the pressures at which carbonic acid gas liquefies. It gave, indeed, the pressures exercised by the liquid when contained in large quantity in a Thilorier's reservoir; but these pressures are always considerably in excess of the true pressures in consequence of the unavoidable presence of a small quantity of compressed air, although the greatest precautions may have been taken in filling the apparatus. Even $\frac{1}{500}$ part of air will exercise a serious disturbing influence when the reservoir contains a notable quantity of liquid.

Law of Boyle.—The large deviations in the case of carbonic acid at high pressures from this law appeared distinctly from several of the results given in my former paper. I have now finished a long series of experiments on its compressibility at the respective temperatures of 6°·7, 63°·7, and 100° Centigrade. The two latter temperatures were obtained by passing the vapours of pyroxylic spirit (methyl alcohol) and of water into the rectangular case with plate-glass sides, in which the tube containing the carbonic acid is placed. The temperature of the vapour of the pyroxylic spirit was observed by an accurate thermometer, whose indications were corrected for the unequal expansion of the mercury; while that of the vapour of water was deduced from the pressure as given by the height of the barometer and a water-gauge attached to the apparatus. At the lower temperature (6°·7) the range of pressure which could be applied was limited by the occurrence of liquefaction; but at the higher temperatures, which were considerably above the critical point of carbonic acid, there was no limit of this kind, and the pressures were carried as far as 223 atmospheres. I have only given a few of the results; but they will be sufficient to show the general effects of the pressure. In the following Tables p designates the pressure in atmospheres as given by the air-manometer, t' the temperature of the carbonic acid, ϵ the ratio of the volume of the carbonic acid under one atmosphere and at the temperature t' to its volume under the pressure p' and at the same temperature, and θ the volume to which one volume of carbonic acid gas measured at 0° and 760 millimetres is reduced at the pressure p and temperature t':—

Carbonic Acid at 6°·7.

p. at.	t'. °	ϵ.	θ.
13·22	6·90	$\frac{1}{14·36}$	0·07143
20·10	6·79	$\frac{1}{23·01}$	0·04456
24·81	6·73	$\frac{1}{29·60}$	0·03462
31·06	6·62	$\frac{1}{39·57}$	0·02589
40·11	6·59	$\frac{1}{58·40}$	0·01754

Carbonic Acid at 63°·7.

p. at.	t'. °	ϵ.	θ.
16·96	63·97	$\frac{1}{17·85}$	0·06931
54·33	63·57	$\frac{1}{66·06}$	0·01871
106·88	63·75	$\frac{1}{185·9}$	0·00665
145·54	63·70	$\frac{1}{327·3}$	0·00378
222·92	63·82	$\frac{1}{446·9}$	0·00277

Carbonic Acid at 100°.

p. at.	t'. °	ϵ.	θ.
16·80	100·38	$\frac{1}{17·33}$	0·07914
53·81	100·33	$\frac{1}{60·22}$	0·02278
105·69	100·37	$\frac{1}{137·1}$	0·01001
145·44	99·46	$\frac{1}{218·9}$	0·00625
223·57	99·44	$\frac{1}{380·9}$	0·00359

These results fully confirm the conclusions which I formerly deduced from the behaviour of carbonic acid at 48°, viz. that while the curve representing its volume under different pressures approximates more nearly to that of a perfect gas as the temperature is higher, the contraction is nevertheless greater than it would be if the law of Boyle held good, at least for any temperature at which experiments have yet been made. From the foregoing experiments it appears that at 63°·7 carbonic acid gas, under a pressure of 223 atmospheres, is reduced to $\frac{1}{447}$ of its volume under one atmosphere, or to less than one half the volume it ought to occupy if it were a perfect gas and contracted in conformity with Boyle's law. Even at 100° the contraction under the same pressure amounts to $\frac{1}{381}$ part of the whole. From these observations we may infer by analogy that the critical points of the greater number of the gases not hitherto liquefied are probably far below the lowest temperatures hitherto attained, and that they are not likely to be seen, either as liquids or solids, till much lower temperatures even than those produced by liquid nitrous oxide are reached.

(*To be continued.*)

*NEW METHOD OF OBTAINING ISOTHERMALS ON THE SOLAR DISC**

On June 5, 1875, I devised a method for obtaining the isothermals on the solar disc. As this process may create an entirely new branch of solar physics, I deem it proper that I should give a short account of it in order to establish my claim as its discoverer.

In the American Journal, July 1872, I first showed how one can, with great precision, trace the progress and determine the boundary of a wave of conducted heat in crystals, by coating sections of these bodies with Meusel's double iodide of copper and mercury, and observing the blackening of the iodide where the wave of conducted heat reaches 70° C. If we cause the image of the sun to fall upon the smoked surface of thin paper, while the other side of the paper is coated with a film of the iodide, we may work on the solar disc as we formerly did on the crystal sections.

