Deer (between *Cervus mesopotamicus* ♂, and *Cervus dama* ♀), a Hybrid Muntjac (between *Cervulus lacrymans* ♂, and *Cervulus muntjac* ♀), born in the Gardens.

GEOGRAPHICAL NOTES

THE U.S. steamer *Corwin*, which has been searching for the missing, and we fear lost, *Jeannette*, has succeeded in reaching Wrangel Land, which has been annexed to the United States. We learn that it is probable that an international effort will be made next year to find traces of the *Jeannette;* our own Government has been moved in the matter, and may very possibly fit out a vessel for the purpose.

THE French Geographical Society has received intelligence of the assassination of a young explorer, M. Henri Dufour, by a tribe of the Ovambos, now at war with the Portuguese. M. Dufour left Omoruru in company with some merchants in December last for the purpose of exploring the basin of the River Cumene, in Eastern Africa. On arriving at this river his companions deemed it expedient to abandon the enterprise, on which M. Dufour courageously resolved to continue his course alone. No tidings of him having reached Omoruru, an inquiry was instituted, which led to the discovery of his untimely end. M. Dufour's papers and effects have been found, but his body has not yet been recovered.

THE current number of the Geographical Society's *Proceedings* is chiefly remarkable for a very long instalment of the report of papers read at the Geographical Section of the British Association, including Sir J. Hooker's address, Sir R. Temple's paper on Asia, and Sir F. J. Evans' on maritime discovery. The paper of this month's number is one by Dr. Bell, of the Geological Survey of Canada, on the commercial importance of Hudson's Bay, with remarks on recent surveys and explorations, which is accompanied by a large and carefully drawn map of the region. The most important of the geographical notes are those respecting Mr. J. M. Schuver's journey in Africa and the proposition of the British Association that the Geographical Society should undertake a scientific expedition to Kilinnandjaro and Mount Kenia, with a subsidy of one hundred pounds. Another note records the presence of the first British traveller at Hami, but seemingly his name and plans are alike a mystery.

WITH reference to the recent census of India the *Pioneer* learns that the census returns show a grand total of population for all India of 252,000,000. Figures amounting to 218,000,000 can be compared with previous censuses, and show an increase of 6·2 per cent. But in some provinces apparent large increases may be due to the inaccuracy of previous enumerations. Provincial totals are—Bengal, 68,800,000; Assam, 4,800,000; Madras, 30,800,000; Bombay, 13,900,000; ditto Native States, 6,900,000; Sind, 2,400,000; North-West Provinces, 32,600,000; ditto Native States, 700,000; Oudh, 11,400,000; British Punjab, 18,700,000; Native ditto, 3,800,000; Central Provinces, 11,500,000; Berar, 2,600,000; British Burmah, 3,700,000; Mysore, 4,100,000; Rajpootana, 11,000,000; Central India, 9,200,000; Hyderabad, 9,100,000. The total makes males 123,000,000, females 118,000,000. The provincial increases per cent. as compared with previous censuses, are as follows:—Bengal, 10; Assam, 19; Sind, 10; North-West, 6; Oudh, 1; Punjab, 7; Central Provinces, 25; Berar, 20; Burmah, 35. The decreases are—Madras, 2·4 per cent.; Bombay, ·3; Mysore, 17.

A SOMEWHAT curious boat has been built and launched at Granton, N.B., for use by the Rev. T. J. Comber, of the Baptist expedition on the Congo. With a view to its being at once portable and durable, this boat has been made of canvas, coated with a mixture of lampblack and tar, and is stretched into shape by malacca canes, while the interior consists of three movable umbrella-shaped structures, which can be tightened at will; it has a partly-covered deck, and weighs only 60 lbs.; further, it can be easily taken to pieces, so as to be carried by two persons, and by a little arrangement will form a tent.

Petermann's Mittheilungen for October is filled up with two articles—one by Mr. W. H. Dall, on the hydrology of Behring Sea and neighbouring waters, and Hofrath A. Regel's account of his expedition to Turfan in 1879.

MESSRS. BLACKWOOD have issued a tenth edition of Page's "Introductory Text-Book of Physical Geography," revised and enlarged by Prof. Lapworth, of the Mason College, Birmingham.

CAPT. POPELIN, of the Belgian station at Karema, Lake Tanganyika, whose death was lately announced, appears to have died when on his way from Ujiji to the Mampara district, in Southern Uguha.

