice in Bengal, silkworm thorn, Jamaica india-rubber, seedlings of sugar-cane at Barbadoes, and ramie. In the paper on seedlings of sugar-cane at Barbadoes, attention is called to the fact that Mr. J. B. Harrison, Professor of Chemistry and Agricultural Science at Barbadoes, acting in conjunction with Mr. T. R. Bovell, superintendent of Dodd's Reformatory, has been engaged during the last three years in cultural and chemical experiments with various kinds of sugar-canes. A statement sent by Prof. Harrison appears to prove, in a perfectly natural and circumstantial manner, that a few mature seeds may occasionally be produced by the sugar-cane under certain circumstances. This discovery, if it is fully confirmed, may have an important effect on the practical treatment of the question whether the saccharine qualities of the sugar-cane are capable of being improved on the same lines as those successfully adopted with regard to the beet.

WE are glad to see that a German translation of Miss A. M. Clerke's "Popular History of Astronomy during the Nineteenth Century" has just been issued. A most appreciative review of the work appears in the current number of the *Naturwissenschaftliche Wochenschrift*.

MESSRS. CASSELL AND CO. have begun to issue, in monthly parts, a new edition of their well-known "Popular Educator." This work, we need scarcely say, has been of essential service to many a student who has undertaken in earnest the task of self-education, and in its new form it may be even more useful in the future than it has been in the past. The lessons are being revised throughout, and a large portion of the work will be entirely rewritten. Among the new illustrations is a series of coloured plates, prepared for the benefit of students of ethnology, geology, astronomy, physical geography, botany, &c.

MESSRS. MACMILLAN AND BOWES, Cambridge, announce that the first volume of the "Mathematical Papers," by Prof. Arthur Cayley, will be ready in January 1889.

A LARGE number of new fluorine compounds of the rare metal vanadium have been prepared by Dr. Emil Petersen, of Copenhagen. No fluoride of vanadium has hitherto been obtained, the only compounds previously known containing fluorine and vanadium being the fluoxy-vanadates of Baker, and a few other oxy-compounds, recently described by Piccini and Giorgio, which latter appear to have been independently obtained by Petersen. The most important of the new compounds is sesquifluoride of vanadium itself, V_2F_6, which has been obtained in fine large rhombohedrons of a dark-green colour, containing six molecules of water of crystallization, and very soluble in water. Next in importance are two probably isomorphous double fluorides of vanadium with potassium and ammonium, $V_2F_6 . 4KF . 2H_2O$, and $V_2F_6 . 4NH_4F . 2H_2O$; the former was obtained in the form of a bright-green crystalline precipitate, and the latter in brilliant emerald-green and tolerably large octahedra. Besides this compound with ammonium fluoride, another, of the composition $V_2F_6 . 6NH_4F$, was isolated in small grass-green, regular octahedra; this salt is especially interesting as being isomorphous with the analogous chromium and titanium compounds. To complete the isomorphous group, Dr. Petersen has also prepared the aluminium compound $Al_2F_6 . 6NH_4F$. Another interesting pair of isomorphous salts are the compounds $V_2F6 . 2CoF_2 . 14H_2O$ and $V_2F6 . 2NiF_2 . 14H_2O$, the former of which was obtained in dark-green, and the latter in grass-green monoclinic prisms. The remarkable similarity of the sesqui-vanadium and sesqui-chromium compounds is again beautifully shown by the fact that two precisely analogous salts containing cobalt or nickel and chromium instead of vanadium were successfully prepared, containing also fourteen molecules of water of crystallization and crystallizing in green monoclinic prisms. In addition to these important double fluorides of vanadium sesqui-fluoride, a number of oxy-fluorides, derived from vanadic anhydride, V_2O_5, and analogous to the well-known oxychlorides of phosphorus, have also been obtained in combination with alkaline fluorides. The two most important of these appear to be the oxyfluorides, $VOF_3 . 2KF$ and $VO_2F . 2KF$, the latter forming beautiful golden-yellow hexagonal prisms. This preliminary communication of Dr. Petersen, which will be found in the current *Berichte*, just received, forms a rich addition to our information concerning the element vanadium, and the details of the preparation of these well-crystallized salts, a small selection of which only have been described above, will be looked forward to with considerable interest.

THE new Ethnological Museum in Sydney, nominally opened last January, has now really been made accessible to the Australian public. The collection, which includes a large number of weapons and implements obtained from aboriginal races, is described by the *Sydney Daily Telegraph* as one "of absorbing interest."

WE have received Nos. 2 and 3 of vol. lvii. part 2, of the Journal of the Asiatic Society of Bengal. They contain notes on Indian Rhynchota, by E. T. Atkinson; a paper on the tornado which occurred at Dacca on April 7, 1888, by A. Pedler and A. Crombie; notes on the Amphipoda of Indian waters, by G. M. Giles; a paper on *Eupetaurus*, a new form of flying squirrel from Kashmir, by O. Thomas; and notes on Indian Chiroptera, by W. T. Blanford, F.R.S.

MR. THOMAS's account of the new form of flying squirrel from Kashmir, is very interesting. In connection with its dental evolution Mr. Thomas says it would be advisable for naturalists and sportsmen in Kashmir to notice what its food is, as compared with that of other squirrels. Judged from its blunt claws, it probably frequents rocks and precipices rather than trees, and it is therefore possible that its ordinary food may consist of lichens, mosses, and other rock-loving plants, which, by being mixed with sand and particles of rock, would necessitate the development of such long lasting molars as it is remarkable for possessing. Additional specimens of *Eupetaurus* would be most valuable for scientific examination, especially if of different ages; and Mr. Thomas expresses a hope that some of the many British sportsmen who annually visit Kashmir will help to enrich either the Indian Museum in Calcutta, or the National Museum at home, with examples of this, the latest addition to the mammal fauna of our Indian Empire.

IN the new number of the *Zoologist* Mr. T. Southwell has an interesting article on Pallas's sand grouse in Norfolk. Speaking of a large flock which Mr. Wood, of Morston, had under his close observation for some months, Mr. Southwell says that they frequented the same fields with great regularity; their favourite feeding-place being a large clover layer, from which, if disturbed, they flew across to some adjacent turnip-fields, choosing the bare patches for their feeding-ground. Here they spread over a circle of some 30 or 40 yards, separating, and diligently searching the ground until they appeared to have exhausted the food in that particular locality, when they all rose together and repaired to a fresh spot, which they exhausted in like manner. At stated times they departed for the salt marshes adjacent. The bird is usually extremely shy, but not always. Mr. A. Napier was shooting on the Holkham sand-hills with Lord Leicester and party, on October 13, when they met with a flock of about thirty-five. "A single bird," says Mr. Napier, "which I came upon, I felt convinced must have had either a nest or young. When first I saw it, it fluttered along in front of me just like a partridge with young. It was so tame that I called Lord Leicester and the others up to see it, and it did not fly up until we had approached to within 3 or 4 yards of it. At first I thought it must have been a wounded bird, but I do not think so now, for it flew away very strongly, calling out most lustily. Its action reminded me very much of the turtle-dove." Other incidents of a like kind are recorded by Mr. Southwell. On August 5 the gardener at Shernbourne Hall came to Mr. Parsons to say that a sand grouse was running about on the lawn. Mr. Parsons went out to catch it, thinking his son's pinioned bird had escaped. On being approached, the bird "ran and skulked in a little ditch," and did not rise till Mr. Parsons was about to put his hand on it, when it flew away "quite strong." Another, now in Mr. Gurney's aviary at Northrepps, was found, on October 31, floundering in a wet ditch at Suffield, and taken by hand.