The method of proceeding is as follows: beginning with an aperture of object-glass which does not give sufficient heat in any part of the solar image to blacken the iodide, I gradually increase the aperture until I have obtained that area of blackened iodide which is the smallest that can be produced with a well-defined contour. This surface of blackened iodide I call the *area* of blackened temperature. On exposing more aperture of object-glass, the surface of blackened iodide extends and a new area is formed bounded by a well-defined isothermal line. On again increasing the aperture another increase of blackened surface is produced with another isothermal contour; and on continuing this process I have obtained maps of the isothermals of the solar image. By exposing for about twenty minutes the surface of iodide to the action of the heat inclosed in an isothermal, I have obtained thermographs of the above areas; which are sufficiently permanent to allow one to trace accurately their isothermal contours. There are other substances, however, which are more suitable than the iodide for the production of permanent thermographs.

The contours of the successively blackened areas on the iodide are *isothermals*, whose successive thermometric values are inversely as the successively increasing areas of aperture of object glass which respectively produced them.

As far as the few observations have any weight, the following appear to be the discoveries already made of this new method. (1) There exists on the solar image an area of sensibly uniform temperature and of maximum intensity. (2) This area of maximum temperature is of variable size. (3) This area of maximum temperature has a motion on the solar image. (4) The area of maximum temperature is surrounded by well-defined isothermals marking successive gradations of temperature. (5) The general motions of translation and of rotation of these isothermals appear to follow the motions of the area of maximum temperature which they inclose; but both central area and isothermals have independent motions of their own.

On projecting the enlarged image of a sun-spot on the blackened surface and then bringing a hot-water box, coated with lamp-black, near the other side of the paper, one may

* The discovery of a method of obtaining Thermographs of the Isothermal Lines of the Solar Disc, by Alfred M. Mayer in Silliman's *American Journal* for July.

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develop the image of the spot in *red* on a dark ground. A similar method probably may serve to develop the athermic lines in the ultra-red region of the solar and other spectra.

OUR BOTANICAL COLUMN

Ferula Alliacea.—The late Mr. D. Hanbury was a valuable and frequent contributor to the Kew Museums, and the very last contribution made, or rather bequeathed by him, has a scientific as well as a melancholy interest. The specimen in question was a fine umbel, bearing ripe fruits of *Ferula alliacea*, Boiss., the label to which we believe was written at his dictation just before his death. Seeds of this plant were also received at Kew from him some time before the receipt of this specimen, and these have germinated, and, though healthy, are as yet naturally very small plants. In the "Pharmacographia" Mr. Hanbury refers to this plant as exhaling a strong odour of Asafœtida, but says it is not known as the source of any commercial product. In contradistinction of this, however, Mr. W. Dymock, Professor of Materia Medica at Bombay, writing on the Asafœtidas of the Bombay market in a recent number of the *Pharmaceutical Journal*, says that this plant produces one of the distinct kinds known in the above drug market under the name of "Abushaheree Hing," and is brought from the Persian Gulf ports, principally from Abushaher and Bunder Abbas, and is produced in Khorassan and Kirman. The specimens received at Kew from Mr. Hanbury appear to have been first received by him from the author of the paper in question, for he refers to having sent such specimens; therefore, if the specimens are authentic, there is no reason to doubt the truth of the statement made by Mr. Dymock, that the drug which appears in the Bombay Customs Returns as Hing or Asafœtida, is produced by this plant. It arrives in Bombay either in skins sewn up so as to form a flat oblong package, or in wooden boxes. Its appearance varies according to age, being soft, and about the thickness of treacle when quite fresh, and of a dull olive brown colour and a pure garlic odour. It becomes hard and translucent and of a yellowish brown colour after being kept some time. Slices of the root are found mixed with the resin in about equal proportion. In 1872-73 as many as 3,367 cwt. of this drug were imported into Bombay from the Persian Gulf. The information given in the paper from which we have quoted the above particulars seems to be of a trustworthy nature, and will prove a valuable addition to what we already know of the Asafœtidas.

Diverse Effects of the same Temperature on the same Species in Different Latitudes.—In the *Comptes Rendus des Séances de l'Académie des Sciences*, June 1875, Mr. A. de Candolle gives the results of some experiments instituted by himself last winter to determine the degree of influence of heat on the vegetation of the same species under otherwise diverse conditions. The sudden burst into life and the rapid development of the vegetation of northern regions is proverbial; the advent of mild weather seems to bring at once into activity the accumulated vital energies, and growth is exceedingly rapid. In the south the same temperature would have far less visible effect on the same species. De Candolle has attempted by direct experiment to ascertain to what extent this influence is exercised. For this purpose he procured specimens of several common deciduous trees from Montpellier, and submitted them to the same temperature as, and with, specimens of the same species collected at Geneva. In the ordinary course of things the same species came into leaf from three weeks to a month earlier at Montpellier than at Geneva, but the specimens from the south, by the side of the northern specimens, did not unfold their leaves so early as the latter by about three weeks. The White Poplar Hornbeam and Tulip Tree were the principal trees employed. Catalpa, a very late leafing subject, exhibited less diversity in this respect. This phenomenon is equally striking in cereals and other cultivated plants. The learned author attributes these differences in effect mainly to the fact that vegetation, or external growth, never entirely ceases in the south, whereas in the north there is a long period during which internal changes and modifications of substances alone is carried on.

