Bureau, the Paris Press are deprived of all the documents for current meteorology which were put at their disposition by M. Leverrier.

WE are informed that Admiral Mouchez has signed with M. Martin the contract for the polishing of the great lens of the great refracting telescope prepared by M. Leverrier. The lamp, of 75 centimetres diameter, has been placed in the hands of M. Feil, the glass founder, to repair a few defects which have been detected. This operation is done by cutting out the defective parts and heating the glass to a state of liquidity. This process is sometimes used for central parts with success. Guinault, the originator of the process used now for glass-founding, is said to have so mended eighteen times one of the most celebrated glasses produced by him at the end of the last century.

WE regret to announce the death of Dr. Eugen von Gorup Besanez, Professor of Chemistry at Erlangen University, and author of an excellent chemical handbook in three volumes. He had attained the age of sixty-two years.

BENTLEY AND TRIMEN'S "Medicinal Plants" has now reached its thirty-fifth number, and maintains in every way the excellent promise with which it started. Both the letterpress and the illustrations are of sterling quality, and the work, when completed, will be a complete repertorium for the botanico-medical student.

NEAR the Rhinefall at Schaffhausen a cave has been discovered which was evidently used as a dwelling-place in prehistoric times. Flints, broken jars, and bone rests were found in it. The jars were partly of Celtic and Roman origin.

WE have on our table the following works:—"Six Months in Ascension," by Mrs. Gill, John Murray; "Robert Dick, Geologist and Botanist," by Dr. Smiles, John Murray; "Pocket Book for Chemists," by Thomas Bayley, E. and F. H. Spon; "The Mollusca of the Firth of Clyde," by Alf. Brown, Hugh Hopkins; "A Visit to South America," by Edwin Clark, Dean and Son; "Coal: its History and Uses," Edited by Prof. Thorpe, F.R.S., Macmillan and Co.; "Bau des Eozoon Canadense," by Karl Möbius, Theodore Fischer; "Flowers, and their Unbidden Guests," Translated by W. Ogle, Kegan Paul; "Vogelbilder aus fernen Zonen," by Dr. Ant. Reichenon, Theodore Fischer; "Dictionary of Scientific Terms," by William Rossiter, W. Collins and Sons; "On Foot in Spain," by J. S. Campion, Chapman and Hall; "Elementary Geometry Books," i.-v., Fourth Edition, by J. M. Wilson, Macmillan and Co.; "Treatise on Chemistry," vol. ii., part 1, by Professors Roscoe and Schorlemmer, Macmillan and Co.; "The Magic Lantern Manual," by W. J. Chadwick, F. Warne and Co.; "The Localisation of Cerebral Disease," by Dr. Ferrier, Smith, Elder, and Co.; "Cassell's Natural History," vol. ii., Edited by P. Martin Duncan, F.R.S., Cassell, Petter, and Galpin.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Dr. Whately, R.N.; a Brazilian Tree Porcupine (*Sphingurus prehensilis*) from Trinidad, presented by Dr. J. F. Chittenden, jun.; a Common Peafowl (*Pavo cristatus*) from India, presented by Mrs. Russ; two Common Cormorants (*Phalacrocorax carbo*), British, presented by Mr. Frank Buckland, F.Z.S.; a Water Rail (*Rallus aquaticus*), British, presented by Mr. W. Thompson; a Black Lemur (*Lemur macaco*) from Madagascar, a Rufous-vented Guan (*Penelope cristata*) from Central America, purchased; a Red Kangaroo (*Macropus rufus*), born in the Gardens.

ROYAL SOCIETY—THE PRESIDENT'S ANNIVERSARY ADDRESS[1]

GENTLEMEN,

AT the conclusion of this, the fifth and last year during which I shall have held the most honourable office of your president, I have the gratifying assurance that the communications made to the Society and its publications have in no respect fallen off in scientific interest and value. We have not, indeed, been called upon to undertake during the past year such responsible and time-absorbing duties in behalf of the Government as the Polar, Circumnavigation, Transit of Venus, and other Committees demanded of us during the previous four years; but some of the results already achieved by those expeditions have been contributed to our publications, and we are in expectation of more. It is also with satisfaction that I can refer to the good attendance at our evening meetings, *soirées*, and *réunions*, as evidence of the interest taken in our proceedings by the Fellows generally and their friends.

Before proceeding to touch upon some of the advances made in science during the last few years, I have, as heretofore, to inform you of the Society's condition and prospects, and of those duties undertaken by its Council, for information as to which non-resident Fellows look to the annual address.