WE learn from the *Canadian Record of Science* (vol. iii. No. 3) that in June 1887 a small collection of graptolites was obtained by Dr. G. M. Dawson, on Dease River, in the extreme northern and inland portion of British Columbia, about lat. 59° 45′, long. 129°. These fossils were derived from certain dark-coloured, carbonaceous and often calcareous shales, which, in association with quartzites and other rocks, characterize a considerable area of the lower part of the Dease, as well as the Liard River, above the confluence. In 1886 a similar small collection was obtained by Mr. G. R. McConnell, near the line of the Canadian Pacific Railway, in the Kicking Horse (Wapta) Pass. No other locality in the western portion of the Dominion has yet been found to yield graptolites. Prof. Lapworth, to whom Dr. Dawson's collection has been transmitted, thinks that the graptolite-bearing rocks are clearly of about Middle Ordovician age. They contain forms he would refer to the second or Black River Trenton period; *i.e.* they are newer than the Point Lévis series, and older than the Hudson and Utica groups. The association of forms, he says, is such as we find in Britain and Western Europe, in the passage beds between the Llandeilo and Caradoc Limestones.

THE following are the lecture arrangements of the Royal Institution before Easter:—Prof. Dewar, six lectures (adapted to a juvenile auditory) on clouds and cloudland; Prof. G. J. Romanes, twelve lectures constituting the second part of a course on before and after Darwin (the evidences of organic evolution and the theory of natural selection); Prof. J. W. Judd, four lectures on the metamorphoses of minerals; Dr. Sidney Martin, four lectures on the poisonous action of albuminoid bodies, including those formed in digestion; Prof. J. H. Middleton, four lectures on houses and their decoration from the classical to the mediæval period; Prof. Ernst Pauer, four lectures on the characters of the great composers and the characteristics of their works (with illustrations on the pianoforte); and eight lectures by the Right Hon. Lord Rayleigh, on experimental optics (polarization; the wave theory). The Friday evening meetings will begin on January 25, when a discourse will be given by Prof. G. H. Darwin; succeeding discourses will probably be given by Prof. W. C. McIntosh, Sir William Thomson, Prof. A. W. Rücker, Mr. Harold Crichton Browne, Prof. Oliver Lodge, Prof. Archibald Geikie, the Rev. Alfred Ainger, the Right Hon. Lord Rayleigh, and other gentlemen.

THE Russian naturalist, M. K. Nossilow, has been making geological investigations in Nova Zembla, and has discovered traces of gold.

PROF. OLIVER J. LODGE writes to us as follows about his letter on the "Velocity of Sound" (NATURE, November 22, p. 79):—"In equation (6), $U + v$ should, strictly, be $-U + v$, because the sign of U has changed with its signification. Equation (7) is therefore wrong. In the paragraph between equations (3) and (4), the words 'condensation' and 'rarefaction' should be transposed."

THE additions to the Zoological Society's Gardens during the past week include two Squirrel Monkeys (*Chrysothrix sciurea*) from Guiana, presented by Master H. B. Young; a Silvery Gibbon (*Hylobates leuciscus* ♂) from Burmah, presented by Captain D. L. de la Chevois; a Pig-tailed Monkey (*Macacus nemestrinus* ♀) from Java, presented by Mr. W. Merryweather; a Polecat (*Mustela putorius*), British, presented by Mr. F. D. Lea Smith, F.Z.S.; a Raven (*Corvus corax*), British, presented by Mr. C. Petrzywalski; a Sparrow Hawk (*Accipiter nisus*), British, presented by Mr. G. Skegg; two Barn Owls (*Strix flammea*), British, presented by Mr. E. Hart, F.Z.S.; a Lion Marmoset (*Hapale rosalia*) from Brazil, deposited; a Blue-cheeked Barbet (*Megalæma asiatica*) from India, a Golden-crowned Conure (*Conurus aureus*) from South-East Brazil, a Golden-winged Parrakeet (*Brotogerys chrysopterus*) from the Amazons, purchased.

OUR ASTRONOMICAL COLUMN.

STONYHURST COLLEGE OBSERVATORY.—The Report of this Observatory for 1887, which has been recently published, is of the usual character, giving the results of the magnetic and meteorological observations for the year. The daily areas of the spots observed upon the sun during 1886 and 1887, expressed in millionths of the sun's visible hemisphere, are also given in both tabular and graphical form. The latter shows in a very striking manner the remarkable depression in spot-activity which marked the seven months from the end of September 1886 to the end of April 1887, and the regular series of gentle undulations which succeeded it. A note on the "Upper Glows in 1887" records that the white haze round the sun, and the pink "fore" and "after" glows consequent upon the Krakatão explosion, were still observed occasionally in 1887, but more feebly and less frequently than in 1886.

THE HOPKINS OBSERVATORY.—The little Observatory of this name attached to Williams College, Mass., is the oldest public Observatory in the United States, and during the past summer the jubilee of its dedication was duly celebrated. This interesting commemoration was made the occasion for the delivery of a discourse by Prof. T. H. Safford, Field Memorial Professor of Astronomy at Williams College, on the development of astronomy in the United States, with especial reference to its earliest days; indeed Prof. Safford in his address went back not merely to the surveying work of Mason and Dixon, but even glanced lightly at the history of the institution where the former had been trained—Greenwich Observatory. The Hopkins Observatory was the work of the two brothers, President Mark Hopkins and Prof. Albert Hopkins, the latter of whom worked with his own hands at the erection of the building. Both were gifted men, and of advanced ideas, and their purpose in erecting the Observatory seems to have been the hope that the practical work of observing would increase their students' interest in the science, and develop their powers in fresh directions. It is still used by the students for occasional star-gazing, but for scientific purposes it has been superseded of late years by the meridian instrument of the "Field Memorial Observatory." The Hopkins Observatory was soon followed by others, at West Point, at Harvard College, at Washington, and other places, but though there had been previously one or two private observatories, and also a few telescopes in the possession of some public bodies, as, for example, at Yale College, yet until 1838 no permanent structure had been erected for any public observatory, so that the credit of being the pioneer of the long and distinguished succession of American Observatories belongs to the little building erected by the energy of Prof. Hopkins.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 DECEMBER 9–15.

(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 December 9

Sun rises, 7h. 56m.; souths, 11h. 52m. 48·6s.; sets, 15h. 49m.: right asc. on meridian, 17h. 7·4m.; decl. 22° 54′ S. Sidereal Time at Sunset, 21h. 4m.

Moon (at First Quarter December 10, 7h.) rises, 12h. 36m.; souths 17h. 43m.; sets, 23h. 0m.: right asc. on meridian, 22h. 58·8m.; decl. 10° 51′ S.

