ogy for the presentation of reports and papers. Twenty-four papers, with discussions, may be roughly grouped as follows: Rainfall, infiltration and groundwater, 15, and one appendix; stream-flow and flood-control, 6; and one each on evaporation, on glaciology and on contributions of the Water Resources Committee to hydrological investigations. The annual reports of permanent research committees were received and discussed as follows: (1) Snow; (2) glaciers; (3) evaporation from water-surfaces; (4) runoff; (5) physics of soil-moisture; (6) underground waters, with three appendices; (7) dynamics of streams; (8) chemistry of natural waters; (9) rainfall. Reports were also presented by newly formed special committees as follows: (1) Soil Conservation Service; (2) flood-waves, with six appendices; (3) density-currents. The total of 45 reports and papers affords evidence of the activity of the section.

The regional meetings of the Section of Hydrology at Spokane, Wash., and Davis, Calif., were arranged by special committees, of which W. A. Lamb and Morrough P. O'Brien were chairmen, respectively. Only three formal hydrological papers were presented before the North Continental Divide regional meeting at Spokane, the time being largely devoted to conferences and discussions; this meeting was held in affiliation with the Northwest Scientific Association.

The South Pacific Coast regional meeting at Davis, Calif., was held jointly with the Western Interstate Snow-Survey Conference. Sixteen formal hydrological papers were presented at three sessions, January 7 and 8, 1938. These related to hydrometeorology, precipitation and vegetation, evaporation, transpiration, forest and range hydrology (in relation to water-supply, forest management, live-stock industry and flood-control), floods, flood-control, evaporation and runoff from snow and studies in quality of irrigation-water. Nineteen reports and papers were presented and discussed at the Snow-Survey Conference on development of snow-surveying, methods of forecasting, economic aspects of snow-surveying, improvement of snow-survey equipment and winter sports. This meeting was concluded with a round-table conference and dinner.

The present *Transactions*, edited by the general secretary, include either in full or in abstract in Part I 140 papers and reports presented at Washington, and in Part II 38 papers and reports not elsewhere reported, with discussions presented during the regional meetings at Spokane and at Davis.

These *Transactions* afford further evidence of the scientific and economic value of geophysical research and of the contribution of the union through its coordination of many agencies. Further substantial progress may be confidently expected through the activities of the special committees of the union and of its sections, including the newly created planning and project committee.

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SPECIAL ARTICLES

THE SURVIVAL OF PLANT CELLS IMMERSED IN LIQUID AIR

A REVIEW of the literature[1] on the survival of plants or animals exposed to extremely low temperatures reveals that two kinds of organisms can support an immersion in liquid air (about −190° C.): (1) Those which resist a previous drying, *e.g.*, seeds, spores, protozoan cysts, tardigrades, nematodes; (2) those which do not exceed a few micra in size, *e.g.*, bacteria, yeast, monocellular algae, flagellates of the type trypanosome. This observation suggests that the survival might be due to the fact that water does not crystallize in these organisms, either because there is not enough water left in them to freeze, or because, on account of their small size and relatively large area, so much water can be withdrawn from them by osmosis during the congelation of their culture medium that they are practically desiccated. (The resistance to congelation offered by capillarity does not seem to be sufficient, alone, to explain the cold resistance of micro-organisms.) If, then, crystallization of water is the factor responsible for death by low temperature, all the cells in which formation of ice can be prevented should survive. In the research reported here, we intended to study if and to what extent protoplasm vitrified at low temperatures (as described in a previous work[2]) that is, protoplasm hard and breakable like glass, but in which water had not crystallized, keeps its vitality.

In the work just mentioned, it has been shown: (1) That gelatin gels containing 37 to 90 per cent. water can be brought into the vitreous state by a sudden immersion in liquid air; (2) that the thickness of the vitrifiable layer decreases with increasing water-content, extending from 0.3 mm to a few micra when the water content varies from 50 to 90 per cent.; (3) that the temperatures at which the material crystallizes cover a range of some 15 degrees only (from 0° to about −15° C.) and that crystallization takes place either during a cooling from the atmospheric to sub-

[1] B. J. Luyet and P. M. Gehenio, *Biodynamica*, No. 33, 1938.