The loss by death of Fellows, twenty-one in number, is but little short of last year's rate, while that of Foreign Fellows (six) is twice as great as last year. On the home list is Sir George Back, the last, with the exception of our late venerable President, Sir E. Sabine, of that celebrated band of Arctic voyagers which during the early part of the century added so much to our renown as navigators and discoverers. Sir George was further the companion of Franklin and Richardson in that overland journey to the American Polar Sea, in which human endurance was tried to the uttermost compatible with human existence, and the modest but thrilling narrative of which, by the first-named officers, will ever hold a unique place in the annals of scientific discovery. Of Indian explorers no less than four have been taken away, namely, Col. Sir Andrew Waugh, for many years Director of the Great Trigonometrical Survey of India; and shortly afterwards his successor, Col. Montgomerie; Dr. Oldham, for a quarter of a century the Director of the Geological Society of India; and Dr. Thomas Thomson, my fellow-traveller in the Himalaya, the narrative of whose explorations in Western Tibet contains the first connected account of the physical and natural features of that remote and difficult country. Lieut.-Gen. Cameron survived but for one year our late Fellow, Sir Henry James, his predecessor in the Direction of the Ordnance Survey of Great Britain. In the Rev. James Booth we have lost a mathematician of high attainments, and the author of many contributions to our own and other scientific journals. The Rev. W. B. Clark, of New South Wales, wrote many papers abounding in excellent observations on Meteorology and Geology, especially made in England, the Cape of Good Hope, Australia, and the Pacific. The Rev. R. Main, the Director of the Radcliffe Observatory, at Oxford, was a very eminent astronomer, and for nearly half a century an indefatigable author. Lastly, Earl Russell, the distinguished statesman and the earnest advocate, whether in the Government or in Parliament, of every measure for the promotion of scientific inquiry.

Of Foreign Fellows our losses are a great chemist in Becquerel, of Paris, whose election took place upwards of forty years ago; a great physiologist in Claude Bernard, also of Paris; the father of mycology, and for long the patriarch of Scandinavian botanists, Elias Fries; a most distinguished physicist and the recipient of both a Rumford and Copley medal in Regnault; a veteran anatomist in Weber; and in Secchi, of Rome, an astronomer of astonishing activity, the author of more than three hundred separate contributions to the science of which he was so great an ornament.

In matters of finance I may with satisfaction refer you to our treasurer's balance-sheets.

It will be in your recollection that Mr. T. J. Phillips Jodrell placed in 1874 a sum of 6,000*l.* at the disposal of the Society, with the view of its being devoted to the encouragement of scientific research by periodical grants to investigators whom your Council might think it expedient thus to aid. Shortly after the receipt of this munificent gift, the Government announced its

[1] Address of Sir Joseph Hooker, C.B., K.C.S.I., the President, delivered at the Anniversary Meeting of the Royal Society, on Saturday, November 30, 1878.

intention of devoting annually for five years 4,000*l.* to the same object, thus anticipating the special purpose which Mr. Jodrell had in view. Thereupon, with that gentleman's consent, his donation was temporarily funded, and the proceeds applied to the general purposes of the Society until some other scheme for its appropriation shall be approved. In April last I received a further communication from Mr. Jodrell, declaring it to be his wish and intention that, subject to any appropriation of the sum which we might, with the approval of the Society, make during his lifetime, it should immediately on his death be incorporated with the Donation Fund, the annual income in the meantime going to the general revenue of the Society. Upon this subject I have now to state that since the receipt of that letter Mr. Jodrell has approved of 1,000*l.* of the sum being contributed to a fund presently to be mentioned.

I have also to inform you of a check for 1,000*l.* having been placed in my hands by our Fellow, Mr. James Young, of Kelly, to be expended in the interests of the Society in such manner as I should approve.

Mr. De La Rue, to whose beautiful experiments I shall have occasion to refer, has presented to the Society both the letter-press and the exquisitely engraved facsimiles of the electric discharges described in his and Dr. Hugo Müller's paper, and which have appeared with that paper in the *Transactions*.

Our Fellow, Dr. Bigsby, has presented seven copies of his "Thesaurus Devonico-carboniferus" for distribution, and they have been distributed accordingly.

A very valuable addition to our gallery of deceased eminent Fellows has been the gift, by Mr. Leonard Lyell, of a copy in marble, by Theed, of the bust of his uncle, the late Sir Charles Lyell, F.R.S., together with a pedestal. This is the best likeness of the late eminent geologist that has been executed, and is in every respect a satisfactory one.