Planet.	Rises. h. m.		Souths. h. m.		Sets. h. m.		Right asc. and declination on meridian. h. m.		° ′
Mercury..	7 1	...	11 7	...	15 13	...	16 21·8	...	21 23 S.
Venus.....	10 41	...	14 37	...	18 33	...	19 51·7	...	23 4 S.
Mars	11 4	...	15 19	...	19 34	...	20 34·3	...	20 5 S.
Jupiter....	7 52	...	11 51	...	15 50	...	17 5·7	...	22 27 S.
Saturn....	20 53*	...	4 19	...	11 45	...	9 32·1	...	15 40 N.
Uranus ...	2 39	...	8 4	...	13 29	...	13 18·4	...	7 37 S.
Neptune..	14 54	...	22 38	...	6 22*	...	3 54·6	...	18 34 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·4 ...	81 16 N. ...	Dec.	9,	23 25	*m*
			,,	14,	23 5	*m*
Algol	3 0·9 ...	40 31 N. ...	,,	9,	23 53	*m*
			,,	12,	20 42	*m*
U * Orionis... ...	5 49·2 ...	20 9 N. ...	,,	9,		*M*
T Monocerotis ...	6 19·2 ...	7 9 N. ...	,,	11,	3 0	*M*
ζ Geminorum ...	6 57·5 ...	20 40 N. ...	,,	9,	6 0	*m*
			,,	14,	6 0	*M*
R Canis Majoris ...	7 14·5 ...	16 12 S. ...	,,	9,	19 9	*m*
		and at intervals of			27 16	
T Canis Minoris ...	7 27·8 ...	11 59 N. ...	Dec.	9,		*M*
S Libræ	15 15·0 ...	19 59 S. ...	,,	12,		*m*
T Herculis	18 4·9 ...	31 0 N. ...	,,	9,		*M*
β Lyræ...	18 46·0 ...	33 14 N. ...	,,	13,	20 0	*m*
R Serpentis	19 10·1 ...	19 3 S. ...	,,	13,		*M*
S Aquilæ	20 6·5 ...	15 17 N. ...	,,	15,		*m*
T Vulpeculæ ...	20 46·7 ...	27 50 N. ...	,,	9,	19 0	*m*
Y Cygni	20 47·6 ...	34 14 N. ...	,,	10,	1 48	*m*
			,,	13,	1 42	*m*
δ Cephei	22 25·0 ...	57 51 N. ...	,,	11,	6 0	*M*
			,,	15,	0 0	*m*

M signifies maximum; *m* minimum.

* Mr. Gore's new variable discovered in 1885. This star has hitherto been more generally known as T Orionis, but as Mr. Chandler gives it the above denomination in his new Catalogue of Variable Stars, reserving T Orionis for the tenth magnitude variable in the great Orion nebula discovered by Bond in 1863, it will be well for observers, in order to avoid confusion, to follow his nomenclature.

Meteor-Showers.

	R.A.	Decl.	
Near Castor	108 ...	33 N. ...	Swift; short. The *Geminids.* Max. December 10–11.
From Leo Minor	144 ...	38 N. ...	Swift; streaks.
,, Sextans	145 ...	7 N. ...	,, ,,
Near λ Draconis	160 ...	70 N.	

GEOGRAPHICAL NOTES.

THE rumour brought from the Cameroons as to the position of Mr. Stanley is too vague to be of much value. He is said to be behind "the Oil Rivers and the Niger," annexing territories wholesale for the British Crown. He may possibly enough be coming out in this direction. If so, he must have been with Emin, for it is inconceivable that, if able to get so far, he would fail in the chief object of his mission. If he has been with Emin, that must have been some time ago, and surely some word of it would have oozed out. We should not be surprised to find Mr. Stanley coming out by the West Coast; it would be quite in accordance with the purpose he had of settling, if possible, the problem of the Shari and Wellé. He may have sought to discover the parting that separates the basins of Lake Chad and the Congo, and the upper waters of the Binué. If he has really been on the Binué, we should have expected some definite news from the officials of the Royal Niger Company.

THOUGH Mr. Joseph Thomson was summoned home from Morocco to lead an expedition to Emin Pasha, we regret to learn that the British East African Company are hesitating to carry out the purpose they entertained when they telegraphed for Mr. Thomson.

M. RABOT, in describing to the Paris Geographical Society the results of a visit which he recently made to Western Greenland, states the following conclusions:—In comparing the inland ice of Greenland with the glaciers of Lapland, it appears to him absolutely certain that the latter are nothing more than inland ice in miniature. The Lapland glaciers are simply the remains of the Glacial period in Scandinavia, which have persisted to the present time owing to special circumstances. The great glacier of Jakobshavn, on the west coast of Greenland, has been advancing during the last few years. Its front edge is at present 3 kilometres in advance of the point where it was seen by Lieut. Hammer in 1878. The drift ice of the south-west coast transports only a very small quantity of material. M. Rabot saw only one piece among fifty or sixty which bore debris of detritic origin, while traversing pack-ice 60 miles broad. Only one piece was black with earth.

IN connection with Dr. Nansen's journey across Greenland, a paper by Dr. Rink, in No. 137 of the *Zeitschrift* of the Berlin Geographical Society, is of interest. Dr. Rink discusses the data which have been obtained by the various Danish Expeditions to Greenland, as well as by the parties which at different times have attempted to cross the land. He enters in some detail into the general subject of glaciation, and the relation between glaciers and icebergs. He seems to be of opinion that the ice of Greenland is shrinking, as he points out that there are evidences that at one time the ice covered the whole of the coastland, which is at present free, as well as the peninsulas and islands in its vicinity.

THE same number contains a paper, by Dr. von Danckelmann, on the altitudes of the country at the junction of the Kassai and Congo.

IN No. 8 of the *Verhandlungen* of the Berlin Geographical Society, Dr. Schweinfurth gives a useful sketch of his explorations in Egypt during the past fifteen years. In a letter to the President, in the same number, Dr. Hettner describes his observations on the Peruvian coast between Mollendo and Arequipa.

NOTES ON METEORITES.[1]

VI.

COMETS ARE METEOR-SWARMS WHICH HAVE ENTERED THE SOLAR SYSTEM SOME TIME OR OTHER.

THESE swarms, then, are comets. The final demonstration, as we have seen, we owe to the labours of Newton, Adams, and Schiaparelli chiefly. But long before their time the connection between shooting-stars (and even meteorites) and comets had been suspected on various grounds.[2]

Many shooting-stars pass through the air with a trail. This appearance is certainly suggestive of a very rapid comet. Hence, perhaps, it was that such an appendage, often noticed in the case of bright meteors, was sometimes in ancient records described as a comet. It is known that Cardano described as a comet the great meteor from which fell 1200 stones on the territory of Crema on September 4, 1511.[3]

Not only, as we have seen, Kepler (1600) regarded shooting-stars as akin in nature to meteorites, but he held that both had the same origin as comets :—"Falling stars are composed of inflammatory viscous materials. Some of them disappear during their fall, while others indeed fall to the earth, drawn by their own weight. Nor, indeed, is it improbable that they have been formed into globes from feculent materials mixed with the ethereal air itself, and thrown from the ethereal region in a straight line through the air like very small comets, the cause of the motion of both being hidden."[4]

Halley (1700) though he thought that the phenomenon of shooting-stars[5] was produced by a material disseminated through celestial space falling upon the sun and meeting the earth in its passage, did not associate it with cometary phenomena; but Maskelyne (1765) held that meteors were of celestial origin, and was inclined to assimilate them to comets. He wrote as follows in a letter to the Abbé Cesaris, the astronomer at Milan, about December 12, 1783 :—"Freely accept, I pray you, this map, which I have lately published in order to stir up learned men rather than the unlearned, to observe more keenly the phenomena called fire-balls. In all probability they will turn out to be comets. . . ."[6]

To Chladni belongs the credit of having broached the theory which modern observations have established.

