A specially designed top upon which operations can be performed is superimposed on the sewing machine frame. This gives the proper angle to work the treadle with ease and affords ample surface space for the animal, the lamp, the microscope and the other instruments.

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SPECIAL ARTICLES

THE EFFECT OF HEAVY WATER OF LOW CONCENTRATION ON EUGLENA

EXPERIMENTS[1] in May, 1933, demonstrated that a very low concentration of deuterium oxide (1 part in 2,000) slightly higher than that occurring in ordinary water (1 part in 5,000)[2] has a pronounced effect in increasing the length of life of *Spirogyra* filaments. It was also shown[3] that *Oscillatoria* spread more extensively in this dilute heavy water and that the enzymes, amylase and zymin were less active after incubation in this isotope water. Richards[4] and also Meyer[5] have confirmed the dilute heavy water effect, since they find that it increases the dry weight of yeast and *Aspergillus*.

Increased cell division was observed in *Spirogyra* in the isotope water[6] (possibly due to the greater longevity), so it was decided to try a form like *Euglena* in which cell counts can be made easily. Moreover, it had been shown previously that Euglena grows more rapidly in recently melted ice water than in recently condensed water.[7] Taylor, Swingle, *et al.*,[8] observed cessation of movement in *Euglena* in 92 per cent. heavy water and "no effect" after 6 days in 30 per cent. heavy water, but the cells were not counted at the end of the experiments, which were designed to detect a toxic action of deuterium rather than its rôle in normal physiological processes for which study the concentrated heavy water is obviously not suitable.

Dr. Theo. L. Jahn kindly supplied *Euglena gracilis* from a two weeks' old peptone culture (bacteria free). The solution was washed off by centrifuging five times at low speed with distilled water. Eight Pyrex test tubes, each containing 10 cc of water (four with isotope water of density 1.000061 and four with ordinary glass distilled water) were inoculated with 1 cc of a suspension of *Euglena*, making the average concentration at the beginning of the experiment 31,750 cells per cc (February 10, 1934). The tubes were exposed to northern light (Temp. 17–20° C.) and counts were made after forty-five days (March 28, 1934). It was found that more cells were present in the isotope water, the average population being 59,087 cells as compared to 51,112 cells in ordinary water (Table I). Moreover, there were more active forms in the isotope water as indicated by an average of 4,400 moving individuals per cc as compared to an average of 1,900 moving individuals in the ordinary water cultures. The results are of interest in connection with the greater longevity and increased cell division in *Spirogyra*[9] in the dilute heavy water, and it is possible that a small proportion of deuterium is a necessary constituent of living systems. It will be recalled that Washburn and Smith[10] found that a preferential selection of the heavy H isotope occurs in the process of synthesis of organic compounds by a growing willow tree. In *Spirogyra* and *Euglena* in hypotonic solutions the reduced enzymic hydrolysis[11] may enable the cells to live longer, and consequently there is more opportunity for cell division. Further experiments on a similar longevity effect in *Planaria* are in progress.

TABLE I

MULTIPLICATION OF EUGLENA GRACILIS IN ORDINARY DISTILLED WATER AND IN HEAVY WATER OF LOW CONCENTRATION. AVERAGE POPULATION AT BEGINNING 31,750 PER CC.

Tube No.	Kind of water	Final population (average)
1	ordinary distilled	51,750 per cc.
2	ordinary distilled	50,800 per cc.
3	ordinary distilled	50,400 per cc.
4	ordinary distilled	51,500 per cc.
5	isotope	56,750 per cc.
6	isotope	59,650 per cc.
7	isotope	62,000 per cc.
8	isotope	57,950 per cc.

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INFRA-RED ABSORPTION OF WATER FRESHLY PREPARED FROM ICE AND FROM STEAM

A SERIES of papers,[1] published during the last two years in other than biological journals, dealing with differences in the physiological effects of water freshly prepared from ice and from steam, have come to our

1 Barnes, *Jour. Am. Chem. Soc.*, 55: 4332, 1933.
2 Bleakney and Gould, *Phys. Rev.*, 44: 265, 1933.
3 Barnes and Larson, *Jour. Am. Chem. Soc.*, 55: 5059, 1933.
4 Richards, *Am. Jour. Bot.*, 20: 679, 1933.
5 Meyer, SCIENCE, 79: 210, 1934.
6 Barnes and Larson, *ibid.*
7 Barnes and Jahn, *Proc. Nat. Acad. Sci.*, 19: 638, 1933.
8 Taylor, Swingle, Eyring and Frost, *Jour. Cell. and Comp. Phys.*, 4: 1, 1933.
9 Barnes and Larson, *ibid.*
10 Washburn and Smith, SCIENCE, 79: 188, 1934.
11 Barnes and Larson, *ibid.*
1 H. T. Barnes and T. C. Barnes, *Nature*, 129: 691, 1932; T. C. Barnes, *Proc. Nat. Acad. Sci.*, 18: 136, 1932; F. E. Lloyd and T. C. Barnes, *Proc. Nat. Acad. Sci.*, 18: 422, 1932; T. C. Barnes and T. L. Jahn, *Proc. Nat. Acad. Sci.*, 19: 638, 1933; T. C. Barnes and E. J. Larson, *Jour. Amer. Chem. Soc.*, 55: 5059, 1933.