I have the gratification of announcing to you, that through the munificence of a limited number of Fellows, means have been advanced for reducing the fees to which all ordinary Fellows in future elected will be liable. That these fees, though not higher than the most economical expenditure on the part of the Society for its special purposes demanded, were higher than it was expedient to maintain if any possible means for reducing them could be obtained, was not only my own opinion but that of many Fellows. They exceed considerably those of any other scientific society in England or abroad; their amount has occasionally prevented men of great merit from having their names brought forward as candidates, and they press heavily, especially upon those who, with limited incomes, have other scientific societies to subscribe to. Nor does it appear to me as otherwise than regrettable that so high an honour as Fellowship of the Royal Society, the only one of the kind in England that is limited as to the number annually elected, and selective in principle, should be attainable only at a heavy pecuniary expenditure. It is true that our Fellows receive in return annually volumes of publications of great value to science generally; but these treat of so many branches of knowledge that it is but a fraction of each that can materially benefit the recipient, while their bulk entails an additional expenditure; and now that the individual papers published in the *Transactions* are separately obtainable, the advantages of Fellowship are less than they were when to obtain a treatise on his own subject a specialist had either to join the Society, or to purchase a whole volume or a large part of it annually.

It was not, however, till I had satisfied myself that the annual income of the Society, though not ample, was sufficient for its ordinary purposes, that its prospects in other points of view were good, and that the expenditure upon publication was the main, if not the sole, obstacle to a reduction of fees, that I consulted your treasurer on the subject of taking steps to attain this object.

My first idea was to create, by contributions of small amount, a fund, the interest of which should be allowed to accumulate; and when the income of the accumulated capital reached a sufficient amount to enable the Society to take the step without loss of income, to reduce either the entrance fee or annual contribution; and to which fund Mr. Young's gift should be regarded as the first donation.

This proposal was in so far entertained by your Council that they resolved to establish a Publication Fund, and to place Mr. Young's gift to the credit thereof; and further, appointed a committee to consider and report upon the Statutes of the Society concerning the fees.

The movement, once set on foot, met with an unexpectedly enthusiastic reception; several Fellows, with the best means of forming a judgment, not only approved of it, but offered liberal aid, urging that the reduction of fees should be the first and immediate object, and that, if such a course were thought desirable, the means of carrying it out would surely be forthcoming. On this your Treasurer prepared for my consideration a plan for raising 10,000*l.*, the sum required for effecting any material reduction; and we resolved to ascertain by private inquiry whether so large an amount could be obtained.

Here again our inquiries were responded to in a spirit of, I may say, unexampled liberality: in a few weeks upwards of 8,000*l.* was given or promised by twenty Fellows of the Society, and I need hardly add that the remaining 2,000*l.* was contributed very shortly afterwards.

At a subsequent meeting of the Council it was resolved:—

1.—That the sums referred to as the Publication Fund, as well as those received or that may be hereafter received, for the purpose of relieving future ordinary Fellows from the Entrance Fee, and for reducing their Annual Contribution, be formed into one fund.

2.—That the Entrance Fee for ordinary Fellows be henceforth abolished; and that the Annual Contribution for ordinary Fellows hereafter elected be three pounds (3*l.*). Also, that the income of the Fund above-mentioned be applied, so far as is requisite, to make up the loss to the Society arising from these remissions and reductions.

3.—That the account of this Fund be kept separate; and that the annual surplus of income, after providing for the remission and reduction above recommended, be re-invested, until the income from the Fund reaches 600*l.* So soon as the annual income reaches this amount, any surplus of income in any year, after providing for the remission and reduction above-mentioned, shall be available, in the first instance, in aid of publication and for the promotion of research.

A list of subscribers to this Fund will be placed in the hands or every Fellow, with the information that it will be kept open for future contributions, in the interests of research and of the Society's publications. I hope that it will be largely and speedily augmented, and that it may eventually reach an amount which will provide us with the means of accomplishing as much as is effected by the Government Fund, upon our own sole and undivided responsibility. I must not conclude my notice of this movement without a mention of those whose encouragement and liberality have most largely promoted it; and first of all, Mr. Spottiswoode, to whose counsel and active co-operation throughout, its success is mainly due; Messrs. Young's and Jodrell's contributions have already been alluded to, they have been supported by others:—2,000*l.* from Sir Joseph Whitworth, 1,000*l.* from Sir W. Armstrong, and 500*l.* each from His Grace the Duke of Devonshire, Mr. De La Rue, Messrs. Spottiswoode and Eyre, Dr. Siemens, and the Earl of Derby, and 250*l.* from Dr. Gladstone. The balance is the joint contributions of thirty-two Fellows.

I have to mention your obligations to Dr. W. Farr for the labour he has bestowed on ascertaining these vital and other statistics of the Society, upon an accurate knowledge of which the calculations for the reduction of fees had to be based; and to Mr. Bramwell for constructing a table showing to what extent the above changes will affect the Society's present and future income. It may interest you to know that the contributions of ordinary Fellows in future to be elected, is but little over that which was required of all Fellows from the very commencement of the Society's existence, namely, 1*s.* per week, and that the last Fellow who paid that sum died in 1869. So recent (1823) has been the augmented scale of payment in force up to the present date.

