The address on the opening of the Bangor Laboratories will be of interest to all who have to do with their like; that on the occasion of the unveiling of Joule's statue will interest everybody who cares for or who knows of the greatest generalization of modern science. In short, every page of this volume is deserving of the careful perusal of all who are devoted to Natural Philosophy in its most comprehensive sense, and who wish to know something of the spirit of one whose splendid contributions to physical science are, as a whole, greater than those of any other philosopher of the present time.

The mechanical execution of the book does not seem to be quite in keeping with the classical character of its contents, and its pages are occasionally marred by negligent proof reading. T. C. MENDENHALL.

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Laws of Temperature Control of the Geographic Distribution of Life.

In the December issue of the *National Geographic Magazine*, Dr. C. Hart Merriam announces the discovery of the laws of temperature control of the geographic distribution of terrestrial animals and plants. Dr. Merriam has been engaged on this problem for sixteen years and believes he has at last obtained a formula which fulfills the requirements. He states that in the Northern Hemisphere animals and plants are distributed in circumpolar belts, the boundaries of which follow lines of equal temperature rather than parallels of latitude. Between the pole and the equator there are three primary belts or regions—Boreal, Austral and Tropical. In the United States the Boreal and Austral have each been split into three secondary transcontinental zones, of which the Boreal are known as the Arctic, Hudsonian and Canadian; and the Austral as the Transition, Upper Austral and Lower Austral.

The temperature data computed and plotted on maps as isotherms are not available in locating the boundaries of the zones, because they show the temperature of arbitrary periods—periods that have reference to a particular time of year rather than a particular degree or quantity of heat.

It is assumed that the distribution of animals and plants is governed by the temperature of the season of growth and reproductive activity—not by that of the entire year. The difficulty is to measure the temperature concerned.

Physiological botanists have long maintained that "the various events in the life of plants, as leafing, flowering and maturing of fruit, take place when the plant has been exposed to a definite quantity of heat, which quantity is the sum total of the daily temperatures above a minimum assumed to be necessary for functional activity." The minimum used by early botanists was the freezing point (0° C or 32° F), but recent writers believe that 6° C or 42.8° F more correctly expresses the temperature of the awakening of plant life in spring. "The substance of the theory is that *the same stage of vegetation is attained in any year when the sum of the mean daily temperatures reaches the same value*, which value or total is essentially the same for the same plant in all localities. This implies that the period necessary for the accomplishment of a definite physiological act, blossoming, for instance, may be short or long, according to local climatic peculiarities, but the total quantity of heat must be the same. The total amount of heat necessary to advance a plant to a given stage came to be known as the *physiological constant* of that stage." But students of geographic distribution are not concerned with the physiological constant of any stage or period in the life of an organism, but with *the physiological constant of the species itself*—if such a term may be used. "If it is true that the same stage of vegetation is

attained in different years when the sum of the mean daily temperatures reaches the same value, it is obvious that the physiological constant of a species must be *the total quantity of heat or sum of positive temperatures required by that species to complete its cycle of development and reproduction.*" Now, "if the computation can be transferred from the species to the zone it inhabits—if a *zone constant* can be substituted for a *species constant*—the problem will be well nigh solved." This Dr. Merriam has attempted to do. "In conformity with the usage of botanists, a minimum temperature of 6°C (43°F) has been assumed as marking the inception of the period of physiological activity in plants and of reproductive activity in animals. The effective temperatures or degrees of normal mean daily heat in excess of this minimum have been added together for each station, beginning when the normal mean daily temperature rises higher than 6°C in spring and continuing until it falls to the same point at the end of the season." The sums thus obtained were plotted on a large scale map of the United States, and isotherms were run which were found to conform to the *northern* boundaries of the several zones. This is shown by colored maps. The data seem to justify the statement that "*animals and plants are restricted in northward distribution by the total quantity of heat during the season of growth and reproductive activity.*"

In the case of the *southern* boundaries of the zones, it was assumed that animals and plants in ranging southward would encounter, sooner or later, a degree of mean summer heat they are unable to endure. "The difficulty is in ascertaining the length of the period whose mean temperature acts as a barrier. It must be short enough to be included within the hottest part of the summer in high northern latitudes, and would naturally increase in length from the north southward. For experimental purposes, and without attempting unnecessary refinement, the mean normal temperature of the six hottest consecutive weeks of summer was arbitrarily chosen and plotted on a large contour map of the United States, as in the case of the total quantity of heat."

