bines readily with the oxygen of the air at the ordinary temperature, and he claims that the iron so set free is allotropic; but Joule did much more than this. Magnus had shown (1851) that the thermo-electric properties of hard and soft steel and iron differ. Joule, in a paper on some thermo-electric properties of solids, incidentally shows that the generation of a thermo-electric current affords a method of ascertaining the degree of carburization of iron, and he appeals to the "thermo-electricity of iron in different states" as presenting a "fresh illustration of the extraordinary physical changes produced in iron by its conversion into steel," and he adds the expression of the belief "that the excellence of the latter metal might be tested by ascertaining the amount of change in thermo-electric condition which can be produced by the process of hardening."[1] It is by a thermo-electric method that the views as to the existence of iron in allotropic forms has been confirmed. Jullien seems to have inclined to the view that iron is allotropic in his "Théorie de la Trempe,"[2] published in 1865, but he cannot be said to have added much to our knowledge, although he certainly directed attention to the importance of hardening and tempering steel.

The next step was made in Russia, in 1868. Chernoff, who has found an admirable exponent to English readers in Mr. W. Anderson, President of Section G, showed that steel could not be hardened by rapid cooling until it had been heated to a definite temperature—to a degree of redness which he called *a*. Then in 1873, Prof. Tait[3] used this expression in a Rede Lecture delivered at Cambridge: "It seems as if iron becomes, as it were, a different metal on being raised above a certain temperature; this may possibly have some connection with the ferricum and ferrosum of the chemists." He also published his now well-known "first approximation to a thermo-electric diagram," which is of great interest in view of recent work. At about this time those specially interested in this question remembered that Gore[4] had shown that a curious molecular change could be produced by heating an iron wire, which sustains a momentary elongation on cooling. Barrett repeated Gore's experiment, and discovered that as an iron wire cools down it suddenly *glows*, a phenomenon to which he gave the name *recalescence*, and these investigations have been pursued and developed in other directions by many skilful experimenters.[5] In 1879, Wrightson[6] called attention to the abnormal expansion of carburized iron at high temperatures.

The next point of special importance seems to me to be that recorded by Barus, who, by a thermo-electric method, showed, in an elaborate paper published in 1879,[7] that "the hardness of steel does not increase continuously with its temperature at the moment of sudden cooling, but at a point lying in the dark-red heat the glass-hard state" may suddenly be attained by rapid cooling. I shall have again to refer to the remarkable series of papers published by Barus and Strouhal,[8] embodying the results of laborious investigations, to which, in the limited space of this lecture, I can do but scanty justice; and finally, within the last few years, Pionchon[1] showed that at a temperature of 700° the specific heat of iron is altogether exceptional, and Le Chatelier[2] has detected that at the same temperature a change occurs in the curve representing the electromotive force of iron—both experimenters concluding that they had obtained evidence of the passage of iron into an allotropic state.

Osmond,[3] in France, then made the observations of Gore and Barrett the starting-point of a fresh inquiry, which will now be considered at some length, as Osmond has arrived at conclusions of much interest and importance.

(*To be continued.*)

[1] Phil. Trans., cxlix., 1859, p. 91.
[2] "Annexe au traité de la Métallurgie du Fer," 1865.
[3] NATURE, viii., 1873, pp. 86, 122; and Trans. Roy. Soc. Edin., xxvii., 1873, p. 125.
[4] Proc Roy. Soc, xvii., 1869, p. 260.
[5] G. Forbes, Proc. Roy. Soc. Edin., viii., 1874, 363; Norris, Proc. Roy. Soc., xxvi., 1877, 127; Tomlinson, *Phil. Mag.*, xxiv., 1887, 256; xxv., pp. 45, 103, and 372; xxvi. p. 18; Newall, *Phil. Mag.*, xxiv., 1887, 435; xxv, 1888, p. 510.
[6] Journ. Iron and Steel Inst., No. ii. 1879; No. i. 1880.
[7] Barus, *Phil. Mag.*, viii., 1879, p. 341.
[8] "Hardness (Temper), its Electrical and other Characteristics," Barus, *Phil. Mag.*, viii p. 341, 1879; *Wied. Ann.*, vii. p. 383, 1879; Strouhal and Barus, *Wied. Ann.*, xi. p. 930. 1880; *ibid.*, xx. p. 525, 1883. "Hardness and Magnetization," *Wied. Ann.*, xx. pp. 537, 662. 1883. "Density and (Internal) Structure of Hard Steel and of Quenched Glass," Barus and Strouhal, *American Journ.*, xxxi. p. 386, 1886; *ibid.*, p. 439; *ibid.*, xxxi. p. 181, 1886. "Temper and Chemical Composition," *Am. Journ.*, xxxii. p. 276, 1886. "Temper and Viscosity," *Am. Journ.*, xxxii. p. 444, 1886; *ibid.*, xxxiii. p. 20, 1887; Barus, *ibid.*, xxxiv. p. 1, 1887; *ibid.*, xxxiv. p. 175, 1887. These papers, systematically discussed and enlarged, are embodied with new matter in the *Bulletins* of the United States Geological Survey, viz.:—*Bull.*, No. 14, pp. 1-226, 1885; *Bull*, No. 27, pp. 30-61, 1886; *Bull.*, No. 35, pp. 11-60, 1836; *Bull.*, No. 42, pp. 98-131, 1887.