Looking back over the five years during which I have occupied this chair I recognise advances in scientific discovery and research at home and abroad far greater than any previous semi-decade can show. I do not here allude to such inventions as the telephone, phonograph, and microphone, wonderful as they are, and promising immediate results of great importance to the community, nor even to those outcomes of great research and high attainments, the harmonic analyser of Sir W. Thomson, the radiometer and otheoscope of Crookes, the bathometer and gravitation meter of Siemens, but to those discoveries and advances which appeal to the seeker of knowledge for its own sake, whether as developing principles, suggesting new fields of

research, or awakening attention to hitherto unseen or unrecognised, or unexplained phenomena of nature.

In the foremost rank as regards the magnitude of the undertakings and the combination of means to carry them out, nothing in the history of physical science can compare with the Transit of Venus Expeditions. To observe the transit of Venus various nations of Europe and the United States competed as to the completeness of the expeditions they severally equipped. The value[1] of the solar parallax cannot be ascertained until the results of all the expeditions are taken into account, when it will have an international claim to acceptance. But advances in this direction will not have ended here, the very difficulties attending the observation of the transit of Venus, having directed attention to the method originally suggested by the Astronomer-Royal in 1857, of obtaining the solar parallax from the diurnal parallax of Mars at its opposition.

Mr. Gill, by the skilful employment at Ascension Island of the heliometer lent by Lord Lindsay, has greatly increased the accuracy of the method by which the necessary star comparisons with Mars are made, and there is every reason to believe that the results of his observations, which are now in course of reduction, will be very satisfactory.

Within the last two years a remarkable addition has been made to the number of members of the solar system by Prof. Asaph Hall's discovery of the satellites of Mars; and more recently, during the solar eclipse which was visible in America, by Prof. Watson's detection of planetary bodies within the orbit of mercury.

In 1876 Schmidt recorded an outburst of light in a star in Cygnus, which showed a continuous spectrum containing bright lines similar to those of the remarkable star of 1866. As the star waned the continuous spectrum and bright lines faded, all but one bright line in the green, giving the object the spectroscopic appearance of a small gaseous nebula.

Great progress has been made during the last five years at Greenwich in the method of determining the motions of the heavenly bodies by the displacement of the lines in their spectra, as first successfully accomplished by Mr. Huggins in 1868. Not only do the results obtained by the stars observed at Greenwich agree with those of Mr. Huggins, as satisfactorily as can be expected in so delicate an investigation, but the motions of seventeen more have been determined; whilst the trustworthiness of the method has been shown by the agreement of the values for the rotation of the sun and the motions of Venus, with the known movements of these bodies. Mr. Huggins has also obtained photographs of the spectra of some of the brighter stars, which give well-defined lines in the violet and ultra-violet parts of the spectrum. These spectra have already shown alterations in the lines common to them and the sun, which are of much interest.

In solar physics, which afford remarkable evidence of Mr. Lockyer's energetic labours in this country and Mr. Janssen's in France, I must mention our Foreign Member's wonderful photographs of the sun, wherein the minutest of the constant changes in the granulations exhibited on its surface (and which vary in size from $\frac{1}{10}$ of a second to 3 or 4 seconds) can be studied in the future from hour to hour and day to day; as can also their different behaviour at different periods of frequency of sun-spots.

Before dismissing this fruitful field of research, I must allude to Mr. Lockyer's discovery of carbon in the sun; and to his announced but not yet published observations on the changes and modifications of spectra under different conditions, some of which he even regards as indicating the breaking up of the atoms of bodies hitherto regarded as elementary.

Some important investigations on the electric discharge have been communicated to the Society by Messrs. De La Rue and Müller, and by Mr. Spottiswoode. These, prosecuted by different means, tend to limit the possible causes of the stratification observed in discharges through vacuum tubes. They also point to the conclusion that this phenomenon is in a great measure due to motions among the molecules of the residual gas, which themselves become vehicles for the transmission of electricity through the tube. It is well known that gases at atmospheric pressure offer great resistance to the passage of electricity; and that this resistance diminishes (to a certain limit, different for different gases) with the pressure. And the researches in question appear to show that the discharge, manifestly disruptive at the higher pressures, is really also disruptive even at pressures when stratification takes place. The period of these discontinuous discharges has not yet been the subject of measurement, but it must, in any case, be of a very high order.