We have already seen that Chladni formulated the view, in 1794, that space is filled with matter. In 1819 he extended it by stating that both shooting-stars, meteorites, and comets were but different manifestations of it.[7]

Chladni made a step in this matter of which, as pointed out by Schiaparelli, only to-day are we able to appreciate the importance. In suggesting the cosmical hypothesis, he regarded two possible cases : either the meteors were formed of masses of independent materials which had never formed part of the larger celestial bodies, or they are the result of the destruction of a celestial body previously existing. Chladni held the second hypothesis as possible, but held to the first as more probable. He stated that we could not doubt the existence in the celestial space of small bodies endowed with movement, which are now and then visible by passing before the sun.

He held, therefore, that the small masses which appear under the forms of bolides and falling stars do not differ essentially from comets. It is also probable, he says, that comets consist of clouds composed in great part of masses of vapour and dust, which are kept together by mutual attraction. That this attraction is not enough to sensibly disturb the planetary movements is a proof of the exceeding tenuity and dispersion of the materials in such clouds, through which, however large, it is possible, to observe the fixed stars.[8]

In 1839 the Abbé Raillard suggested a connection between luminous meteors and comets and the aurora,[9] and Dr. Forster noted that the years marked by the appearance of a large comet are remarkable also for the abundance of falling stars, especially of white ones.[1]

Perhaps the first to give a more solid support to the cometary theory of falling stars on geometric grounds was Boguslawski, who conceived the idea of representing by means of parabolas the apparent orbits observed in some of the August meteors of 1837.[2]

For the next important advance in thought upon this subject we have to come down to 1858, in which year Baron Reichenbach published a most important memoir[3] attacking the question from an entirely new point of view. Reichenbach, accepting as proven by the then knowledge the most intimate connection between meteorites and falling stars, reasoned in the following manner, that both were connected with comets. He first recapitulated the facts then accepted with regard to comets :—

(1) Comets, both tail and nucleus are transparent.

(2) Light is transmitted through comets without refraction ; hence the cometary substance can be neither gaseous nor liquid.

(3) The light is polarized, and therefore borrowed from the sun.

(4) Comets have no phases like those of moon and planets.

(5) They exercise no perturbing influences.

(6) Donati's comet (which was then visible) in its details and its contour is changing every day—according to Piazzi, almost hourly.

(7) The density of a comet is extremely small.

(8) The absolute mass is sometimes small (von Littrow having calculated very small comets, tail and all, as scarcely reaching 8 pounds).

From these data the following conclusions might be drawn :—

(1) That a comet's tail must consist of a swarm of extremely small but solid particles, therefore granules.

(2) That every granule is far away from its neighbour—in feet, so far that a ray of light may have an uninterrupted course through the swarm.

(3) That these granules, suspended in space, move freely and yield to outer and inner agencies—agglomerate, condense, or expand ; that a comet's nucleus, where one is present, is nothing else than such an agglomeration of loose substances consisting of particles.

Hence we must picture a comet as a loose, transparent, illuminated, free-moving swarm of small solid granules suspended in empty space.

The next step in Reichenbach's reasoning was to show that meteorites (of which he had a profound knowledge) were really composed of granules.

He pointed out that these granules (since called chondroi) formed really the characteristic structure both of irons and stones, so that both orders were chiefly aggregates of chondroi—stony ones in iron meteorites, iron ones in stony meteorites.

In some irons, such as Zacatecas, they exist as big as walnuts, firmly adherent, but they can be separated ; inside these are balls of troilite, often firmly embedded, so that on breaking the meteorite they will divide, but in other cases so loose that they fall out, and they are smooth enough to roll off a table.

Sometimes chondroi have smaller ones sprinkled in them, sometimes dark chondroi have white earthy kernels.

In some cases these chondroi are so plentiful as to form nearly the whole mass of the meteorite. They are often perfectly round, but not always, and they are often so loose that they tumble out and leave an empty smooth spherical cavity.

The stones chiefly consist of such chondroi and their *débris*.

He adds that each magnesic chondros "is an independent crystallized individual—it is a stranger in the meteorite. Every chondros was once a complete, independent, though minute meteorite. It is embedded like a shell in limestone. Millions of years may have passed between the formation of the spherule and its embeddal."

He then goes on to remark that the chondroi of meteorites indicate a condensation of innumerable bodies such as we see must exist in the case of comets ; further, that they have been formed in a state of unrest and impact from all sides. Many meteorites are true breccias ; they have *many times* suffered mechanical violence. He then shows that in comets we have precisely the conditions where such forces could operate, and

[1] Continued from vol. xxxviii. p. 605.
[2] For many references in what follows I am indebted to the historical notice in Schiaparelli's "Stelle Cadente."
[3] Humboldt, "Cosmos," iv. p. 587 (Otté). Cardani, "Opera," Lugduni, 1663, t. iii. p. 279. See also Schiaparelli, "Stelle Cadente."
[4] Kepler, "Opera," ed Frisch, vol. vi. p. 157.
[5] Coulvier-Gravier et Sargey, "Introd. Historique," p. 5.
[6] *Memorie della Società Italiana*, vol. iii. p. 345, Verona, 1786.
[7] "Ueber Feuermeteore, und ueber die mit denselben herabgefallenen Massen" (Wien, 1819). See also "Ueber den Ursprung der von Pallas gefundenen Eisenmassen," p. 24.
[8] "Feuermeteore," p. 395 ; see Kaemtz, "Meteorologie," vol. iii. p. 316.
[9] *Les Mondes*, t. xii. p 649, et t. xiii. p. 606.

[1] "Essai sur l'Influence des Comètes," &c. (Bruges, 1843).
[2] Coulvier-Gravier et Sargey, "Introd. Historique," p. 103.
[3] *Poggendorff's Annalen*, vol. cv. p. 438.

hence arrives at the view that "comets and meteorites may be nothing else but one and the same phenomenon."[1]

This was in 1858, eight years before Schiaparelli's discovery.

Newton, as we have seen, referred the comet of 1862 to the largest meteorite in the August swarm.

We may assume from the work which has already been done that Reichenbach's view is more probably the true one, and that the head of a comet is merely the denser part of the swarm. Whether that denser part is at the end or at the beginning of the long line to which reference has been made, it does not very much matter, but where that is there we shall have the appearance of a comet presented to us in the heavens. That being so, we are able to apply everything that we have learned about comets to the movements of meteorites in space; in the case of meteors and falling stars we were limited to what took place in our own air.

The Appearances presented by Comets away from the Sun.

When a comet first becomes visible, it appears in the telescope as a round misty body, and moves very slowly in consequence of its still great distance from the sun. At this time, too, its light is very feeble. Its appearance under these conditions strikingly resembles that of a nebula, and in fact comets have often thus been mistaken for nebulæ.

FIG. 12.—A comet near aphelion.

Occasionally the appearance put on is that of a planetary nebula in small telescopes and a globular one in larger ones.

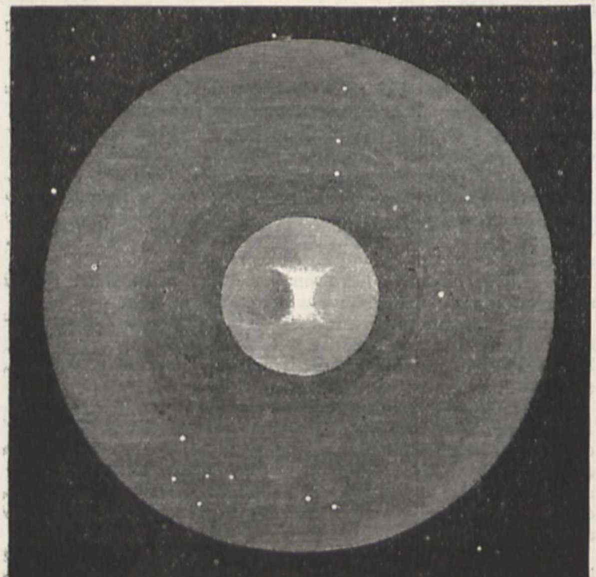

FIG. 13.—The Pons-Brooks comet, January 13, 1884 (Thollon).

