To make the KCl junction the plug is rotated until the holes (a) and (b) are in line with the inlet funnel and the arm connecting with the KCl reservoir respectively as shown in Fig. 2. When the saturated KCl

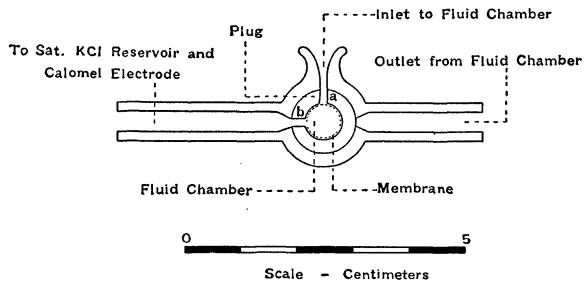

FIG. 2

solution begins to run into the fluid chamber the plug is rotated until the hole (a) communicates with the outlet from the fluid chamber and hole (b) with the inlet funnel. By means of rubber tubing, the fluid is sucked from the chamber through the arm serving as an outlet and into a waste bottle placed in the suction line. Continuing the suction, the fluid chamber is rinsed out by introducing distilled water from a rubber-tipped medicine dropper into the inlet funnel. If necessary, soap solution or alcohol may be used, followed by distilled water, and suction is discontinued when the fluid chamber is practically dry. The fluid whose pH is to be determined is then introduced into the fluid chamber and when it begins to run into the outlet arm, after the chamber is full, the plug is rotated in the same direction as before (clockwise in Fig. 2) until the hole (a) just fails to communicate with the KCl bridge. This closes hole (b) and the E.M.F. is measured. After the freshly greased plug has been wet with KCl solution in the middle by previous rotation of the plug, it is sufficient to bring the margin of the hole (a) in line with the margin of the bore of the KCl bridge without having the two communicate fully with each other in making a measurement. With buffer solutions this procedure is desirable and gives steady and reproducible potentials.

The glass and calomel electrodes are mounted in an electrically shielded, thermostatically controlled air chamber provided with an air circulator. In the measurements of the potentials, we have found the thermionic vacuum tube potentiometer described by Hill[4] to be highly satisfactory.

With this glass electrode assembly accuracy usually reported by other workers may be attained. Over 600 determinations of hydrogen-ion activity made on 16 different standard phosphate buffer solutions, ranging in pH from 5.24 to 7.22, have shown that an accuracy within 0.01 pH unit is readily obtainable. It is not unusual, in making 15 to 20 consecutive measurements on a given buffer solution, taking a different sample each time, to obtain voltage readings whose variations correspond to a difference not greater than 0.003 pH unit. Measurements on body fluids of larvae and pupae of more than 500 individual insects in different stages of metamorphosis[5] indicate that this micro vessel with the glass electrode is highly suitable and convenient for use with biological fluids.

IVON R. TAYLOR
JAMES H. BIRNIE

BROWN UNIVERSITY

SPECIAL ARTICLES

THE RÔLE OF PEROXIDASE IN THE DETERIORATION OF FROZEN FRUITS AND VEGETABLES

OXIDATION, especially following injury to the tissues by freezing, apparently is responsible, at least in part, for the discoloration, browning, loss in flavor and production of certain objectionable unnatural flavors which occur during the freezing, storage and thawing of fruits and vegetables. These changes, which occur in the presence of air, apparently are catalyzed by the oxidases present in "oxidase plants," such as apricots, peaches, etc. Loss of organic peroxide or removal of oxygen from the tissues by biological or other means, or inactivation of the oxygenase present markedly improves the keeping quality of the oxidase plants. However, we find that "peroxidase plants," such as pineapple, orange, peas, string-beans, spinach, asparagus, etc., are also subject to marked deterioration during freezing storage. We have found that slices of pineapple exposed to air darken in color and deteriorate in flavor upon prolonged storage at 0° F. The deterioration in flavor of frozen orange juice and to some extent of pineapple juice is largely due to oxidation. It is difficult to believe that this deterioration is due to the peroxidases present, and that an incomplete oxidizing system will catalyze the type of changes observed. The evidence for orange juice leads us to believe that the oxidation is non-enzymatic in nature. However, oxidizing systems other than the conventional one composed of oxygenase, peroxidase and catechol may be involved.

Unnatural hay-like flavors develop in vegetables during freezing and subsequent thawing. These

[4] S. E. Hill. SCIENCE, 73: 529, 1931.