[1] *Comptes rendus*, cii., 1886, pp. 675 and 1454, ciii. p. 1122.
[2] *Ibid.*, cii. p 819.
[3] The reader will find the principal part of Osmond's work in the following papers: Osmond et Werth, "Théorie Cellulaire des Propriétés de l'Acier," *Ann. des Mines*, viii., 1885, p. 5; "Transformations du Fer et du Carbone," Paris, Baudoin et Cie., 1888; "Études Métallurgiques," *Ann. des Mines*, Juillet-Août, 1888. There is also a very interesting paper, "Sur les Nouveaux Procédés de Trempe," which he communicated to the Mining and Metallurgical Congress, Paris, 1889.

ON A NEW APPLICATION OF PHOTOGRAPHY TO THE DEMONSTRATION OF CERTAIN PHYSIOLOGICAL PROCESSES IN PLANTS.

MR. WALTER GARDINER, Lecturer on Botany in the University of Cambridge, who delivered the evening address at Newcastle on "How Plants maintain themselves in the Struggle for Existence," has discovered a new method of printing photographic negatives, employing living leaves in place of sensitive paper. Mr. Gardiner read a paper on the subject before the British Association. Before dealing with the immediate subject of his paper, the author described how prints may be obtained from *Protococci*, or the free-swimming swarm-spores of many green Algæ. It is possible to take advantage of their sensitiveness to light. Into one end of a water-tight box, a thin glass plate is securely fitted. The negative to be printed is then placed next the glass, film side nearest. The box is filled with water containing a fairly large quantity of swarm-spores. The lid is shut down, and the whole is exposed to diffused light. In the case of a strong and well-developed negative, the swarm-spores swim towards the most highly-illuminated parts, and there in the greatest numbers come to rest, and settle upon the glass, so that, after some four or six hours, on pouring out the water and removing the negative, a print in green swarm-spores can be obtained. The print may be dried, fixed with albumen, stained, and varnished. The author then dwelt upon the well-known fact that the whole of the animal life upon the globe depends directly or indirectly upon the wonderful synthetic formation of proteid and protoplasm which takes place in the living tissue of plants containing chlorophyll, *i.e.* green plants, or, to be more exact, in the green chlorophyll corpuscles. He stated that, whatever is the exact chemical nature of the process, this is at least clear, that the first *visible* product of the assimilatory activity is starch, which, moreover, is found in the chlorophyll grains. The presence of this starch can be made manifest by treating a decolorized leaf with a water solution of iodine dissolved in potassic iodide. This formation of starch only takes place under the influence of light; the radiant energy of the sun providing the means of executing the profound synthetic chemical change, and building up proteid from the carbonic acid of the air which is taken up by the leaves and the salts and water of the soil absorbed by the roots. If a plant (and preferably a plant with thin leaves) be placed in the dark over-night, and then brought out into the light next morning, the desired leaves being covered with a sharp and well-developed negative, starch is formed

when light is transmitted, and in greatest quantity in the brightest areas. Thus a positive in starch is produced which can be developed by suitable treatment with iodine. [A leaf was then developed, and handed round to the audience for inspection.] The author showed that it might be possible to obtain a permanent print by suitable washing and treatment with a soluble silver salt, silver iodide being formed. The author regards this discovery as a most striking illustration of the way in which plants are working for themselves, and so for all living things, and points out that the extraordinary manner in which the green parts of plants (so to speak) catch the radiant energy of the sun, and employ it for analytical and synthetical chemical processes, may be easily and clearly demonstrated.

NOTES.

WE understand that the late Mr. John Ball, F.R.S., has bequeathed his botanical library and herbarium to Sir Joseph Hooker, to the Director of the Royal Botanic Gardens at Kew for the time being, and to the President of the Royal Society for the time being, requesting them to give the same to such person or persons or public institution in this country, the British colonies, or elsewhere in the world, as they or any two of them may select, with the sole object of promoting the knowledge of natural science. Right is, however, reserved for Kew to select previously such specimens or books as it may want.

THE following is the list of names recommended by the President and Council of the Royal Society for election into the Council for the year 1890, at the forthcoming anniversary meeting on the 30th inst.:—President: Sir George Gabriel Stokes, Bart. Treasurer: Dr. John Evans. Secretaries: Prof. Michael Foster, the Lord Rayleigh. Foreign Secretary: Dr. Archibald Geikie. Other Members of the Council: Prof. Henry Edward Armstrong, Prof. William Edward Ayrton, Charles Baron Clarke, Prof. W. Boyd Dawkins, Dr. Edward Emanuel Klein, Prof. E. Ray Lankester, Dr. Hugo Müller, Prof. Alfred Newton, Captain Andrew Noble, C.B., Rev. Stephen Joseph Perry, Sir Henry E. Roscoe, Dr. Edward John Routh, William Scovell Savory, Prof. Joseph John Thomson, Prof. Alexander William Williamson, Colonel Sir Charles William Wilson, R.E.