The globular form, after a time, gives way, and the concentration of light is now a star-like concentration at one end of an elliptic patch.

[1] For this analysis of a part of Reichenbach's memoir, I am indebted to my friend Mr. L. Fletcher, of the British Museum.

In the next phase, both the star-like object and the elliptic patch lengthen, and the appearance becomes more like what is ordinarily recognized as a comet.

As the comet approaches nearer the earth, so that observations of its several portions may be seen, we get a still greater differentiation of the phenomena.

FIG. 14.—The first beginnings of a tail.

Fig. 16,[1] which is a representation of Donati's comet as it appeared in 1858, will serve to illustrate the main characteristics of comets. The brighter part is called the *head* or *coma*, and sometimes there is within this a still brighter and smaller portion called the *nucleus*. The *tail* is the dimmer part radiating from the head, and this varies greatly in different comets; it may be long or short, straight or curved, single, double, or multiple. The comet of 1744 had six tails, that of 1823 two. In others the tail is entirely absent. The tail of the comet of 1861 was 20,000,000 miles in length, and that of the comet of 1843 was 112,000,000 miles long.

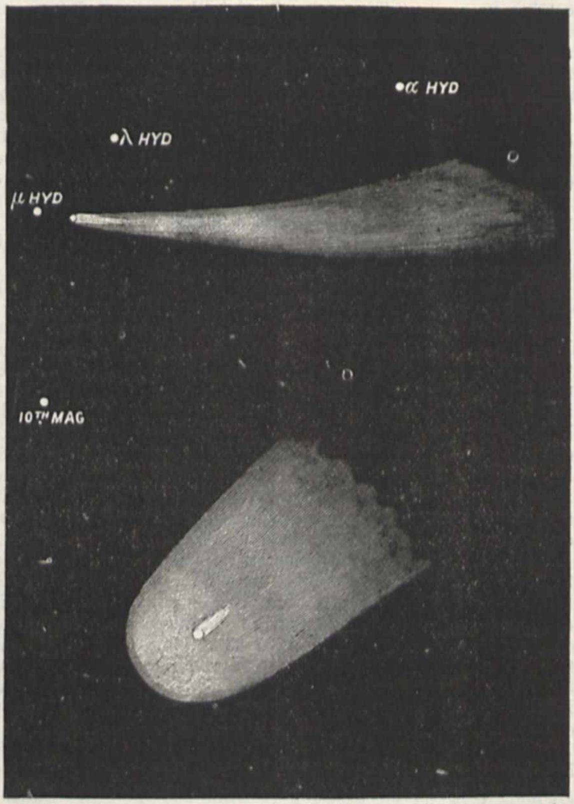

FIG. 15.—The lower portion represents the elongation of the star-like luminosity; the upper one, the concomitant extension of the whole comet (Comet 1882 October 25, Seabroke).

Both head and tail are so transparent that all but the faintest stars are easily seen through them. The star Arcturus was seen through the tail of Donati's comet in 1858 at a place where it was 90,000 miles in diameter.

As a comet approaches the sun, its velocity, like that of the planets, increases, and it gradually gets hotter and gives out more light.

When the comet gets sufficiently hot, *aigrettes* or *jets* make their appearance; these are so called because they seem to shoot

Fig. 16.—Donati's comet (general view).

out from the nucleus like sparks shoot out from a squib. The jets rapidly change their positions and directions, and the tail is formed, apparently at the expense of the matter of which the head was in the first instance built up. The tail is always turned from the sun, whether the comet be approaching or receding.

Drawings of a comet, as seen at different times, show how the jets vary in appearance and direction. Instead of jets, some comets present phenomena of a very different character, called envelopes, which are thrown off concentrically from the nucleus.

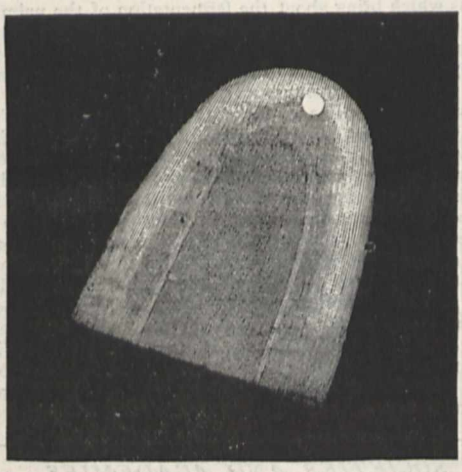

Fig. 17.—Comet with single nucleus (Cruls's comet, 1882, Riccò).

These are among the chief physical peculiarities about the heads of comets; and we see at once that we have something perfectly distinct from the planets, and that some comets are at first sight different from others. The envelopes have been observed to rise from the nucleus with perfect and exquisite regularity in exactly the same way that the jets swing backwards and forwards.

The enormous effect produced by a near approach to the sun may be gathered from the fact that the comet of 1680, at its perihelion passage, while travelling at the rate of 1,200,000 miles an hour, in two days shot out a tail 60,000,000 miles in length.

We must now enter somewhat more into details with regard to some of these cometary characteristics.

First of all, it must be pointed out that the meteoritic swarms

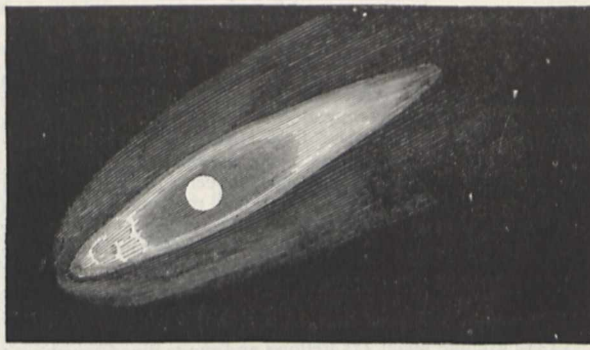

Fig. 18.—Nucleus surrounded by ellipsoidal head (Comet 1882 October 25, in Washington refractor).

are not always single, for in some comets the nuclei are double or triple.

In the case of single nuclei the nucleus may be the origin, and lie in the brighter region the extension of which forms the

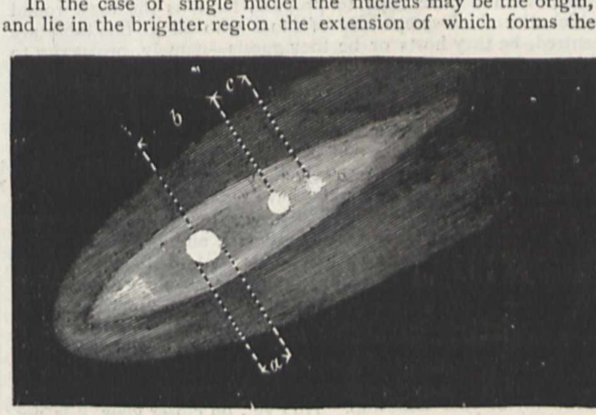

Fig. 19.—Compound nucleus (same comet November 5).

tail. But this is not invariable: the nucleus may be caught forming part of an elliptic head (Fig. 18) before any very great extension of the tail begins to take place, owing to reasons which will be stated further on.