SCIENTIFIC SERIALS

The American Journal of Science and Art, July.—The original articles are:—On the United States Weather Map, by E. Loomis, which we have already noticed.—On a magnetic proof plane, by H. A. Rowland. The apparatus required is a small coil of wire $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter and containing 10 to 50 and a Thomson galvanometer. Having attached the small coil (or magnetic proof plane, as Mr. Rowland calls it) to the galvanometer, it has to be laid on the required spot and then suddenly pulled away and carried to a distance, and the momentary deflection of the galvanometer will be proportional to that component of the lines of force at that point which is perpendicular to the plane of the coil. By a coil of this kind it is possible to determine the intensity of the magnetic field at any point, and thus be able to make a complete map of it. Illustrations of the method are given.—On pseudomorphs of chlorite after Garnet at the Spurr Mountain Iron Mine, Lake Superior, by Raphael Pumpelly, with a coloured plate of a section magnified $\frac{22}{1}$.—A brief note on the application of the horizontal pendulum, by Harcourt Amory.—Explosive properties of methyl nitrate, by Carey Lea. This communication describes a new method and the requisite apparatus for preparing it, so that danger is reduced to a minimum.—On zonochlorite and chlorastrolite, by G. W. Hawes.—On glycogen and glycocoil in the muscular tissue of *Pecten irradians*. The glycogen has the formula of the sugars of that of the starch group plus a molecule of water. The amount of glycocoil occurring in the tissue is small. Analyses are given.—On Dr. Koch and the Missouri mastodon, by Edmund Andrews. The object of the article is to show that Dr. Koch's testimony contributes nothing reliable on the question of the occurrence of human remains in conjunction with the mastodon. —On the rate of growth of corals, by Prof. Joseph Le Conte. Examining a grove of madrepores he noticed that all the prongs grew to the same level, which at the time were very near the surface; and that all of them were dead at the tips for about three inches. The varying level of the ocean at the place is known from the Coast Survey Report, and as it seems that during the high water the madrepores *grow* up, the living points of the madrepores grow up till the descending water-level exposes and kills them down to a certain level; with the rise of the mean level again new points start upwards. The annual growth, calculated from the known rise and fall of water level, is from $3\frac{1}{2}$ to 4 inches per annum.—Results of dredging expeditions off the New England Coast in 1874, by A. E. Verrill. Lists of species are given.—Examination of gases from the meteorite of Feb. 12, 1875, by A. W. Wright.—Discovery of two new asteroids, 144 and 145, by C. H. Peters. The diameter of 144 is as the 10th, and 145 as 11·5.—The discovery of a method of obtaining thermographs of the isothermal lines of the solar disc, by Alfred M. Mayer. We reprint the paper this week.

Jahrbücher für wissenschaftliche Botanik. Herausgegeben von Dr. N. Pringsheim. Band x. Heft. 1. (Leipzig, 1875).—In the first part of the tenth volume of Pringsheim's well-known *Jahrbuch* we have three papers all of very considerable importance. The first is a translation of Count Francesco Castracane's paper on the Diatomaceæ of the Carboniferous period. Ashes of coal from Liverpool yielded, on microscopic examination, several species of Diatomaceæ. The chief forms identified by Count Castracane all belong to fresh-water genera and species, viz.:—

Fragilaria Harrisonii. Sm.
Epithemia gibba. Ehrbg.
Sphenella glacialis, Kz.
Gomphonema capitatum, Ehrbg.
Nitzschia curvula, Kz.
Cymbella Scotica, Sm.
Synedra vitrea, Kz.
Diatoma vulgare, Bory.

In addition to these there existed a Grammatophora, a small Coscinodiscus, and probably an Amphipleura (*danica?*). These three marine forms were only observed on one occasion, and their presence must have indicated some accidental inroad of sea-water among the vegetation from which the piece of coal was formed. All the fresh-water forms which occurred in the coal are not to be distinguished from the living forms of the same species, a fact of great interest and importance, as it indicates the remarkable permanence of these forms in time; and it is probably an unique instance of the occurrence of species which have remained unmodified through all the lapse of ages which separates the present epoch from the coal period. Count Castracane examined other varieties of coal besides that obtained from near Liverpool, viz., coal from the mines at St. Etienne, another from Newcastle, and a third specimen

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