[2] B. J. Luyet, *Biodynamica*, No. 29, 1937.

zero temperatures or during a warming from the lower temperatures to above $-15°$; (4) that the possibility of obtaining the vitreous state depends primarily on the velocity of crystallization; pure water could not be vitrified on account of its excessively high crystallization velocity,[3] while gelatin gels are capable of vitrification in proportion to the slowness of their crystallization, that is, in proportion to their gelatin concentration.[4] The relation between the possibility of vitrification and the crystallization velocity is due to the fact that the vitrifying procedure consists essentially in cooling rapidly enough to bring the temperature of the material across the zone of crystallization temperatures (from $0°$ to $-15°$) before the ice crystals have time to form.

This method of vitrification could be applied to entire plant leaves.[2] But preliminary experiments on the vitality of entire leaves gave results which suggested that some cells or tissues were alive, while some others were dead. We then investigated the tissues singly, beginning with the epidermis. This tissue can be obtained in monocellular layers thin enough for the extremely rapid cooling required, it stays alive a long time after being separated from the plant and it lends itself to several vitality tests. The present report is concerned only with investigations on the vitality of the epidermis.

Pieces of onion epidermis previously stained with neutral red and differentiated with potassium hydroxide—a procedure which allows the living and the dead cells to be distinguished by their color[5]—were mounted in small metal clips in such a way that each side of the tissue presented an exposed area of about 20 mm.^{2} The preparations were then immersed in liquid air. When removed therefrom and brought back, in air, to room temperature, the cells were all dead, as Becquerel, who made similar experiments on the same material, has also observed.[6] Comparing these results with those reported above on the vitrification of gelatin, we thought that the epidermal cells might behave as the gels containing 90 per cent. water which, to be vitrified, must either be reduced to a thickness of a few micra or lose some of their high water content. We then tried to dehydrate them by plasmolysis.

Stained pieces of epidermis immersed for about 15 seconds in a 5 per cent. solution of sodium chloride, were mounted as indicated above and, after removal, with a blotter, of the excess plasmolysing solution, they were immersed in liquid air. On being withdrawn from it, they were brought back, in air, to room temperature; the cells were all dead.

[3] J. H. Walton and R. C. Judd, *Jour. Phys. Chem.*, 18: 722, 1914.
[4] E. H. Callow, *Proc. Roy. Soc. A.*, 108: 307, 1925.
[5] B. J. Luyet, SCIENCE, 85: 106, 1937.
[6] P. Becquerel, *Comptes rendus Ac. Sc.*, 204: 1267, 1937.

Assuming that death might have resulted from a congelation during the too slow warming of the material in the atmosphere after its exposure to liquid air and that warming in a liquid medium would be more rapid on account of the better heat conductivity afforded by the liquid contacts, we immersed the preparations in the plasmolysing solution after their treatment in liquid air. Several cells were now found intact and could be deplasmolysed or plasmolysed to a further extent, when put in a more concentrated solution of sodium chloride.

If, instead of a 5 per cent., we used a 10 or 15 per cent. plasmolysing solution, before and after immersion in liquid air, more of the cells were intact.

The fact that, to save the cells from disintegration, one must use the same means as for saving a gelatin gel from crystallization, that is, (1) dehydrate them, (2) cool them rapidly, (3) warm them rapidly; and the fact that the further the dehydration the more resistant are the cells to injury or the gels to crystallization, suggest that the same fundamental process takes place in the two cases, in other words, that disintegration of protoplasm subjected to extremely low temperatures is due to crystallization and that any method, such as vitrification, which prevents crystallization, prevents protoplasmic disorganization.

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INSULIN AND THE OXIDATION OF ETHYL ALCOHOL BY EXCISED DIABETIC LIVER TISSUE

A RECENT study in this laboratory of the action of insulin in increasing the rate of disappearance of alcohol from the blood has indicated that the acceleration of glucose oxidation by insulin catalyzes the oxidation of alcohol.[1] It seemed to us that conclusive information regarding this relation might be gained by a study of excised tissue from an animal completely deprived of its insulin supply by pancreatectomy. So far only liver has been extensively studied, since this tissue is probably responsible for the major portion of alcohol oxidation.[2, 3]

Cats were employed for this study because pancreatectomy in this species results in severe diabetes. The pancreas was removed aseptically under anesthesia; and the animals were given adequate food and laboratory care until the diabetes became maximal.

[1] B. B. Clark and R. W. Morrissey, *Am. Jour. Physiol.*, (Proc.), 123: 37, 1938.
[2] E. Lundsgaard, *Compt. rend. Trov. Lab. Carlsberg*, 22: 333, 1938.
[3] L. F. Lelior and J. M. Muñoz, *Biochem. Jour.*, 32: 299, 1938.