Under the auspices of the Elder Brethren of the Trinity House, and as their scientific adviser, Prof. Tyndall has conducted an investigation on the acoustic properties of the atmosphere. The instruments employed included steam whistles, trumpets, steam syrens, and guns. The propagation of sound through fog was proved to depend not upon the suspended aqueous particles, but upon the condition of the sustaining air. And as air of great homogeneity is the usual associate of fog, such a medium is often astonishingly transparent to sound. Hail, rain, snow, and ordinary misty weather, were also proved to offer no sensible obstruction to the passage of sound. Every phenomenon observed upon the large scale was afterwards reproduced experimentally. Clouds, fumes, and artificial showers of rain, hail, and snow were proved quite ineffectual to stop the sound, so long as the air was homogeneous, while the introduction of a couple of burners into a space filled with acoustically transparent air soon rendered it impervious to the waves of sound. As long as the continuity of the air in their interstices was preserved, the sound-waves passed freely through silk, flannel, green baize, even through masses of hard felt half an inch in thickness, the same sound-waves being intercepted by goldbeater's skin. A cambric handkerchief which, when dry, offered no impediment to their passage, when dipped into water became an impassable barrier to the sound-waves.

Echoes of extraordinary intensity were sent back from non-homogeneous transparent air; while similar echoes were afterwards obtained from the air of the laboratory, rendered non-homogeneous by artificial means. Detached masses of non-homogeneous air often drift through the atmosphere, as clouds pass over the face of the sky. This has been proved by the fluctuations observed with bells having their clappers adjusted mechanically, so as to give a uniform stroke. The fluctuations occur only on certain days; they occur when care has been taken to perfectly damp the bell between every two succeeding strokes; and they also occur when the direction of the sound is at right angles to that of the wind. Numerous observations were also made on the influence of the wind, the results obtained by previous observers being thereby confirmed. From his own observations, as well as from the antecedent ones of Mr. Alexander Beazeley and Prof. Osborne Reynolds, Prof. Tyndall concludes that the explanation of this phenomenon given by Prof. Stokes is the true one.

Turning now to biological branches of science, I find that the discoveries and researches of the past five years in this department also are far in advance of those of any previous period of equal length. The *Challenger* Expedition was, in point of the magnitude of the undertaking and completeness of its equipment, the rival of that for observing the Transit of Venus. Its general results, as far as hitherto made known, have been dwelt upon at length in my previous addresses, and the publication of them in detail is being rapidly pushed forward. Some very important papers by Mr. Moseley on the corals collected on the voyage have indeed been published in our *Transactions* with admirable illustrations by himself.

To the botanist and geologist no subject has a greater interest than that of the conditions under which the successive floras, which inhabited the polar area, existed and were successively dispersed over lower latitudes previous to their extinction, some *in toto* and over the whole globe, whilst others, though extinct in the regions where they once flourished, exist now only in lower latitudes under identical or under representative forms. It is only during the last few years that, thanks to the labours of those engaged in systematic botany in tracing accurately the directions of migrations of existing genera and species, and in determining the affinities of the extinct ones, and of palæontologists in referring the latter to their respective geological horizons, that any material advance has been made towards a knowledge of the origin and distribution of earlier and later Floras. I cannot better illustrate the condition of this inquiry than by calling your attention to two most recent publications on the subject, which have both appeared within the last few months.

[1] The Astronomer-Royal informs me that Capt. Tupman, who has taken the principal share in the superintendence of the calculation, fixes provisionally on a mean parallax of 8″·8455, corresponding to a distance of 92,400,000 British miles, but that the observations would be fairly satisfied by any parallax between 8″·82 and 8″·88, which in distance produces a range of from 92,044,000 and 92,770,000 miles, differing by 726,000 miles, a quantity almost equal to the sun's diameter.

As a contribution to the principles of geographical botany, Comte Gaston de Saporta's essay, entitled "L'Ancienne Végétation Polaire" (which appeared in the *Comptes Rendus* of the French International Geographical Congress) is a very suggestive one, and, having regard especially to its author's eminence as a geologist and palæontologist, is sure to command attentive study. Although it may be argued that neither solar nor terrestrial physics, nor geology, nor palæontology are in a sufficiently advanced condition to warrant the acceptation as altogether established truths of all conclusions advanced in it, still the array of facts adduced in evidence of these conclusions is very imposing, while the ability and adroitness with which they are brought to bear on the subject are almost worthy of the great French genius whose speculations from the starting-point of the theory, which is that life appeared first in the northern circumpolar area of the globe, and that this was the birthplace of the first and of all subsequent floras.