ON SOME APPLICATIONS OF ELECTRIC ENERGY TO HORTICULTURE AND AGRICULTURE[1]

ON the 1st of March, 1880, I communicated to the Royal Society a paper "On the Influence of Electric Light upon Vegetation, &c.," in which I arrived at the conclusion that electric light was capable of producing upon plants effects comparable to those of solar radiation; that chlorophyll was produced by it, and that bloom and fruit, rich in aroma and colour, could be developed by its aid. My experiments also went to prove that plants do not as a rule require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected (in winter time) to solar light during the day and to electric light during the night.

During the whole of last winter I continued my experiments on an enlarged scale, and it is my present purpose to give a short account of these experiments, and of some further applications of electric energy to farming operations (including the pumping of water, the sawing of timber, and chaff and root-cutting) at various distances, not exceeding half a mile from the source of power, giving useful employment during the daytime to the power-producing machinery, and thus reducing indirectly the cost of the light during the night-time.

The arrangement consists of a high-pressure steam-engine of 6 horse-power nominal, supplied by Messrs. Tangye Brothers, which gives motion to two dynamo-machines (Siemens D), connected separately to two electric lamps, each capable of emitting a light of about 5000 candle-power. One of these lamps was placed inside a glass house of 2318 cubic feet capacity, and the other was suspended at a height of 12 to 14 feet over some sunk greenhouses. The waste steam of the engine was condensed in a heater, whence the greenhouses take their circulating supply of hot water, thus saving the fuel that would otherwise be required to heat the stoves.

The experiments were commenced on October 23, 1880, and were continued till May 7, 1881. The general plan of operation consisted in lighting the electric lights, at first at 6 o'clock, and during the short days at 5 o'clock every evening except Sunday, continuing their action until dawn.

The outside light was protected by a clear glass lantern, whilst the light inside the house was left naked in the earlier experiments, one of my objects being to ascertain the relative effect of the light under these two conditions. The inside light was placed at one side over the entrance into the house, in front of a metallic reflector, to save the rays that would otherwise be lost to the plants within the house.

The house was planted in the first place with peas, French beans, wheat, barley, and oats, as well as with cauliflowers, strawberries, raspberries, peaches, tomatoes, vines, and a variety of flowering plants, including roses, rhododendrons, and azaleas. All these plants being of a comparatively hardy character, the temperature in this house was maintained as nearly as possible a 60° Fahr.

The early effects observed were anything but satisfactory While under the influence of the light suspended in the open ai over the sunk houses the beneficial effects due to the electric light, observed during the previous winter, repeated themselves, the plants in the house with the naked electric light soon manifested a withered appearance. Was this result the effect of the naked light, or was it the effect of the chemical products—nitrogenous compounds and carbonic acid—which are produced in the electric arc?

Proceeding on the first-named assumption, and with a view of softening the ray of the electric arc, small jets of steam were introduced into the house through tubes, drawing in atmospheric air with the steam, and producing the effect of clouds interposing themselves in an irregular fashion between the light and the plants. This treatment was decidedly beneficial to the plants, although care had to be taken not to increase the amount of moisture thus intro-

[1] Paper read at the British Association by C. William Siemens, D.C.L. LL.D., F.R.S., M. Inst. C.E.

duced beyond certain limits. As regards the chemical products it was thought that these would prove rather beneficial than otherwise, in furnishing the very ingredients upon which plant-life depends, and further that the constant supply of pure carbonic acid resulting from the gradual combustion of the carbon electrodes might render a diminution in the supply of fresh air possible, and thus lead to economy of fuel. The plants did not, however, take kindly to these innovations in their mode of life, and it was found necessary to put a lantern of clear glass round the light, for the double purpose of discharging the chemical products of the arc, and of interposing an effectual screen between the arc and the plants under its influence.

The effect of interposing a mere thin sheet of clear glass between the plants and the source of electric light was most striking. On placing such a sheet of clear glass so as to intercept the rays of the electric light from a portion only of a plant, for instance a tomato plant, it was observed that in the course of a single night the line of demarcation was most distinctly shown upon the leaves. The portion of the plant under the direct influence of the naked electric light, though at a distance from it of nine to ten feet, was distinctly shrivelled, whereas that portion under cover of the clear glass continued to show a healthy appearance, and this line of demarcation was distinctly visible on individual leaves. Not only the leaves, but the young stems of the plants soon showed signs of destruction when exposed to the naked electric light, and these destructive influences were perceptible, though in a less marked degree, at a distance of twenty feet from the source of light. A question here presents itself that can hardly fail to excite the interest of the physiological botanist. The clear glass does not apparently intercept any of the luminous rays, which cannot therefore be the cause of the destructive action. Prof. Stokes showed, however, in 1853, that the electric arc is particularly rich in highly refrangible invisible rays, and that these are largely absorbed in their passage through clear glass; it therefore appears reasonable to suppose that it is those highly refrangible rays beyond the visible spectrum that work destruction on vegetable cells, thus contrasting with the luminous rays of less refrangibility, which, on the contrary, stimulate their organic action.