attention. The result of the experiments reported in these papers has always been the same, namely, water recently prepared by melting ice is a more favorable medium for the maintenance of life and for the rapidity of cell division of certain microscopic organisms (*Spirogyra* and *Euglena gracilis*) than water recently prepared by condensing steam and brought to the same temperature. These writers have generally interpreted their results in terms of a supposedly greater concentration of polymers in the water prepared from ice.

There are two features in the short-wave infra-red absorption spectrum of water which are associated with the presence of polymers or aggregates. They are (1) an unsymmetrical broadening of those bands (1.96μ, 1.44, 1.20, 0.97, 0.75) in the liquid which have quantum analogues in water vapor. These bands all sharpen greatly and shift their centers of gravity toward shorter wave-lengths, both when the temperature[2] of the water is raised and when certain substances are dissolved[3] in the water. Although the complete explanation of this effect is lacking, it has generally been associated with a partial breaking up of molecular aggregates. (2) The second effect is the diminution in intensity of certain other bands (4.7μ, 1.78) which do not occur in water vapor, upon raising the temperature[4] and upon introducing dissolved substances.[5] This effect is also consistent with the hypothesis of the destruction of polymers.

We have made use of the two preceding tests to see if we could get any spectroscopic evidence to support the notion that ice water and steam water have different amounts of polymers. A freshly prepared sample of each was quickly brought to a temperature of about 21° C. and placed in turn before the slit of a recording prism spectrograph which gives a photometric tracing of the absorption spectrum between 0.6μ and 2.7. The 1.96μ, 1.78 and 1.44 bands were favorably recorded through the use of a 0.25 mm absorbing layer, and the two curves were so extremely similar that there seems to be no possibility of assuming unlike concentrations of polymers in the two samples. Rises in temperature in the water cell caused by the radiation were guarded against by making the absorbing layer a part of a 40 cc volume of water.

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[2] J. R. Collins, *Phys. Rev.*, 26: 771, 1925.
[3] Suhrmann and Breyer, *Zeits. f. Phys. Chem.*, B, 20: 17, 1933.
[4] J. W. Ellis, *Phys. Rev.*, 38: 693, 1931; also some unpublished data.
[5] Tamman, *Naturwiss.*, 15: 632, 1927; also Suhrmann and Breyer, ref. 3.

EFFECTS OF SOIL TEMPERATURE ON THE ABSORPTION OF WATER BY PLANTS

FROM the time of Sachs's classical experiments it has been known that decreased soil temperature results in decreased absorption of water by plants. Apparently, most investigators have considered this decrease to result solely from the physiological effects of low temperature on the cells of the roots.[1] It has been suggested that the viscosity of protoplasm is increased and its permeability decreased, thus slowing up the movement of water into and through the root cells. Such a view results from the fact that most quantitative studies of this problem have been made with potometers in which the root system is surrounded by liquid water and is therefore under conditions entirely different from those to which a root system growing in soil is subjected. The use of this method of study has resulted in overlooking the purely physical effects of decreased temperature on the rate of movement of water in the soil and from soil to root. However, in view of the effect of temperature on the viscosity and other properties of water it appears probable that these physical effects are fully as important in retarding absorption as are the physiological effects on the root cells themselves.

So far as the writer is aware, no quantitative determinations of the effect of temperature on the movement of water through the soil or from soil to root have ever been made. In fact it would be impossible to measure directly the effects of temperature on the physical processes concerned in the movement of water from soil to living roots, because its effects on the physical processes involved could not be distinguished from its physiological effects on the root cells. It is readily possible, however, to determine the effect of temperature variations on the movement of water to a non-living absorbing surface such as that afforded by the porcelain soil-point cones of Livingston and Koketsu.[2] These cones measure the rate at which water is absorbed by a dry porcelain surface when placed in close contact with the soil. This is considered to be a measure of what is generally termed the water-supplying power of the soil, but which will here be referred to as the water-supplying capacity, because the term "capacity" seems to express more accurately the rôle of the soil.

A number of determinations were made of the water-supplying capacity of soils at various temperatures, and part of the data obtained are summarized in the accompanying table. The amount of water absorbed is stated in milligrams per square centimeter of absorbing surface for a period of one hour. Each

[1] N. A. Maximov, "The Plant in Relation to Water," summary, pp. 83–87. London, 1929.
[2] B. E. Livingston and R. Koketsu, *Soil Sci.*, 9: 469–485, 1920.