On comparing this map with the zone map, the isotherms of 18°, 22° and 26°C were found to conform respectively to the southern boundaries of the Boreal, Transition and Upper Austral zones, leading to the belief that "*animals and plants are restricted in southward distribution by the mean temperature of a brief period covering the hottest part of the year.*"

Except in a few localities the northern boundary of Austral species coincides with the southern boundary of Boreal species, but for a distance of more than a thousand miles along the Pacific coast a curious overlapping and intermingling of northern and southern types occurs. On looking at the temperature maps this is at once explained, for the mean temperature of the six hottest consecutive weeks from about lat. 35° northward to Puget Sound is truly Boreal, being as low as the mean of the corresponding period in northern Maine and other points well within the Boreal zone. On the other hand, the total quantity of heat is found to be the same as that required by Austral species. "It is evident, therefore, that the principal climatic factors that permit Boreal and Austral types to live together along the Pacific coast are a low summer tempera ture combined with a high sum total of heat."

A table is given showing the actual governing temperatures, so far as known, of the northern and southern boundaries of the several zones.

In conclusion, Dr. Merriam calls attention to the subordinate value of humidity as compared with temperature. "Humidity and other secondary causes determine the

presence or absence of particular species in particular localities within their appropriate zones, but temperature predetermines the possibilities of distribution; it fixes the limits beyond which species cannot pass; it defines broad transcontinental belts within which certain forms may thrive if other conditions permit, but outside of which they cannot exist, be the other conditions never so favorable."

Grasses of Tennessee—Part II.—F. LAMSON-SCRIBNER.—University of Tennessee, Agric. Exper. Sta. Bull., VII. 1–141, 187 figures. 1894.

The first part of this important work treating of the structure of grasses in general, issued two years ago, is now supplemented by the part here noticed, containing descriptions and figures of all species known by the author to inhabit Tennessee. Carefully prepared keys to the genera and species are a feature of the book. The cuts are good, although printed on paper hardly firm enough to bring them out to the best advantage. The descriptions are diagnostic and couched in strictly technical language; on this point it is remarked: "Attempts to avoid technical or 'hard' words often result in obscuring the meaning of the author, and an undue simplicity of expression is often apt to be offensive by implying a lack of intelligence on the part of the reader." As the book is intended primarily for the farmers of the State, this may be considered by some as a position of doubtful value.

It is to be regretted that the rules of nomenclature adopted by the botanists of the American Association for the Advancement of Science, which are practically those approved by the zoölogists, have not been strictly followed. This will seriously hamper the usefulness of the book, for some of the names used by Prof. Scribner have become obsolete.

N. L. B.

NOTES.

PHYSICS.

THE newly discovered gas is to be the subject of a discussion at a meeting of the Royal Society on January 31st, when Lord Rayleigh and Prof. Ramsay will present their paper. This will be the first meeting under a resolution of the Council of the Society passed last session, whereby certain meetings, not more than four in number, are to be devoted every year each to the hearing and consideration of some one important communication, or to the discussion of some important topic.—*Nature.*

PERSONAL.

THE University of Berlin is seriously crippled by the deaths of Helmholtz and Kundt. Their places cannot be filled, but Prof. Kohlrausch will probably be called to one of the vacant chairs.

THE *Physical Review* has published excellent portraits of Helmholtz, Kundt and Hertz, with biographical sketches by the editor-in-chief, Professor Nichols. Probably the best account so far published in English of the work of Helmholtz is that contributed to the *Psychological Review* for January by Professor Stumpf, of the University of Berlin.

MR. F. Y. Powell, of Christ's College, succeeds Froude in the Regius Professorship of Modern History at Oxford.

ZOÖLOGY.

A PICTURE-PUZZLE of a remarkable kind appears in the *Zoölogist* for December. It is a reproduction of two photographs of a Little Bittern, showing the strange attitude assumed by the bird to favor its concealment. One of the figures shows the the bird standing in a reed-bed, erect, with neck stretched out and beak pointing upwards; and in this position it is difficult to distinguish the bird at all from the