Being desirous to follow up this inquiry a little further, I sowed a portion of the ground in the experimental conservatory with mustard and other quick-growing seeds, and divided the field into equal radial portions by means of a framework, excluding diffused light, but admitting light at equal distances from the electric arc. The first section was under the action of the naked light, the second was covered with a pane of clear glass, the third with yellow glass, the fourth with red, and the fifth with blue glass. The relative progress of the plants was noted from day to day, and the differences of effect upon the development of the plants was sufficiently striking to justify the following conclusions:—Under the clear glass the largest amount of and most vigorous growth was induced; the yellow glass came next in order, but the plants, though nearly equal in size, were greatly inferior in colour and thickness of stem to those under the clear glass; the red glass gives rise to lanky growth and yellowish leaf, while the blue glass produces still more lanky growth and sickly leaf. The uncovered compartment showed a stunted growth with a very dark and partly shrivelled leaf. It should be observed that the electric light was kept on from five p.m. till six a.m. every night except Sundays during the experiment, which took place in January, 1881, but that diffused daylight was not excluded during the intervals; also that circulation of air through the dividing framework was provided for.

These results are confirmatory of those obtained by Dr. J. W. Draper[1] in his valuable researches on plant cultivation in the solar spectrum in 1843, which led him to the conclusion, in opposition to the then prevailing opinion, that the yellow ray, and not the violet ray, was most efficacious in promoting the decomposition of carbonic acid in the vegetable cell.

Having, in consequence of these preliminary inquiries, determined to surround the electric arc with a clear glass lantern, more satisfactory results were soon observable. Thus, peas which had been sown at the end of October produced a harvest of ripe fruit on February 16, under the influence, with the exception of Sunday nights, of continuous light. Raspberry stalks put into the house on December 16 produced ripe fruit on March 1, and strawberry plants put in about the same time produced ripe fruit of excellent flavour and colour on February 14. Vines which broke on December 26 produced ripe grapes of stronger flavour than usual on March 10. Wheat, barley, and oats shot up with extraordinary rapidity under the influence of continuous light, but did not arrive at maturity; their growth, having been too rapid for their strength, caused them to fall to the ground, after having attained the height of about twelve inches.

Seeds of wheat, barley, and oats, planted in the open air and grown under the influence of the external electric light, produced, however, more satisfactory results; having been sown in rows on January 6, they germinated with difficulty, on account of frost and snow on the ground, but developed rapidly when milder weather set in, and showed ripe grain by the end of June, having been aided in their growth by the electric light until the beginnin of May.

Doubts have been expressed by some botanists whether plants grown and brought to maturity under the influence of continuous light would produce fruit capable of reproduction, and in order to test this question the peas gathered on February 16 from the plants which had been grown under almost continuous light action were replanted on February 18. They vegetated in a few days, showing every appearance of healthy growth.

Further evidence on the same question will be obtained by Dr. Gilbert, F.R.S., who has undertaken to experiment upon the wheat, barley, and oats grown as above stated; but still more evidence will probably be required before all doubt on the subject can be allayed.

I am aware that the great weight of the opinion of Dr. Darwin goes in favour of the view that many plants, if not all of them, require diurnal rest for their normal development. In his great work on "The Movements of Plants" he deals in reality with plant life, as it exists under the alternating influence of solar light and darkness; he investigates with astonishing precision and minuteness their natural movements of circumnutation and nightly or nyctitropic action, but does not extend his inquiries to the conditions resulting from continuous light. He clearly proves that nyctitropic action is instituted to protect the delicate leaf-cells of plants from refrigeration by radiation into space, but it does not follow, I would submit, that this protecting power involves the necessity of the hurtful influence. May it not rather be inferred from Dr. Darwin's investigations that the absence of light during night-time involved a difficulty to plant life that had to be met by special motor organs, which latter would perhaps be gradually dispensed with by plants if exposed to continual light for some years or generations?