I should premise that Count Saporta professedly bases his speculations upon the labours of his friend, Professor Heer, whose reasonings and speculations he ever puts forward with generous appreciation, while differing from him wholly on the subject of evolution, of which he is an uncomprising supporter, Professor Heer holding to the doctrine of the sporadic creation of species.

In his "Epoques de la Nature" Buffon argues that the cooling of the globe, having been a gradual process, the polar regions must have been the first in which the heat was sufficiently moderate for life to have appeared upon it; that other regions being as yet too hot to give origin to organised beings, a long period must have elapsed, during which the northern regions, being no longer incandescent, as they and all others originally were, must have had the same temperature as the most tropical regions now possess.

Starting from this thesis, Count Saporta proceeds to assume that the termination of the azoic period coincided with a cooling of the water to the point at which the coagulation of albumen does not take place; and that then organic life appeared, not in contact with the atmosphere, but in the water itself. Not only does he regard life as originating, if not at the North Pole, at least near to it, but he holds that for a long period life was active and reproductive only there. In evidence of this he cites various geological facts, as that the older, and at the same time the richest, fossiliferous beds are found in the cool latitudes of the North, namely in lats. 50° to 60°, and beyond them. It is in the North, he says, that Silurian formations occur, and though they extend as far south as lat. 35° N. in Spain and America, the most characteristic beds are found in Bohemia, England, Scandinavia, and the United States. The Laurentian rocks again, he says, reach their highest development in Canada, and palæozoic rocks cover a considerable polar area north of the American great lakes, and appear in the coasts of Baffin's Bay, and in parts of Greenland and Spitzbergen. It is the same with the Upper Devonian and marine carboniferous beds preceding the coal formations; these extend to 76° N. in the polar islands and in Greenland, and to 79° N. in Spitzbergen, and he adds that M. d'Archiac has long ago remarked that, though so continuous to the northward, the coal-beds become exceptional to the southward of 35° N. Hence Count Saporta concludes that the climatic conditions favourable to the formation of coal were not everywhere prevalent on the globe, for that while the southern limit of this formation may be approximately drawn, its northern must have extended to the Pole itself.

I pass over Saporta's speculations regarding the initial conditions of terrestrial life, which followed upon the emergence of the earlier stratified rocks from the Polar Ocean, and proceed to his discussion of the climate of the carboniferous epoch as indicated by the characters of its vegetation, and of the conditions under which alone he conceives this can have flourished in latitudes now continuously deprived of solar light throughout many months of the year. In the first place, he accepts Heer's conclusions (founded on the presence of a tree-fern in the coal measures specifically similar to an existing tropical one), that the climate was warm, moist, and equable, and continuously so over the whole globe, without distinction of latitude. This leads him to ask whether, when the polar regions were inhabited by the same species as Europe itself, they could have been exposed to conditions which turned their summers into a day of many months' duration, and their winters into a night of proportional length?

A temperature so equable throughout the year as to favour a rich growth of cryptogamic plants, appears, he says, to be at first sight incompatible with such alternating conditions (as a winter of one long night and a summer of one long day); but equability, even in high latitudes, may be produced by the effect of fogs due to southerly warm oceanic currents, such as bathe the Orkneys and even Bear Island (in lat. 75° N.), and render their summers cool and winters mild. To the direct effects of these he would add the action of such fogs in preventing terrestrial radiation, and hence the cold this produces; and he would further efface the existing conditions of a long winter darkness by the hypothesis that the solar light was not, during the formation of the coal, distributed over the globe as it now is, but was far more diffusive, the solar body not having yet arrived at its present state of condensation.

That the polar area was the centre of origination for the successive phases of vegetation that have appeared in the globe is evidenced, under Count Saporta's view, by the fact that all formations, carboniferous, jurassic, cretaceous, and tertiary, are alike abundantly represented in the rocks of that area, and that, in each case, their constituents closely resemble that of much lower latitudes. The first indications of the climate cooling in these regions is afforded by *Coniferæ*, which appear in the polar lower cretaceous formations. These are followed by the first appearance of dicotyledons with deciduous leaves, which again marks the period when the summer and winter season first became strongly contrasted. The introduction of these (deciduous-leaved trees) he regards as the greatest revolution in vegetation that the world has seen; and he conceives that once evolved they increased, both in multiplicity and diversity of form, with great rapidity, and not in one spot only, and continued to do so down to the present time.

Lastly, the advent of the miocene period, in the polar area, was accompanied with the production of a profusion of genera, the majority of which have existing representatives which must now be sought in a latitude 40° further south, and to which they were driven by the advent and advance of the glacial cold; and here Count Saporta's conclusions accord with those of Prof. A. Gray, who first showed, now twenty years ago, that the representatives of the elements of the United States flora previously inhabited high northern latitudes, from which they were driven south during the glacial period.