IN the list of Englishmen decorated in connection with the British Section of the Paris Exhibition, the names of the following men of science are included:—Grand Officer of the Legion of Honour: Sir William Thomson, F.R.S. Officers of the Legion of Honour: Sir Douglas Galton, K.C.B., Sir Henry Roscoe, M.P., F.R.S., Mr. W. H. Preece, F.R.S. Chevaliers of the Legion of Honour: Prof. Francis Elgar, Prof. W. Roberts-Austen, F.R.S., Dr. C. Le Neve Foster. Officer of Public Instruction: Mr. C. V. Boys, F.R.S.

THE Naturforschende Gesellschaft at Emden is to celebrate its seventy-fifth anniversary on December 29 next. The Society was founded in 1814 by twenty-four burgesses of Emden. The festivities in December will consist of a general meeting of the Society and the Society's correspondents at noon in the Museum, and a *Festessen* at four o'clock.

A REPORT of the proceedings of the International Zoological Congress, held in Paris two months ago, will be published shortly.

A FRENCH translation of Dr. Wallace's "Darwinism" will be published next year.

THE greater part of the ethnographical collection sent to the Paris Exhibition is to remain in Paris, in the Colonial Museum.

THE following botanical appointments are announced:—The Directorship of the Botanic Garden at Berlin, vacant by the death of Dr. Eichler, having been conferred on Prof. Engler, of Breslau, Prof. Urban becomes Second Director of the Berlin Botanic Garden; and Prof. Prantl, of Aschaffenburg, succeeds Prof. Engler as Director of the Botanic Garden at Breslau. Prof. Sadebeck, of Hamburg, is appointed Director of the Botanic Garden in that town, in the place of the late Dr. Reichenbach. Dr. G. von Lagerheim vacates the Professorship at Lisbon, to which he was lately appointed, and goes to Ecuador as Professor of Botany and Director of the Botanic Garden at Quito. Dr. H. Molisch, of Vienna, takes the Chair of the late Dr. Leitgeb in the Polytechnic at Gratz. Dr. F. Hueppe is appointed Professor of Bacteriology at the University of Prague, and is succeeded in the same Chair at Wiesbaden by Dr. G. Frank, of Berlin. The venerable Professor von Naegeli retires from the Directorship of the Botanic Garden at Munich. Mr. F. S. Earle, Prof. E. S. Goff, and Prof. L. R. Taft have been appointed special agents in the Section of Vegetable Pathology of the United States Department of Agriculture. Mr. H. H. Rusby has been appointed Professor of Botany and Materia Medica in the New York College of Pharmacy.

THE Economic Museum, Calcutta, has completed and despatched the first instalment of important Indian fibres required by the India Office for presentation to the Museums of the Royal Botanical Gardens at Kew and Edinburgh, and to the Chambers of Commerce at Dundee and Manchester.

A PRIZE of about £20 is offered by the Geographical Societies of Dresden and Leipzig, for "a physico-geographical description of the course of the Elbe between Bodenbach and its entrance on the flat country, with special reference to depth, quantity of water and its variations, ice, and changes in the form of the banks." The date is the end of 1890.

IN his address at the opening of the winter session of the University of Toronto, Sir Daniel Wilson, the President of the University, referred to the recent Toronto meeting of the American Association for the Advancement of Science. "Everything available for the special requirements of the Association," he said, "was placed at the disposal of the Sections; and we are gratified by the assurance that, at the close of a highly successful meeting, our visitors carried away with them pleasant memories of their reception here." The meeting of the representatives of science in the buildings of the Toronto University was in some respects, as the President pointed out, peculiarly opportune. "The long-felt need of adequately furnished and equipped laboratories and lecture-rooms for our scientific staff was anew brought into prominence by the restoration to the University of its Medical Faculty; and we now enter on the work of another year provided with buildings admirably adapted for biological and physiological study and research. Plans, moreover, have been approved of, which, when carried out to their full extent, will furnish equally satisfactory accommodation for the departments of botany, chemistry, geology, and palæontology, along with laboratories, work-rooms, museum, and other requisites for efficient instruction in the various branches of science."

THE thirty-fourth general meeting of the Society for Psychical Research was held on Friday afternoon, October 25, at the Westminster Town Hall. The President (Prof. Sidgwick) gave an account of the International Congress of Experimental Psychology held in Paris last August. The Congress had adopted the scheme of a census of hallucinations, already set on foot by the Society for Psychical Research in England, France, and the United States, and it was hoped that the collection of statistics might gradually be extended to other European countries. Much matter valuable to psychologists was