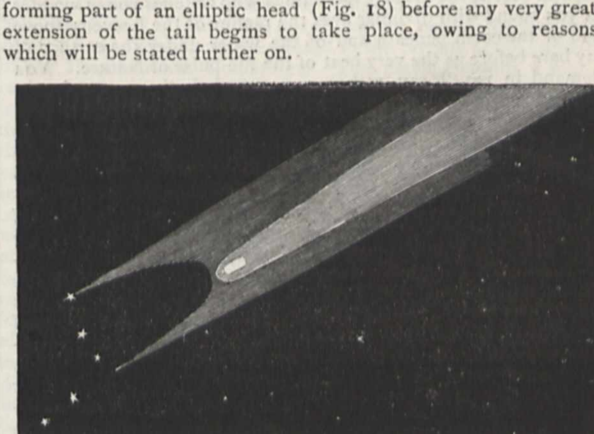

Fig. 20.—Commander Sampson's sketch of the great comet, 1882, October 10.

In the case of double or multiple nuclei we have a clear indication of the existence of more than one chief meteoritic swarm, whether they be enveloped in the same atmosphere or give rise to the same tail (Fig. 19). But it would seem that, in some cases, different nuclei may give rise to separate tails; such would seem a possible explanation of Commander Sampson's observation of the comet of 1882 (Fig. 20).

J. NORMAN LOCKYER.

(*To be continued.*)

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held on Friday last, St. Andrew's Day. The President read the anniversary address—a copy of which has not yet reached us—and presented the medals. Prof. Huxley received the Copley Medal, and Mr. Crookes the Davy Medal in person. Prof. Osborne Reynolds was also present to receive one of the Royal Medals. The other Royal Medal was received on behalf of Baron von Mueller by Sir Graham Berry, Agent-General for Victoria, and the Rumford Medal, which had been awarded to Prof. Tacchini, was received on his behalf by the Chevalier Catalani, the *Chargé d'Affaires* at the Italian Embassy. The Society next proceeded to elect the officers and Council for the ensuing year. The selected names we have already published.

In the evening about 175 Fellows and guests dined together at Willis's Rooms. Among the guests were eminent representatives of the English Government, of foreign nations, and of art and literature. Sir Frederick Leighton, in proposing "The Royal Society," said:—

"A great honour is done to me in intrusting to my hands the toast which I have risen to propose, for it is the toast round which the chief sympathies of those who sit at this table are centred, be they hosts or be they guests—namely, prosperity to that ancient and honoured body, the Royal Society. It is, indeed, a toast favoured in this—that no inadequacy of presentment could rob it of your warm reception, but it is one, also, which, in one sense, the individual now before you is so little fitted to propose that I could almost suspect you, Sir, of a little prompting of humour in your selection. I do not mean because the bodies with which you and I have respectively the honour to be connected are now, in Piccadilly, as they were in former days in Somerset House, next-door neighbours, and because it is not habitually to one's next-door neighbour that one looks in life for a kind word, but on this other and more cogent ground—that the subject on which you bid me speak is one in regard to which I am entirely ignorant, and that my attitude is therefore not free from ludicrous aspects in the face of a body to which grasp and accuracy of knowledge is the one thing needful, and precision of statement the first duty of man; and this, Sir, certainly not least in the day of your headship. And yet, on closer view, it is not knowledge, perhaps, that you require of the proposer of this toast so much as respectful sympathy; and that you find in me to the full. No, gentlemen, you do not demand in me knowledge beyond that of the average ignoramus who watches you in wonder as you sound with divining eyes the realms of the heavens above and of the earth beneath and of the water under the earth, and lay bare before us the very beat of the life-pulse of Nature. You demand in me, I say, rather, some sympathetic sense of your magnificent missions, some adhesion to the faith that you profess, and for these you do not look to me in vain. It happens to me, Mr. President, from time to time to have to acknowledge words of recognition of the services of the great institution to which I am bound in a like capacity with your own; and, knowing how earnestly that body is bent on the worthy discharge of an arduous task, such words are deeply grateful to me, but in every such case I see in my inner mind, behind and above the institution which I serve, the sweet and serene countenance of our divine mistress—of Art herself; and so, also, in offering this toast to the acclamation of your guests and to the acceptance of your flock, I am thinking less of the noble services of your renowned Society, less of the many names which are its high adornment at this time and our country's pride, than of your mistress beneficent and supreme, the scatterer of darkness—Science. All of us walk in the daylight of her illumination, the humblest layman can bear witness to her, and the most ignorant concerning the paths she treads may yet not unbecomingly declare his gratitude to her ministers, and express, as I now express, the hope that they and their successors may in the bond of this constituted brotherhood long continue to tend the flame and feed the increasing splendour of her sacred inextinguishable lamp."

The President of the Royal Society responded in a short speech, in which he compared the Royal Society to a wave of light moving onward through space, conveying intelligence from one portion of the universe to another far-distant portion. The molecules which it set in motion had but a brief existence, but the wave moved ever onward.

SCIENTIFIC SERIALS.

THE *Journal of Botany* is still largely occupied with the discussion of points connected with botanical nomenclature, in which English, American, and Genevan botanists take part. The October number contains also a description of a new genus of Berberidaceæ by the Japanese botanist Tokutaro Ito.—In the November number are papers on the genus *Carex*, by Mr. L. H Bailey; on Ferns from West Borneo, by Mr. J. G. Baker; on South Derbyshire plants, by Rev. W. R. Linton; and on the Desmids of Maine, by Mr. W. West. Mr. W. H. Beeby records the interesting fact that of the two very nearly allied species of valerian, *Valeriana Mikanii* and *sambucifolia*, one is very attractive to cats, while to the other they are quite indifferent.

IN the *Botanical Gazette* for September, Mr. C. Robertson completes his essay on zygomorphy and its causes, summing up the results of his observations. The remainder of the number is largely occupied by abstracts of botanical papers read at the Cleveland meeting of the American Association for the Advancement of Science.—In the October number are two important anatomical papers, by Miss Emily L. Gregory on the development of cork-wings on certain trees, and an illustrated one by Mr. W. H. Evans on the stem of Ephedra. Mr. G. Vasey contributes an interesting article on the characteristic vegetation of the North American desert.

THE number of the *Nuovo Giornale Botanico Italiano* for October 1888 is entirely occupied by reports of the papers read before the annual meeting of the Botanical Society of Italy held at Florence in September, many of which are of considerable interest.—Sig. C. Massolongo describes the germination of the spores of three new species of Sphæropsideæ—*Phyllosticta Bizzozeriana*, *P. Aristolochiæ* and *Phoma Orobanches*. He maintains that the only difference between pycnidia and spermogonia is that the sporules (stylospores) contained in the former are capable of germinating directly, while those formed in the latter (spermatia) have no such power.—Sig. A. N. Berlese adds to the very numerous fungus-parasites of the vine two new ones, *Greeneria fuliginea*, S. et V., and *Ascochyta rufo-maculans*, Berk.—Sig. G. Gasperini has investigated the nature of the organisms which bring about the fermentation of the palm-wine known to the Arabs under the name of "*leghbi*." He finds it to be due to *Saccharomyces cerevisiæ*, which is always accompanied by *Bacillus subtilis*. On the surface is also commonly found a pellicle of *Saccharomyces Mycoderma*.—Prof. A. Borzi describes a new species and genus of Ascomycetes—*Eremothecium Cymbalariæ*, found on half-ripe capsules of *Linaria Cymbalaria*.—The little-known germination of the seeds of the water-lily, *Euryale ferox*, is described by Sig. G. Arcangeli, the chief peculiarity being the almost entire suppression of the elongation of the radicle.—Prof. L. Macchiati claims to have discovered an entirely new substance, which he calls *xanthophyllidrin*, as a constituent of the green colouring-matter of plants. It is crystallizable, and altogether distinct from xanthophyll and from the pigment of yellow petals.—Prof. A. Borzi describes the mode in which *xerotropism* displays itself in some ferns—*Ceterach officinarum*, *Notochlæna Marantæ*, *Asplenium Trichomanes*, and several species of *Cheilanthes*; understanding by this term the mechanical contrivances by which an organ protects itself against excessive desiccation.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 22.—"The Waves on a rotating Liquid Spheroid of finite Ellipticity." By G. H. Bryan, B.A. Communicated by Prof. G. H. Darwin.