It is with great diffidence, and without wishing to generalise, that I feel bound to state as the result of all my experiments, extending now over two winters, that although periodic darkness evidently favours growth in the sense of elongating the stalks of plants, the continuous stimulus of light appears favourable for healthy development at a greatly accelerated pace, through all the stages of the annual life of the plant, from the early leaf to the ripened fruit. The latter is superior in size, in aroma, and in colour to that produced by alternating light, and the resulting seeds are not at any rate devoid of regerminating power.

Further experiments are necessary, I am aware, before it would be safe to generalise, nor does this question of diurnal rest in any way bear upon that of annual or winter rest, which probably most plants, that are not so-called annuals, do require.

The beneficial influence of the electric light has been very manifest upon a banana palm, which at two periods of its existence, viz., during its early growth and at the time of the fruit development, was placed (in February and March of 1880 and 1881) under the night action of one of the electric lights, set behind glass at a distance not exceeding two yards from the plant; the result was a bunch of fruit weighing 75 pounds, each banana being of unusual size, and pronounced by competent judges to be unsurpassed in flavour. Melons also, remarkable for size and aromatic flavour, have been produced under the influence of continuous light in the early spring of 1880 and 1881, and I am confident that still better results may be realised when the best conditions of temperature and of proximity to the electric light have been thoroughly investigated.

My object hitherto has rather been to ascertain the general conditions necessary to promote growth by the aid of electric light than the production of quantitative results; but I am disposed to think that the time is not far distant when the electric light will be found a valuable adjunct to the means at the disposal of the horticulturist, in making him really indepen-

[1] See "Scientific Memoirs" by J. W. Draper, M.D., LL D. Memoir X.

dent of climate and season, and furnishing him with a power of producing new varieties.

Before electro-horticulture can be entertained as a practical process it would be necessary however to prove its cost, and my experiments of last winter were in part directed towards that object. Where water-power is available, the electric light can be produced at an extremely moderate cost, comprising carbon electrodes, and wear and tear of and interest upon apparatus and machinery employed, which experience elsewhere has already shown to amount to 6*d*. per hour for a light of 5000 candles. The personal current attention requisite in that case consists simply in replacing the carbon electrodes every six or eight hours, which can be done without appreciable expense by the under-gardener in charge of the fires of the greenhouses.

In my case no natural source of power was available, and a steam-engine had to be resorted to. The engine of 6 normal horse-power which I employ to work the two electric lights of 5000 candle-power each, consumes 56 lbs. of coal per hour (the engine being of the ordinary high-pressure type), which, taken at 20*s*. a ton, would amount to 6*d*. or to 3*d*. per light of 5000 candles. But against this expenditure has to be placed the saving of fuel effected in suppressing the stoves for heating the greenhouses, the amount of which I have not been able to ascertain accurately, but it may safely be taken at two-thirds of the cost of coal for the engine, thus reducing the cost of the fuel per light to 1*d*. per hour; the total cost per light of 5000 candles will thus amount to 6*d*. + 1*d*. = 7*d*. per hour.

This calculation would hold good if the electric light and engine power were required during say twelve hours *per diem*, but inasmuch as the light is not required during the daytime, and the firing of the boiler has nevertheless to be kept up in order to supply heat to the greenhouses, it appears that during the daytime an amount of motive-power is lost equal to that employed during the night.

In order to utilise this power I have devised means of working the dynamo-machine also during the daytime, and of transmitting the electric energy thus produced by means of wires to different points of the farm, where such operations as chaff-cutting, swede-slicing, timber-sawing, and water-pumping have to be performed.

These objects are accomplished by means of small dynamo-machines placed at the points where power is required for these various purposes, and which are in metallic connection with the current-generating dynamo-machine near the engine. The connecting wires employed consist each of a naked strand of copper wire supported on wooden poles or on trees without the use of insulators, whilst the return-circuit is effected through the park-railing or wire fencing of the place, which is connected with both transmitting and working machines by means of short pieces of connecting wire. In order to insure the metallic continuity of the wire fencing, care has to be taken wherever there are gates to solder a piece of wire, buried below the gate, to the wire fencing on either side.

