

laid upon the importance of carefully marking stations; and the detailed instructions in regard to the subject occupy two quarto pages in the manual 'On the field-work of triangulation,' issued by the survey. The most common method used is the one which has been copied by the N. Y. state survey. Other methods, however, are used in special cases. For recovering a station, the main dependence is upon the surface-marks, and the underground-marks are used only for protection in case of the destruction of the others by accident or design.

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Washington, D. C.,
April 22, 1883.

Freezing of liquids in living vegetable tissue.

The conclusions of Mr. Meehan in relation to the above topic (*SCIENCE*, p. 229) seem to me scarcely warranted by the best authenticated facts in vegetable physiology. Experimental investigations and researches, undertaken many years ago, led me to the following deductions:¹—

1. That the sap of many living plants can be frozen by the application of a degree of cold not much below that required to freeze it when removed from the plant; and that in very cold climates the sap of all perennial plants must be frozen in all parts during the winter months.

2. That the congelation of the juices of living vegetables does not, as many phytologists have imagined, necessarily and inevitably result in the death of the whole plant, or of the part in which it takes place, but, on the contrary, that frequently no injurious consequences follow. Consequently it is unwarrantable to assume that a plant which is not killed by severe cold never was frozen; and therefore it is unnecessary to invoke the aid of a 'vital power' to enable plants to survive the influence of cold sufficiently intense to freeze their juices when removed from the living plant.

3. That the bursting of the trunks of trees in high latitudes is not due to the expansion which the sap undergoes in process of congelation, but to the unequal contraction which takes place in the trunk (usually after the complete congelation of its juices) in consequence of a sudden depression of temperature. In short, that the rupture of the trunk in such cases is due to the same cause as the rents in the frozen ground, and the cracks in large sheets of thick ice, which occur in high latitudes when there is sudden accession of cold. This view is fortified by the fact that the coefficient of contraction (or expansion) of ice is greater than that of any other solid body hitherto examined, with the exception of hardened caoutchouc, or ebonite.

JOHN LECONTE.

Berkeley, Cal., April 17, 1883.

Sun's radiation and geological climate.

In his review of Whitney's climatic changes, Mr. Gilbert says, "His [Whitney's] hypothesis that the intensity of solar radiation is gradually lessening, by reason of the dissipation of solar energy, . . . will be admitted by most students." Mr. Whitney and his reviewer fall into the very natural error, that a loss of heat, and, of course, of energy, is necessarily accompanied by a fall in temperature. Paradoxical as it may appear, a loss of both heat and energy may

produce a rise in the temperature of the body that loses them. If it be true that the sun is, as is now thought by many eminent scientists, a globe of gaseous matter, then, under the long process of giving off heat, it has actually been growing hotter, and the intensity of its heat on the earth's surface to-day is greater than it was in the early geological epochs.

The world is indebted for this curious fact to Mr. J. Homer Lane.¹ I quote from Newcomb's *Astronomy*, p. 508: "The principle in question may be readily shown in the following way: if a globular, gaseous mass is condensed to one-half its primitive diameter, the central attraction upon any part of its mass will be increased fourfold, while the surface upon which this attraction is exercised will be reduced to one-fourth. Hence the pressure per unit of surface will be increased sixteen times, while the density will be increased only eight times. Hence, if the elastic and gravitating forces were in equilibrium in the primitive condition of the mass, its temperature must be doubled in order that they may still be in equilibrium after the diameter is reduced one-half."

Admitting, then, the gaseous condition of the sun, as, under our present knowledge, we seem compelled to do, we must also admit that the intensity of the sun's radiation of heat has been slowly increasing through the ages, and to-day is greater than at any previous time. The increase may have been small; but, so far as there has been any change, it has been in the direction of an increase, and hence cannot explain the undoubted decrease in the general temperature of the earth's atmosphere indicated by the paleontological record.

C. B. WARRING.

Distribution of public documents.

Few outside of the ranks of professional politicians will disagree with the report of the committee of Congress on the printing and distribution of public documents, or with the tenor of the editorial remarks on the subject in No. 9 of *SCIENCE*. But it is to be feared that it will be as difficult to induce the average congressman to dispense with these lubricants of the political machine as with the senseless distribution, through the department of agriculture, of seeds that can as well be bought at any country store. If any means can be devised by which the 'costly and beautifully illustrated volumes' shall reach those for whose information they were written, instead of serving to adorn the nurseries of influential ward strikers and campaign committee men, it will redound greatly to the benefit of scientific knowledge and progress; for at present it is mainly through the medium of second-hand book-stands that those interested can occasionally get the professional works of which their political insignificance did not render them worthy recipients.

