The authors began their work about 20 years ago. They carefully examined the previous literature, went to Europe to look up the types preserved in the great herbaria or still in cultivation in the collections of public and private botanic gardens, and besides visited and collected cacti in almost every country in the Americas. Thus the authors brought together a most complete collection of herbarium specimens, photographs and drawings as a basis for their work. These large and unique collections are preserved at the Smithsonian Institution in Washington and at the New York Botanical Garden, to which institutions every future student will have to turn. The amount of work involved in this study can hardly be overestimated, but to every student of this family the difficulties which were to be overcome are at least partly known.

The whole monograph consists of four large quarto volumes, beautifully printed and freely illustrated with drawings and photographs in the text and with excellent plates, most of them from colored drawings of Miss Mary E. Eaton, the able artist of the New York Botanical Garden. These plates, besides being most useful to the student, add a great deal of charm to the books and give to the uninitiated at a glance an idea of the wealth of forms and colors of the cactus family.

The whole work describes 1,235 species under 124 genera. Most of these genera have been revived or are newly proposed by the authors. I see in these many newly created genera, the greatest progress made in our knowledge of these plants. They all form well circumscribed and natural groups and convey to us a precise picture of the development or the evolution of these strange plants, which was completely obscured under the old 20 to 24 collective and arbitrary genera of the older monographs.

In looking through these four volumes we are gratified to see the painstaking care of the authors to do justice to their fellow-workers and the enormous amount of new facts and data, which will make this the standard reference work for generations to come. A complete index of the four volumes, carefully compiled by Miss Rebecca Rose, adds to the value of the work for its ready use.

It is to be hoped that the efforts of both the Carnegie Institution and the authors will find ample reward in the increased interest of botanists as well as of the general public in this marvellous entirely American family of plants. The work is purely systematic, but it suggests on every page any number of biological problems which are still to be solved and which will prove the cacti to be one of the most promising fields for investigation.

It is impossible here to enter into detail, tempting as it may be. We must leave that to the reader himself. The authors deserve great credit for their work and the Carnegie Institution is to be congratulated on having presented such an elegant series of volumes to the students and lovers of plants.

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LABORATORY APPARATUS AND METHODS

A SHORTER CELLOIDIN METHOD

THE celloidin method of embedding has never enjoyed the popularity of the paraffin method among botanists, and some laboratories have now abandoned it or employ it only when the desired results can not be obtained by other means. This antagonistic attitude has undoubtedly arisen because of the length of the process, the need of a long series of celloidin solutions, and the application of heat, which is detrimental to delicate tissues, for long periods of time. These objections have been surmounted in a shortened process now employed in this laboratory wherein air pressure is used and only two celloidin solutions are needed.

The pressure tank, which can be manufactured by a millwright for a nominal sum, is made from a piece of iron pipe six inches in diameter and one foot in length with the lower end closed by a cap and the upper bearing a flange two inches wide and about one inch in thickness. A cast iron cover, the diameter of which equals that of the flange, is fitted with an automobile tire valve to permit the introduction and release of air. This cover is ground smooth on the lower surface and by means of eight bolts can be drawn tightly down on to a rubber gasket laid over the flange. Approximately 30 two-ounce bottles can be placed in a tank of this size, providing pieces of wire gauze are inserted between the layers.

The material to be embedded is covered with two per cent. celloidin in uncorked bottles, placed in the tank, and subjected to an air pressure of approximately 100 pounds per square inch for 30 minutes. Slightly lower pressures have been used with good results, but it has been impossible to obtain much higher pressures with a hand-operated tire pump. After the half-hour interval the pressure is slowly released through the valve, the material transferred to 16 per cent. celloidin and the process repeated. A few shreds of celloidin will then serve to thicken the matrix at room temperature, and hardening in chloroform may take place the following day.

To date this method has been used on only two types of material. Dormant buds of trees and woody plants showed an imperfect penetration, nevertheless the infiltration was much better than that obtained by the older method. Cambial material of woody plants, together with the adjacent phloem and xylem, showed excellent penetration with no distortion of the delicate tissues, and cuttings taken in both the resting and active seasons gave equally acceptable results.