As regards pumping the water, a 3-horse-power steam-engine was originally used, working two force-pumps of 3½-inch diameter, making thirty-six double strokes per minute. The same pumps are still employed, being now worked by a dynamo-machine weighing 4 cwt. When the cisterns at the house, the gardens, and the farm require filling, the pumps are started by simply turning the commutator at the engine station, and in like manner the mechanical operations of the farm already referred to are accomplished by one and the same prime mover.

It would be difficult in this instance to state accurately the percentage of power actually received at the distant station, but in trying the same machines under similar circumstances of resistance with the aid of dynamometers, as much as 60 per cent. has been realised.

In conclusion, I have pleasure to state that the working of the electric light and transmission of power for the various operations just named are entirely under the charge of my head-gardener, Mr. Buchanan, assisted by the ordinary staff of under-gardeners and field-labourers, who probably before never heard of the power of electricity.

Electric transmission of power may eventually be applied also to thrashing, reaping, and ploughing. These objects are at the present time accomplished to a large extent by means of portable steam-engines, a class of engine which has attained a high degree of perfection; but the electric motor presents the great advantage of lightness, its weight per horse-power being only 2 cwt., whilst the weight of a portable engine with its boiler filled with water may be taken at 15 cwt. per horse-power. Moreover, the portable engine requires a continuous supply of water and fuel, and involves skilled labour in the field, whilst the electrical engine receives its food through the wire (or a light rail upon which it may be made to move about) from the central station, where power can be produced at a cheaper rate of expenditure for fuel and labour than in the field. The use of secondary batteries may also be resorted to with advantage to store electrical energy when it cannot be utilised.

In thus accomplishing the work of a farm from a central-power station, considerable savings of plant and labour may be effected; the engine-power will be chiefly required for day work, and its night work for the purposes of electro-horticulture will be a secondary utilisation of the establishment, involving little extra expense. At the same time the means are provided of lighting the hall and shrubberies in the most perfect manner, and of producing effects in landscape gardening that are strikingly beautiful.

THE ELECTRICAL DISCHARGE, ITS FORMS AND ITS FUNCTIONS[1]

II.

AMONG the various circumstances which combine to determine the character of the discharge, one of the most important is the size of the negative terminal. And in this respect, as well as in others, the negative differs fundamentally from the positive. If the negative be small, not so much in comparison with the positive as in absolute magnitude, and perhaps also in reference to the diameter of the tube, the tube will offer great "resistance," as it is termed, to the passage of the discharge. On the other hand, if the negative be large, the discharge passes with comparative ease. In the first case, even when the discharge passes, striæ are formed only with difficulty, if at all; in the second they are readily formed. This may easily be shown by using a tube with one small and one large terminal, which can be used alternately as positive and as negative; or by a tube having a negative terminal of variable length.

The same dependence of striation upon the size of the negative may be shown in the case of a tube with a negative terminal of barely sufficient size. In this case, if the tube be touched by the hand (an operation which, as will be hereafter explained, is equivalent to enlarging the negative), striæ will be brought out clear and distinct, while without this assistance they appear only in a confused and irregular manner.

Other characteristic features of the negative terminal would deserve our attention if time permitted. Thus, the well-known phenomena of the so-called "Holtz tube" (or tube divided into compartments by diaphragms furnished with narrow pipes leading from one compartment to the next, and all pointed in one direction), show that a small aperture will serve as a negative, but not as a positive terminal. This property has been generalised by Goldstein, who, using as a negative terminal a cylinder of non-conducting substance pierced with fine holes, reproduces all the phenomena appertaining to an ordinary metallic negative.

And, even apart from the phenomena of vacuum tubes, it would not be difficult to adduce instances showing the importance of the size of the negative terminal in electrical discharges generally. Of these I will now mention only the latest. In making some modifications of Planté's battery M. de Pozzer has found that, if the negative electrode be made of a plate of lead of half a millimetre in thickness, and the positive of one of two-thirds of a millimetre, but the former double the size of the latter, great advantage arises from the greater size of the negative. The discharge from a battery having a negative double as large as the positive lasted, on an average of several experiments, for an hour; while that from a battery, in which the sizes of the electrodes were reversed, lasted only half an hour. The effect of a battery with electrodes of equal size appears to have been intermediate to that of the two others.

From these phenomena, and especially from those of the moving terminal, as well as from other considerations, it appears that the general configuration of the discharge is mainly determined at the negative terminal.

In order, however, to experiment with any hope of progress

[1] A Lecture delivered before the British Association at York on September 5, 1881, by William Spottiswoode, D.C.L., LL.D., President of the Royal Society. Continued from p. 551.