There is one notable exception, however, to this extravagance and misdirection of precious documents, the result of one of those spasms of virtue mentioned in the editorial. I refer to the law concerning the distribution of the publications of the geological survey, to which director Powell has called attention in a circular issued some time ago. According to the terms of this law, these documents, excepting the general report, can be obtained only by purchase or exchange; that is, the scientific workers of the country may at first get what may be deemed the equivalent of their own publications, or, possibly, of rare works in their possession. But when this resource is exhausted, the only method open to them, for obtaining what in many cases is the sequel of

¹ For the exposition of the basis of these deductions, the reader is referred to the memoir of the writer, entitled "Observations on the freezing of vegetables, and on the causes which enable some plants to endure the action of extreme cold."—(*Proc. Amer. assoc. adv. sc.*, vi. 338-359; *Amer. journ. sc.* [2], xiii. 84-92, 195-206.)

¹ See *Amer. Journ. sc.*, July, 1870.

their own work in the states, is to purchase the memoirs out of their abundant professorial incomes. What that means when it comes to the illustrated memoirs and atlases, most needed by the actual worker, is too obvious to need discussion. They will simply have to be done without by those not within reach of a large public library.

Heretofore, a certain number of copies of such publications, outside of those placed at the disposal of congressmen, were distributed gratuitously to those known to be actively interested in the subject, by the authors, or heads of surveys, who knew exactly whom to reach among their scientific co-workers; and the stimulus thus given to research and scientific intercourse was very great. All this is now effectually embargoed: the very men whom these documents should reach are cut off from them by this penny-wise and pound-foolish legislation.

If it be true that the United States cannot afford to continue the expenditure involved in the gratuitous distribution of such costly publications, even for the encouragement of scientific research, it would be far better that their cost should be reduced from the magnificent quartos and royal folio atlases to such material and dimensions as *can* be afforded consistently with a judicious gratuitous distribution, intrusted, for example, to the judgment and discretion of the director, the Smithsonian institution, and the National academy, severally or jointly. The scientific publications would then be quite sure not to be wasted, and yet would with equal certainty reach those whose active interest in the progress of science should entitle them to their possession. This is the more needful, since the extension of the national survey into the states will, for the time being, undoubtedly render state surveys less numerous, and more scantily endowed for scientific work; so that the publications of the national survey will be the chief source of information hereafter. It does seem that what the states could afford to do gratuitously for their own citizens could be afforded by the national government, now that this kind of work has practically passed into its hands.

E. W. HILGARD.

Berkeley, Cal., April 19, 1883.

THE AGRICULTURAL EXPERIMENT-STATION OF CONNECTICUT.

Annual report of the Connecticut agricultural experiment-station for 1882. New Haven, State, 1883. 114 p. 8°.

THE major portion of this report is, as usual, occupied with analyses and valuations of commercial fertilizers, and divers other fertilizing materials, and though valuable in its way, and in accordance with the design of the station, contains little of general scientific interest. The review of the fertilizer-market for the past year, on pp. 56-60, must prove of considerable aid in the valuation of fertilizers, and will doubtless attract the attention of both manufacturers and consumers.

Among the fodder analyses are two of duplicate samples of field-corn and of fodder-corn, selected with especial care, and also of ensilage from the same material. These analyses dis-

closed the interesting fact, that the duplicate samples of the same material differed more in some cases than did the ensilage and the fresh substance. These results illustrate the great difficulties that stand in the way of preparing a fair sample of such a bulky plant as maize, and throw considerable doubt on the accuracy of some of the recently published results regarding the changes which maize undergoes in the silo.

The most generally interesting portion of the report is the paper on 'Milk,' by Dr. E. H. Jenkins, which includes the results of several analyses of the milk of single Guernsey cows, and of over two hundred partial analyses of the mixed milk of herds. These results afford valuable data in regard to the variations which may occur in commercial milk, and the possibility of establishing by law a standard of purity for milk. In regard to the variations in the milk-solids, "an inspection of all the results . . . leads to the conclusion, that, in pure herd-milk, the solids may in some cases, and at certain seasons, sink as low as 10 or 10.5 per cent, and the fat to 2.6 per cent; and that very frequently (in 28 per cent of the samples examined at this station) the solids are less than 12 per cent."

In one case the total solids amounted to only 9.79 per cent, though it was not *certain* that the milk was unadulterated, and, in six cases out of two hundred and seven, to less than 10.5 per cent. Dr. Jenkins comes to the following conclusions regarding the standard of purity for milk:—

"As evidence of watering, simply, specific gravity furnishes by far the most satisfactory test; and, if 1.029 is adopted as a minimum, no pure milk will be condemned. In some cases moderately watered milk may escape detection.

"If we will establish a minimum limit for the percentage of solids and fat which shall in no case condemn pure milk in any locality, we shall have to make it absurdly low, and thus offer a premium on watering milk of good quality."

While evidently doubting the practicability of establishing a general standard of purity for milk, Dr. Jenkins thinks it possible to establish by mutual consent *local* standards for limited districts, where the pasturage and other conditions are tolerably uniform. Where this is done he would not have the question of the *purity* of the milk raised at all, but would simply condemn all which falls below the standard as too poor to use. Both suggestions seem worthy of general consideration.