Perhaps the most novel idea in Count Saporta's essay is that of the diffused sunlight which (with a densely clouded atmosphere), the author assumes to have been operative in reducing the contrast between the polar summers and winters. If it be accepted it at once disposes of the difficulty of admitting that evergreen trees survived a long polar winter of total darkness, and summer of constant stimulation by bright sunlight; and if, further, it is admitted that it is to internal heat we may ascribe the tropical aspect of the former vegetation of the polar region, then there is no necessity for assuming that the solar system at those periods was in a warmer area of stellar space, or that the position of the poles was altered, to account for the high temperature of pre-glacial times in high northern latitudes; or, lastly, that the main features of the great continents and oceans were very different in early geological times from what they now are. Count Saporta's views in certain points coincide with those of Prof. Le Conte of California, who holds that the uniformity of climates during earlier conditions of the globe is not explicable by changes in the position of the poles, but is attributable to a higher temperature of the whole globe, whether due to external or internal causes, to the great amount of carbonic acid and water in the atmosphere, which would shut in and accumulate the sun's heat, according to the principles discovered by Tyndall and applied by Sterry Hunt in explanations of geological times, and possibly to a warmer position in stellar space, a more uniform distribution of surface temperature, and a different distribution of land and water.[1]

Before Count Saporta's essay had reached this country[2] another continuation of the subject of the origin of existing floras had been communicated to our own Geographical Society, by Mr. Thiselton Dyer in a lecture on "Plant Distribution as a Field for Geographical Research." Mr. Thiselton Dyer's order of procedure is the reverse of Count Saporta's, and his method entirely different. He first gives a very clear outline of the distribution of the principal existing floras of the continents and

[1] Professor Jos. Le Conte, in NATURE, vol. xviii. p. 668.

[2] Count Saporta's essay was presented to the International Congress of Geographical Science which met in Paris in 1875, and was not received in England till the autumn of 1878, though it bears date of 1877 on the title page.

islands of the globe, their composition, and their relations to one another, and to those of previous geological epochs. He then discusses the views of botanists respecting their origin and distinctive characters, and availing himself of such of their hypotheses as he thinks tenable, correlates these with those of palæontologists, and arrives at the conclusion "That the northern hemisphere has always played the most important part in the evolution and distribution of new vegetable types, or in other words, that a greater number of plants has migrated from north to south than in the reversed direction, and that all the great assemblages of plants which we call floras, seem to admit of being traced back at some time in their history to the northern hemisphere." This amount of accordance between the results of naturalists working wholly independently, from entirely different standpoints, and employing almost opposite methods, cannot but be considered as very satisfactory. I will conclude by observing that there is a certain analogy between two very salient points which are well brought out by these authors respectively. Count Saporta, looking to the past, makes it appear that the fact of the several floras which have flourished on the globe being successively both more localised and more specialised, is in harmony with the conditions to which it is assumed our globe has been successively subjected. Mr. Dyer, looking to the present, makes it appear that the several floras now existing on the globe, are in point of affinity and specialisation, in harmony with the conditions to which they must have been subjected during recent geological time on continents and islands with the configuration of those of our globe.

(*To be continued.*)

HAECKEL ON THE LIBERTY OF SCIENCE AND OF TEACHING[1]

PROF. HAECKEL has recently published his reply to the address on "The Liberty of Science in the Modern State," delivered at last year's meeting of the German Association, by Prof. Virchow. If we enter into this subject at greater length than is our custom with pamphlets we do so mainly from a sense of common fairness to both parties, since we reproduced Prof. Virchow's address *in extenso* (NATURE, vol. xvii. pp. 72, 92, and 111). We shall, however, confine ourselves merely to stating Prof. Haeckel's views on the subject, and leave it to our readers to judge of the value of his remarks for themselves.

In the preface to the little book before us Prof. Haeckel states that the general views developed by Virchow are in such complete contrast to his own that no reconciliation of the two is possible. Yet he refrained for a considerable time from publishing his reply; and this for two reasons. On the one hand, he thought he might safely leave the judgment of the strife between them to the future; first, because the evolution theory, which Virchow attacks, has, *de facto*, become the basis of biological science of the present day; secondly, because Virchow's objections to the theory of descent have been so frequently and thoroughly refuted that it seemed superfluous to refute them again. On the other hand, he felt great reluctance in opposing a man whom a quarter of a century ago he honoured as the reformer of medical science, and whose pupil and zealous admirer he was for many years.