The hydrodynamical problem of finding the waves or oscillations on a gravitating mass of liquid which when undisturbed is rotating as if rigid with finite angular velocity in the form of an ellipsoid or spheroid, was first successfully attacked by M. Poincaré in 1885.

Poincaré's analysis, however, did not appear to admit of any definite conclusions being formed as to the nature and frequencies of the various periodic free waves. The present paper contains an application of Poincaré's methods to the simpler case when the fluid ellipsoid is one of revolution (Maclaurin's spheroid). The solution is effected by the use of the ordinary tesseral or zonal harmonics applicable to the fluid spheroid and the auxiliary spheroid required in solving the differential equation.

Denoting by κ the ratio of the frequency of the free waves to twice the frequency of rotation of the liquid about its axis, the values of κ are the roots of a rational algebraic equation, and depend only on the eccentricity of the spheroid as well as the degree and rank of the harmonic, while the number of different free waves depends on the degree of the equation in κ. At any instant the height of the disturbance at any point of the surface is proportional to the corresponding surface harmonic on the spheroid multiplied by the central perpendicular on the tangent plane, and is of the same form for all waves determined by harmonics of any given degree and rank, whatever be their frequency, but the motions of the fluid particles in the interior will differ in nature in every case.

Taking first the case of zonal harmonics of the nth degree, we find that according as n is even or odd there will be $\frac{1}{2}n$ or $\frac{1}{2}(n+1)$, different periodic motions of the liquid. These are essentially oscillatory in character, and symmetrical about the axis of the spheroid. Taking next the tesseral harmonics of degree n and rank s, we find that they determine $n - s + 2$ periodic small motions. These are essentially tidal waves rotating with various angular velocities about the axis of the spheroid, the angular velocities of those rotating in opposite directions being in general different.

With regard to the question of stability, the author shows that in the present problem, in which the liquid forming the spheroid is supposed perfect, the criteria are entirely different from the conditions of secular stability obtained by Poincaré for the case when the liquid possesses any amount of viscosity, which latter depend on the energy being a minimum. In fact for a disturbance initially determined by any harmonic (provided that it is symmetrical with respect to the equatorial plane, since for unsymmetrical displacements the spheroid cannot be unstable), the limits of eccentricity consistent with stability are wider for a perfect liquid spheroid than for one possessing any viscosity. If we assume that the disturbed surface initially becomes ellipsoidal, the conditions of stability found by the methods of this paper agree with those of Riemann.

Finally the methods of treating forced tides are further discussed.

The general cases of a "semi-diurnal" forced tide or of permanent deformations due to constant disturbing forces are mentioned in connection with some peculiarities they present, and the paper concludes with examples of the determination of the forced tides due to the presence of an attracting mass, first when the latter moves in any orbit about the spheroid, secondly when it rotates uniformly about the spheroid in its equatorial plane.

The effects of such a body in destroying the equilibrium of the spheroid when the forced tide coincides with one of the free tides are then considered.

Anthropological Institute, November 13.—Francis Galton, F.R.S., President, in the chair.—Dr. E. B. Tylor read a paper on a method of investigating the development of institutions applied to laws of marriage and descent. With the view of applying direct numerical methods to anthropology, the author had compiled schedules of the systems of marriage and descent among some 350 peoples of the world, so as to ascertain, by means of a "method of adhesions," how far each rule co-exists or not with other rules, and what have been the directions of development from one rule to another. As a first test of the results to be obtained by this means, Dr. Tylor first examined the barbaric custom which forbids the husband and his wife's parents (though on a friendly footing) to speak or look at one another, or mention one another's names. Some seventy peoples practise this or the converse custom of the wife and her husbands relatives being obliged ceremonially to "cut" one another. On classifying the marriage rules of mankind, a marked distinction is found to lie between those peoples whose custom is for the husband to reside with his wife's family and those where he removes her to his own home. It appears that the avoidance custom between the husband and the wife's family belongs preponderantly (in fourteen cases, as compared with eight computed as likely to happen by chance) to the group of cases where the husband goes to live with the wife's family. This implies a causal connection between the customs of avoidance and residence, suggesting as a reason that the husband, being an interloper in the wife's family, must be treated as a stranger; to use an English idiom expressing the situation, he is not "recognized." Other varieties of the custom show similar preponderant adhesions. Another custom, here called *teknonymy*, or naming the parent from the child, prevails among more than thirty peoples; as an example was mentioned the name of Ra-mary, or Father of Mary, by which Moffat was generally known in Africa. This custom proves on examination to adhere closely to those of residence and avoidance, the three occurring together among eleven peoples—that is, more than six times as often as might be expected to happen by chance concurrence. Their connection finds satisfactory explanation in the accounts given of the Cree Indians of Canada, where the husband lives in his wife's house, but never speaks to his parents-in-law till his first child is born; this alters the whole situation, for though the father is not a member of the family, his child is, and so confers on him the status of "Father of So-and-so," which becomes his name, the whole being then brought to a logical conclusion by the family ceasing to cut him. These etiquettes of avoidance furnish an indication of the direction of change in social habit among mankind: there are eight peoples (for instance, the Zulus) where residence is in the husband's family, with the accompanying avoidances, but at the same time avoidance is kept up between the husband and the wife's family, indicating that at a recent period he may have habitually lived with them. The method of tracing connection between customs was next applied, with the aid of diagrams, to the two great divisions of human society, the matriarchal and the patriarchal, or, as Dr. Tylor preferred to call them, the maternal and paternal systems; and the method showed that the drift of society has been from the maternal to the paternal system. Examination was next made of the practice of wife capture, recorded among about a hundred peoples, as a hostile act, a recognized and condoned mode of marriage, or a mere formality. It appears from the tables that the rules of human conduct are amenable to classification, so as to show by strict numerical treatment their relations to one another. It is only at this point that speculative explanation must begin, guided and limited in its course by lines of fact. In the words of Prof. Bastian, the future of anthropology lies in statistical investigation. Dr. Tylor's paper showed that the institutions of man are as distinctly stratified as the earth on which he lives, succeeding one another independently of difference of race and language, by similar human nature acting through necessarily changing conditions of savage, barbaric, and civilized life.

