plies on pages 36 and 37, to understand the whole matter, without alluding to 'grievances half a century old.' W. C. Bond became, in 1838, 'astronomical observer' without salary except the rent of a dwelling house, and without definite relations to the younger 'Perkins professor.' Peirce, perhaps, expected rather too early from the new establishment results which could be 'passed over to the computer.' G. P. Bond, B. A. (Harvard), 1845, was a diligent student of astronomy in all its branches, and soon showed himself capable of improving the methods of computation, as is shown by his early papers, especially 'Some Applications of the Method of Mechanical Quadratures'—a paper which anticipated an important method of Encke's, and which affords ideas not yet completely worked out. One of the few papers which he contributed to the *Astronomical Journal* is entitled 'On the Orbit of Wilmot's Comet,' and employs methods of his own which deserve study.

When W. C. Bond passed away in 1859, at the age of 70, his son had long been the chief assistant in the Observatory, and succeeded quite naturally to his father's place, but Peirce had been himself a candidate, and circumstances had brought about an estrangement between him and Bond, but the latter seems to have done his best to renew pleasant relations.

Other matters, easily traced, are involved in the reasons why these relations were not renewed. Professor Holden alludes to the circumstance that George Bond was not selected as an original member of the National Academy of Sciences as a matter requiring explanation. But this concerns the history of American science in general, and not merely the few persons who may have made up the list submitted to Congress. It is not best to imply here that the omission was more unfair than similar transactions are often liable to be.

At the time, 1863, when the National Academy was founded, Bond had been four years Director of Harvard College Observatory, and had shown in that capacity ample knowledge of mathematics and astronomy to fill the position completely. He had gathered around him a corps of hard working assistants, among them Asaph Hall. The meagre salaries which the College could pay were rendered still more inadequate by the war then prevailing, and the corps of astronomers was diminished by the call for soldiers. One able and enthusiastic observer, Sidney Coolidge, fell in the battle of Chickamauga. The remainder of the assistants were compelled, with one exception, to seek occupation elsewhere. Bond himself struggled on heroically, although stricken with a mortal disease, and finally passed away at his post in 1865, before the close of the war, after completing the great work on Donati's Comet of 1858, the first work of an American astronomer to be rewarded with the gold medal of the Royal Astronomical Society. The vindication of the wisdom of his appointment as Director was complete, but he never received the medal which reached America a short time after his death.

Professor Holden's book has been put together from G. P. Bond's diaries and correspondence, and with the zealous cooperation of his family, Mrs. Richard Bond and his daughters. The author's work is, on the whole, well and judiciously done; some trifling defects are apparently due to unfavorable circumstances; such, for instance, are the want of a subject index; the Index of Proper Names is very defective; the spelling of German names like Brünnow and Rümker is not correct, and the use of capitals to indicate names of persons is a technical practice not approved in general literature. While the book is not a complete history of astronomy in America from 1840 to 1865, it affords precious materials for such a history, and should be read by all who desire to follow out that period of our science, and at the same time to become acquainted with two of its most prominent and faithful workers in the traditional as well as in the newer astronomy. G. P. Bond's experiments in astronomical photography were of very great importance and, in fact, were prior even to Rutherfurd's.

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Handbuch der Klimatologie. Von DR. JULIUS HANN. Stuttgart, Germany, J. Engelhorn. 1897. Second edition. 3 vols. 36 Marks.

If I were asked to mention the greatest authority on matters pertaining to climate and climatology I should give, without hesitancy, the name of Dr. Julius Hann, the director of the Austrian meteorological service.

In 1883 Dr. Hann published a long needed book, a general treatise on the climatology of the whole earth's surface. This work was the outcome of many years of special study and research, and required several years of direct labor in its actual writing. It was received with enthusiasm by the German reading scientific public, and English readers deplored the fact that we had no corresponding work in English. Fourteen years have now elapsed since Hann's work first appeared, and its second and greatly enlarged and rewritten edition finds our language still without any general work on climatology. We have not even a translation to fill the place which should be occupied by a work of honest English or American authorship, and it is to be hoped that some publisher will be induced to take advantage of the appearance of this new German work by bringing out a translation of it either in full or in abridgment.

Hann's climatology consists of three volumes. The first is devoted to general climatological conditions, in which the relations of cause and effect are discussed for the various meteorological elements. The second volume is devoted to the special climatology of the regions embraced in the tropical zone. The third volume treats of the climate of the temperate and cold zones.

One serious drawback to the usefulness of the work is the lack of climatological charts; but the author explains that they were omitted because they would considerably increase the price that must be asked of purchasers of the present treatise, and, moreover, such charts had been published elsewhere in easily accessible form.