"The more I for years regretted Virchow's position as the enemy of our new evolution theory, and the more I was challenged to reply by his repeated attacks upon it, the less inclination I felt, nevertheless, to appear publicly as the antagonist of the highly-honoured and meritorious man. If now I find myself forced to reply, I do so with the conviction that longer silence would only augment the erroneous views which my resignation hitherto has already produced. . . . . I must point out distinctly that it is not Virchow but I who am the person attacked, and that in my case there is no question of *attacking* a formerly highly-honoured friend, but of *defending* myself by necessity against his repeated and violent attacks. Another reason which compels me to speak at last lies in the continued fertile use made of Virchow's speech by all clerical and reactionary organs for the last nine months. . . . Already Friedrich von Hellwald has pointed out the great danger which lies in the fact that it was a Virchow who, under the banner of political Liberalism, and wrapped in the mantle of pure science, combated the liberty of science and of its teaching."

The author then continues to point out that the danger was never so great in Germany as at the present moment, where the political and religious life of the German nation seems to approach a profound reaction. The two mad attempts upon the life of the honoured and aged Emperor have called forth a storm of just indignation of such violence that even many Liberal politicians not only press for severe measures against the utopian teachings of social democracy, but, far overshooting the mark, demand that free thought and free teaching should be confined within the narrowest bounds. What more welcome support can the reactionary party wish for than that a Virchow should publicly demand the suppression of the liberty of science? The danger appears still greater to Prof. Haeckel if Virchow's great influence as a "liberal Progressist" is taken into consideration, now that the Prussian Diet will shortly open its debates on the educational law. "What," Prof. Haeckel asks, "may we expect of this educational law, if in the discussions Virchow, as one of the few authorities who will be consulted, raises his voice in favour of the principles which in his Munich speech he proclaimed as the safest guarantees for the liberty of science in the modern state. Article 20 of the Prussian Constitution, and § 152 of that of the German Empire say: Science and its teachings are free. Virchow's first action, according to his present principles, must be a proposal to cancel this paragraph. In view of the menacing danger, I cannot hesitate any longer with my reply. Amicus Socrates, amicus Plato, magis amica veritas!" The rest of the preface is concerned with a refutation of the "denunciation" by which Virchow wants to make the theory of descent responsible for the horrors of the Paris Commune. Haeckel thinks that by an intentional coupling of Darwinism with Social democracy, Virchow intended to do considerable damage to the former, indeed he sees in it an attempt to remove all "Darwinists" from their Academical chairs. At the same time he points out that nine out of every ten zoologists and botanists now teaching at European universities are Darwinists. Virchow's attempt is therefore perfectly futile, and will certainly never have any effect at Jena. "What the Wartburg was for Martin Luther, what Weimar was for the greatest heroes of German literature, what Jena has been during three centuries for a large number of scientific men, that will Jena continue to be for the evolution-theory of the present day, as well as for all other scientific theories which develop freely, viz., a firm stronghold for free thought free research, and free teaching."

We now come to the first chapter, which is headed "Evolution and Creation." The author remarks at the beginning that nothing has so greatly facilitated the progress of the evolution theory, as the fact that its principal problem, the question of the origin of species, was placed before the alternative: *Either* organisms have been *developed* naturally, in which case they must descend from the simplest and common ancestral forms—*or* this is not the case, and the different species of organisms have originated independently of one another, in which case they can only have been *created* in a supernatural way, *i.e.*, by a miracle. Natural development or supernatural creation of species—the choice must here be made, since a third way does not exist. Since Virchow and many other antagonists of the evolution theory constantly mix this up with the theory of descent, and this again with the theory of natural selection or Darwinism, Prof. Haeckel does not think it superfluous to give a concise definition of each of the three great theories at starting. He then states his definitions as follows:—"The relation of these theories according to the present state of science is therefore simply the following:—I. *Monism*, the universal theory of evolution, or the monistic pro-genesis theory, is the *only* scientific theory, which *rationally* explains the universe and satisfies the desire for causality in the human mind, since it brings all natural phenomena into a *mechanical* causal connection as parts of a great and uniform (*einheitlich*) process of development; II. *Transformism*, or the theory of descent, is an essential and indispensable part of the monistic evolution theory, because it is the *only* scientific theory which explains the origin of organic species in a rational manner, viz., by transformation, and reduces this transformation to *mechanical* causes; III. The theory of selection, or *Darwinism, is up to the present the most important one* amongst the different theories, which try to explain the transformation of species by *mechanical* causes; but it is by no means the *only one*. Even if we suppose that most species have originated through natural selection, yet we know, on the other hand, that many forms called species are merely hybrids from two different species and are propagated as such; at the same time we

[1] Freie Wissenschaft und freie Lehre. Eine Entgegnung auf Rudolf Virchow's Münchener Rede über "die Freiheit der Wissenschaft im modernen Staat." Von Ernst Haeckel.