In presenting this note it is the hope of the author that other workers will find it adaptable to their needs.

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SPECIAL ARTICLES

ON THE SIMULTANEOUS DIURNAL VARIATION OF THE ELECTRIC POTENTIAL OF THE EARTH AND THE AIR

IT has been known for more than a century that there is both an annual and a diurnal variation of the electric potential gradient of the air, but there is, as yet, no consensus of opinion among physicists as to the cause of these variations or even of the potential gradient itself.

The fundamental fact is that the earth is surrounded by an electrostatic field, so that if an elongated, insulated conductor be placed vertical anywhere over the surface of the earth it will regularly be found to have a negative charge at its upper end and a positive charge at its lower end. Such a condition can be maintained in a conductor only by the induction of a charge upon some other body. That this condition is maintained in the conductor mentioned above by a negative charge upon the earth or by a positive charge above the earth was plainly shown by Erman, in 1803, and by Peltier, in 1836. Peltier devised an apparatus for determining the potential gradient over the earth which was based upon the laws of electrostatic induction. This potential gradient has come to be called the potential gradient of the atmosphere, since it is measured in the atmosphere and was originally believed to be due to positive electric charges in the atmosphere.

Both Erman and Peltier believed the inducing charge to be upon the earth, and this opinion has been held by many physicists since that time; but others have believed it to be due to positive electric charges in the air or to a positively charged conducting layer in the upper air.

That the latter assumption can not be the true explanation follows from the fact that there is no potential gradient inside a charged hollow conductor due to a charge upon this conductor. Neither can a potential gradient be induced inside a hollow conductor by a charge outside the conductor. It accordingly follows that if the earth is surrounded by a good conducting layer in the upper atmosphere, the only possible potential gradient around the earth must result from its own charge or a charge upon its lower atmosphere.

In SCIENCE of May 25, 1923, the present writer undertook to show that the yearly variation in atmospheric potential gradient is such as would be expected to result upon a negatively electrified earth under the inductive influence of a similarly electrified sun. This paper is intended to show that the same may be said of the diurnal variation.

The writer has shown in various papers[1] that the day side of the earth is regularly electropositive to the night side. It is well known that the atmospheric potential gradient is regularly greater upon the night side of the earth than upon the day side, as it would be if it were due to the induction of the earth's negative charge.

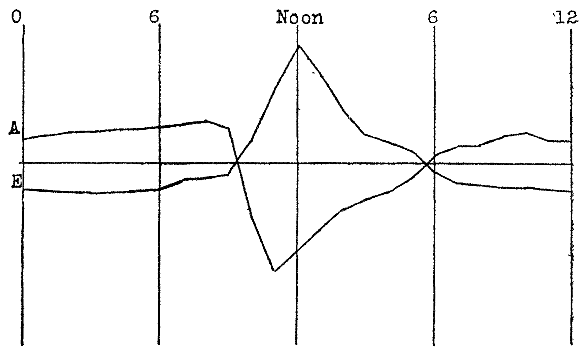

FIG. 1. Diurnal variation of earth potential and of air potential gradient for the months September, 1923–January, 1924. Curve A represents the variation of the air potential gradient and curve E the variation of earth potential.

Since last September, continuous photographic records have been kept of the diurnal changes in both the electrical potential of the earth and of the air. On February 1, the electrometer which was used for measuring the atmospheric potential gradient was moved and its sensitivity was changed, so the present report covers the time from September 1 to February 1. During that time there were occasions when the atmospheric potential gradient was greatly disturbed by storms, and otherwise, but measurable records were obtained for 87 days. All these were used in determining the mean diurnal variation for the period. During the same time 135 measurable records of the earth potential variation were obtained.

The mean values of the two diurnal variations in scale readings are shown in figure 1. Curve E represents the mean diurnal variation of the earth potential and Curve A the mean diurnal variation of the atmospheric potential gradient.

The agreement of these curves with theory is certainly very satisfactory. Since February the two electrometers used in the investigation have been

[1] See, especially, Bulletin of the Terrestrial Electric Observatory of Fernando Sanford, Palo Alto, California, Vol. 1.