The 404 pages of Vol. I. contain: A general idea of the scope of climatology; and complete explanations of the nature, importance and relation to each other of the climatic factors, temperature, humidity, precipitation, cloudiness, wind, air pressure and evaporation. A short statement of the composition of the air and the impurities which it may contain, together with some remarks on plant phenology as related to, and dependent on, climatic conditions. A brief though comprehensive review of our knowledge of the amount of radiation from the sun and the resulting 'solar climate.' The principal forms of telluric or physical climate, which is the solar climate modified by the earth's atmosphere and the existing distribution of land and water; this naturally occupies the greater portion of Vol. I. And, finally, the meteorological cycles and climatic oscillations.

Let us notice more particularly some of the most interesting facts given by the author.

Owing to the elliptic form of the earth's orbit, by which the earth is sometimes a little nearer the sun than at other times, the southern hemisphere receives more solar heat in summer and less in winter than the northern hemisphere. If our earth had no atmosphere the average temperature at the earth's surface would be, *at the equator* for the hottest month 67°C. and for the coldest month 56°C., and *at the poles* for the hottest month 82°C. and for the coldest month —273C. (which latter is, curiously enough, the absolute zero of the thermometric scale).

Concerning the interesting question of the effects of forests on rainfall Hann says that from the nature of the case it is almost impossible to prove anything by direct measurements, and that the increase of rainfall due to forest growth has been far over-estimated. It is quite probable, however, that in the tropics the woods do slightly increase the amount of precipitation, and extensive woods in the middle and higher latitudes probably increase the frequency of rainfall.

The effects of mountains on rainfall has received thorough treatment at the hands of the author, and especially that peculiar phase of increase of rainfall with the altitude up to a certain level, and the subsequent gradual decrease at greater heights. With an increase of altitude amounting to from 2,000 to 4,000 feet the rainfall may be increased by from 50 to 250 per cent. This increase of rainfall is due to the condensation of the moisture in ascending air currents which form on mountain sides.

It has been computed, retrospectively, that in Jurassic times the mean temperature of the earth was about 2°C. warmer than it is at present. At about Lat. 30° N. it was colder, but in other latitudes warmer, and at the equator about 6.5°C. warmer then than now.

The decrease of air temperature with the increase of altitude above the sea-level is of very great importance in climatological considerations, and Hann has given a careful discussion of this phenomenon.

The average decrease of temperature in mountain regions is 0.57°C. per 100 meters ascent, and it seems to be quite uniform for both equatorial and arctic regions. For the very gradual ascents, such as long slopes, the temperature decrease is but about 0.40°C. per 100 meters ascent; while for the free air it is probably about 0.65°C. These values show considerable retardation of the dynamic change of temperature, which is about 1°C. per 100 meters ascent.

Among the peculiar winds none are more interesting than the hot, dry winds which occur in certain mountain regions, and which in Europe are known as Foehn winds, and in the United States as Chinook winds. It was to have been expected that Dr. Hann would devote considerable space to these winds, because they are with him a pet subject; although his modesty has caused him to place his first contribution to its literature a long way down in the reference list, whereas it should have headed that bibliography. Probably no single class of winds have been so little understood as these Foehn winds; and after searching in all directions for some reason for their existence, the simple theory that they are due to the dynamic heating of descending air masses which have a decreased relative humidity due to the increased temperature has sufficed to explain what was considered a most complex phenomenon.

One very interesting problem in climatology is, to determine how the different elements, such as temperature, rainfall and cloudiness, vary with changes of latitude. This is shown by finding the average values of the elements for certain parallels of latitude throughout their whole length as they encircle the globe.

The following little table gives for various latitudes the average temperature for the whole year in degrees Fahrenheit; the average total annual depth of precipitation (which includes both rainfall and snowfall) in inches; and the average annual amount of cloudiness measured on a scale of 0 = a clear sky, and 100 = a sky entirely overcast with clouds.

Lat.	Temp.	Precip. inch.	Cloud per cent.
N. 80°	2°	14	—
70	14°	14	59
60	30°	19	61
50	42°	23	58
40	57°	21	49
30	68°	24	42
20	77°	32	40
N. 10	80°	76	50
Equator	79°	77	58
S. 10°	78°	67	57
20	74°	30	48
30	65°	26	46
40	54°	37	56
50	42°	46	66
S. 60°	31°	[40]	75

This table is also interesting from the fact that it indicates that we have meteorological observations 20° nearer the pole in the northern hemisphere than in the southern hemisphere.