Royal Meteorological Society, November 21.—Dr. W. Marcet, F.R.S., President, in the chair.—The following papers were read:—Results of an investigation of the phenomena of English thunderstorms during the years 1857–59, by Mr. G. J. Symons, F.R.S. This paper was written nearly thirty years ago; it has now been communicated to the Society at the request of the Thunderstorm Committee. The paper contains a summary, chiefly in statistical form, of some of the results of an investigation into English thunderstorms and the accidents produced by lightning during the years 1857–59. The author found that in sheet-lightning the most prevalent colour is white, then yellow, blue, and red. In forked lightning the order is nearly reversed, blue being more than twice as frequent as any other colour, then red, white, and most rarely yellow. Sheet-lightning was seen about twice as often as forked.—Notes on the meeting of the International Meteorological Committee at Zurich in September 1888, by Mr. R. H. Scott, F.R.S. The Committee recommended certain rules for the publication of data by travellers, &c., so as to insure their being useful for the advancement of sound climatological knowledge. The proposals for an international cloud nomenclature, as recommended by Mr. Abercromby and Prof. Hildebrandsson, did not commend themselves to the Committee, who suggested that the subject should be further studied. At the conclusion of the meeting the Committee was dissolved.—On a method of photographing cirrus clouds, by Dr. A. Riggenbach. The author exhibited some photographs of cirrus and other fine clouds which had been obtained by using the surface of the lake as a polarizing mirror.—Mr. A. C. Stratten exhibited some models of very large hailstones—spheres about $2\frac{1}{2}$ inches in diameter—which fell at Montereau, about forty miles south-east of Paris, on August 15, 1888.

Geological Society, November 21.—W. T. Blanford, F.R.S., President, in the chair.—W. Whitaker, F.R.S., who exhibited a series of specimens from the deep boring at Streatham, made some remarks upon the results obtained.—The following communications were read:—Notes on the remains and affinities of five genera of Mesozoic reptiles, by R. Lydekker. This paper was divided into five sections. In the first the author described the dorsal vertebra of a small Dinosaur from the Cambridge Greensand, which he regarded as probably identical with the *Syngonosaurus*, Seeley. The second section described an axis vertebra from the Wealden of the Isle of Wight, which is evidently Dinosaurian, and may possibly belong to *Megalosaurus*. In the third section the femur of a small Iguanodont from the Oxford Clay, in the possession of Mr. A. R. Leeds, was described. The imperfect skeleton of a Sauropterygian from the Oxford Clay near Bedford, which formed the subject of a previous communication, was redescribed. The paper concluded with a notice of the affinities of the Crocodilian genus *Geosaurus*.—Notes on the Radiolaria of the London Clay, by W. H. Shrubsole.—Description of a new species of *Clupea* (*C. vectensis*) from Oligocene strata in the Isle of Wight, by E. T. Newton.

PARIS.

Academy of Sciences, November 26.—M. Janssen in the chair.—On the difficulty of obtaining the exact latitude of the Paris Observatory, by M. Mouchez. In connection with M. Faye's recent communication on this subject, the author states that some improved instruments will soon be fitted up in the Observatory with a view to overcoming some of the almost insurmountable difficulties attending the accurate determination of the latitude of this spot. But even so, it is feared that perfect accuracy cannot be expected, the errors of a few tenths of a second being apparently due rather to the irregularity of the astronomic refractions in the Paris atmosphere than to defective instruments and errors of observation.—On the traction of canal and river craft, by M. Maurice Lévy. It is shown that in the present state of science the mechanical method of traction by means of the telodynamic cable is preferable to any electric system. Various improvements are also described, by which the author and his associate, M. Pavie, have succeeded in surmounting the many obstacles hitherto attending the successful application of the telodynamic cable to inland navigation.—Fresh experiments on the quantitative analysis of the nitrogen present in vegetable soils, by MM. Berthelot and G. André. The researches here described have been carried out for the purpose of testing the accuracy of the analyses hitherto made by various practised chemists operating at different intervals of time and under diverse conditions. Incidentally an attempt has also been made to determine the degree of stability possessed by the nitrogen present in different soils and exposed to varying influences.—On the results of the fourth scientific expedition of the *Hirondelle*, by Prince Albert of Monaco. This expedition, like the previous, was mainly confined to the Azore waters, which were explored in all directions during the summer of the present year. Amongst the improved appliances were two detachable bagging nets with 4000 metres of steel wire, a submarine electric lamp of the newest type, a Thibaudier sounding apparatus with 8000 metres of steel wire, special boats and camping fittings for the exploration of inland waters. Besides rich marine captures in depths ranging from 20 or 30 to 2200 metres, fourteen lakelets were visited, of which thirteen had never been explored and five not yet figured on any maps.—On the application of electrolysis to the treatment of tumours, by M. Darin. Since the recent foundation of the Henry Giffard Clinical Establishment in Paris, the author has effected several remarkable cures by this process. The apparatus is of a very simple character, easily controlled, and fitted with the chloride of zinc pile of the Gaiffe system.—On the determination of the coefficients of expansion at high temperatures, by M. H. le Chatelier. A new process is described, by means of which the author hopes to overcome the great difficulty attending the exact determination of these coefficients, which, apart from their scientific interest, are of such great importance for industrial purposes. The results of some preliminary experiments are given for Bayeux porcelain, iron, steel, and nickel at temperatures ranging from 20° to 970° C.—On an astatic electrometer, by MM. R. Blondlot and P. Curie. The instrument here described is a modification of Sir W. Thomson's electrometer with quadrants, and amongst the various uses to which it is applicable is that of a wattmeter.—Influence of water-surfaces on atmospheric polarization, and observation of two neutral points right and left of the sun, by M. J. L. Soret. Marine and lacustrine surfaces are shown to produce important perturbations on the phenomena of atmospheric polarization. Under certain conditions the curious phenomenon is also observed of two neutral points at the altitude, and to the right and left, of the sun. The polarization is then in a vertical plane between these points, and in the opposite direction beyond them.—On a new process of disinfecting the hands after surgical operations, by MM. Jules Roux and H. Reynès. The process in question is that recently introduced by M. Furbringer; but the experiments here carried out for the purpose of testing its efficacy have given unsatisfactory results in the case of microbes deposited under the finger-nails.—M. Charles Brongniart communicates a paper on Entomophthoræ and their application to the destruction of noxious insects; and M. Marcel Bertrand has a note on a new problem in the geology of the south of France, suggested by the appearance of certain Triassic marls cropping out above the Cretaceous rocks in the neighbourhood of Marseilles.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Lessons in Elementary Mechanics, 1st Stage: W. H. Grieve (Longmans).—A Classified List of Mr. S. W. Silver's Collection of New Zealand Birds (at the Manor House, Letcombe Regis): Sir W. L. Buller (Petherick).—The Alphabet of Economic Science, Part 1, Elements of the Theory of Value or Worth: P. H. Wicksteed (Macmillan).—The Civilization of Sweden in Heathen Times: O. Montelius, translated by Rev. F. H. Woods (Macmillan).—Review of the Planting and Agricultural Industries of Ceylon: J. Ferguson (Haddon).—Electric Bells and All about Them: S. R. Bottone (Whittaker).—Thirty Thousand Years of the Earth's Past History: Major-General A. W. Drayson (Chapman and Hall).—Practical Electrical Measurement: J. Swinburne (Alabaster).—Antiseptics: A. M. Hewer (Lockwood).—Catalogue of Canadian Plants, Part 4—Endogens: J. Macoun (Montreal, Dawson).—Kirchoff's Laws and their Application: E. C. Rimington (Alabaster).—Bibliography of Astronomy for the Year 1887: W. C. Winlock (Washington).—Energy and Vision: S. P. Langley.—Archives Italiennes de Biologie, Tome x. Fasc. 3 (Turin, Loescher).—Proceedings of the Academy of Natural Sciences of Philadelphia, Part 2, 1888 (Philadelphia).—Annalen der Physik und Chemie, 1888, No. 12 (Leipzig, Barth).—Brain, Part 43 (Macmillan).—Geological Magazine, December (Trübner).

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