The last section of this volume, which treats of climatic changes, may be divided into two parts —that treating of changes in geologic times, and that of changes shown by the records of modern civilization. This last has already been given to readers of meteorological literature in Brückner's *Klimaschwankungen*, and this same authority is freely quoted by Hann. But the outline of the various theories accounting for climatic changes in the distant past is a much needed summary. Hann states briefly the main theories which have been promulgated and which depend on possible changes in the inclination of the ecliptic, or in the eccentricity of the earth's orbit. A rough computation convinces him that the effects of neither of these would account for the changes which must have taken place in the earth's climate. Croll's theory is given due prominence, but Hann finds it unsatisfactory. A theory developed by Luigi de Marchi makes a variation in the coefficient of transmission of solar radiation through our atmosphere the important factor in these great climatic changes; but no certain causes of increase or decrease in the amounts of water vapor or carbonic acid gas, which would mainly affect the values of this coefficient, have been pointed out as applicable to the existing case without any manner of doubt. The mystery of the great ice age, and of the former rich vegetation in the present cold zone, still remains to be solved.

FRANK WALDO.

An Outline of the Theory of Solutions, and Its Results, for Chemists and Electricians. By J. LIVINGSTON R. MORGAN, PH.D. (Leipzig), Instructor in Quantitative Analysis, Polytechnic Institute, Brooklyn. New York, John Wiley & Sons; London, Chapman & Hall. 1897. Pp. 63.

The contents of this work are four lectures, delivered before the Brooklyn Institute of Arts and Sciences, and deal with the theory of solutions, methods for the determination of electrolytic dissociation, the theory of the voltaic cell, and analytical chemistry from the standpoint of electrolytic disociation.

The author states in his preface that "a knowledge of the theory of solution and its results, is so important to workers in all branches of chemistry and electricity, that the following pages have been compiled, containing an elementary treatment of the subject." * * * "If by this sketch the author can induce any one to go deeper into the subject he will feel more than repaid for his work."

H. C. J.

Untersuchungen über das Erfrieren der Pflanzen. MOLISCH. Jena, Gustav Fischer. 1897. Pp. viii + 73. 11 illustrations.

A notable addition to the physiology of the cell has been recently published by Professor Molisch as a result of several years' work upon the effect of cold upon plants.

The researches upon which generalizations rest are fragmentary and necessarily inaccurate, since they were carried on in the open air or under conditions of great discomfort to the observer. At the same time no regulation of the temperature could be effected. Dr. Molisch has been enabled to obtain results of great importance, both from the advance in cell physics since the time of Muller's experiments and by the use of ingeniously constructed apparatus.

Dr. Molisch's researches were chiefly conducted by means of a double-walled freezing chamber of wood 33 x 33 x 27 cm. outside measurements. The space of 7 cm. between the double walls on five sides of the chamber was filled with sawdust. The center of the chamber was occupied by a zinc compartment to contain a microscope. A tubulated opening through the walls of the zinc and wooden compartments allowed access of light to the mirror, and toothed rods for adjustment of the stage, objectives and mirror extended outside the walls. The space surrounding the zinc compartment was filled with a mixture of salt and ice, by which temperatures of 4°C. to 10°C. were obtained in a room kept at 10°C.

As a useful preliminary, observations were made upon the freezing of colloidal substances, emulsions, color and salt solutions. The crystals were seen to appear suddenly in a colloid, such as gelatine, and to increase in size, extracting the water from the gelatine, so that the latter shrunk into a network resembling parenchyma tissue. Some colloids return to the original condition upon thawing; others do not. Starch paste is an example of the latter. The suspended particles in an emulsion, such as latex, aggregate in the form of a network of bands upon freezing. Freezing of color and salt solutions result in the more or less complete separation of the solid and solvent.

The chief interest of the paper lies in the results of the direct and continuous observation of the freezing of living cells.

An amœba, after exposure of 25 minutes to a temperature of 9°C., exhibited the formation of clumps of ice crystals in the plasma, and finally became a solid lump consisting of a complicated network of plasma almost devoid of water, ice crystals, vacuoles of concentrated cell-sap and air-bubbles. The slender filaments of Phycomyces froze only when the temperature fell to —17° C. The small diameter of the cells seem to be a direct adaptation against freezing. Yeast cells exhibited a shrinkage of 10 per cent., due to loss of water when the medium was frozen, but the cells were not killed at -15°C. The freezing of Spirogyra filaments at -3 to -6°C. is accompanied by a shrinkage in diameter amounting to 62 per cent. and by the final aggregation of chlorophyll band and nucleus in the center of the cells. The excretion of water in this plant under low temperatures may be easily observed