[5] The results of this work will be reported at an early date.

flavors form during storage at −17.5° C. (0° F.) in vegetables exposed to air. Definite changes in flavor occur in two months, and the off-flavors increase in intensity during storage. Joslyn and Cruess[1] and Joslyn[2] have reported that heating for 1 or 2 minutes in steam or boiling water at 100° C., followed by cooling, was sufficient to prevent the appearance of these hay-like flavors during storage at −17.5° C. for over 8 months. Subsequent tests by us and others have confirmed these findings. Blanching of the vegetables also resulted in a greener color, stable to heat during cooking.

In the course of investigations on the nature of these changes, very striking results were obtained on blanching peas, string-beans and spinach at various temperatures for 2 minutes in water. We found that there was a critical temperature range, somewhat different for each vegetable, at which the color, flavor and texture was most benefited by heating. These temperature ranges were 71 to 76.5° C. (160° to 170° F.) for peas, 82.2 to 90.6° C. (180° to 195° F.) for string-beans and 73.9 to 82.2° C. (165° to 180° F.) for spinach. Blanching below the temperatures given did not entirely inhibit formation of off flavor, and blanching at higher temperatures resulted in loss of fresh flavor and, especially for peas and spinach, the formation of other objectionable flavors, *e.g.*, "cooked" flavors. The texture of the cooked vegetables was also best in approximately the same temperature range, becoming very soft when blanched at the higher temperatures. Vegetables blanched below these tempratures, in general, did not retain the bright green color during cooking, becoming a dull green.

It was found that peas were most susceptible to the formation of hay-like flavors and string-beans least. The hay-like flavor in string-beans after four months' storage was least objectionable and that in spinach most. Unblanched spinach had a fish-like "keroseney" flavor rather than hay-like flavor.

In view of the fact that this change in the favor of vegetables was more intense in the presence of air and was reported to be absent in vegetables stored in cans closed under vacuum, it was thought that vegetable oxidases were in part responsible for these changes. These vegetables were found to turn benzidine blue in the presence but not in the absence of H_2O. Thus a complete oxidase system was not present. The temperatures at which the peroxidases present were inactivated after heating for five minutes so far as the benzidine test is concerned were found to be at about 90° C. However, the rate of color formation in presence of benzidine and H_2O was markedly reduced at temperatures of 70° C. and above and the color formed at higher temperatures was not a true blue color, being a brownish blue.

A very marked difference between the unblanched samples and those blanched at temperatures below the ranges given was found. Although blanching at 70° C. (140° F.) did not inhibit the formation of some hay-like flavor in peas, the intensity of off flavor was markedly less than in the unblanched sample. Similar results were found for other vegetables.

The fact that the vegetable peroxidases were inactivated at temperatures above the desirable range and that peroxidase was present in the tissues of vegetables which retained their flavor during freezing storage lead us to believe that it may not be the chief causative agent involved in the deterioration. Neither tyrosinase nor active proteases were found in these vegetables. It is possible that other oxidizing systems may be involved in these changes. These investigations are being continued and more complete results will be published in the not too far distant future.

M. A. JOSLYN
G. L. MARSH
UNIVERSITY OF CALIFORNIA, BERKELEY

[1] M. A. Joslyn and W. V. Cruess, *Fruit Products Journal*, 8 (7): 9–12, 8 (8): 9–12. 1929.

[2] M. A. Joslyn, California Agr. Expt. Sta. Cir. 320. 1930.

DEVELOPMENT OF CERCARIA MACROSTOMA FAUST INTO PROTEROMETRA (NOV. GEN.) MACROSTOMA[1, 2]

THE life history of *Cercaria macrostoma,* a cystocercous (mirabilis) cercaria, has been experimentally determined. The adult is *Proterometra macrostoma* nov. gen., a member of the family Azygiidae Odhner.[2, 3]

The author has found *Cercaria macrostoma* in *Goniobasis livescens* from the Salt Fork branch of the Vermilion River at Homer Park, Illinois, and in *Pleurocerca acuta* from the Oconomowoc River, Wisconsin. Pratt[4] reported immature specimens under the name *Cercaria fusca* in *Goniobasis livescens* from Oneida River, New York, and Smith[5] described the mature form under the name *Cercaria melanophora* from *Goniobasis* sp. in Alabama. Cahn[6] reported

[1] Contributions from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, No. 441.

[2] E. C. Faust, "Two New Cystocercous Cercariae from North America," *Jour. Parasit.*, 4: 148–153, 1918.

[3] T. Odhner, "Zum natürlichen System der Digenen Trematoden," II *Zool. Anz.*, 37: 237–253, 1911.

[4] H. S. Pratt, "A New Cystocercous Cercaria," *Jour. Parasit.*, 5: 128–131, 1919.

[5] S. Smith, "Two New Cystocercous Cercariae from Alabama," *Jour. Parasit.*, 19: 173–174, 1932.

[6] A. R. Cahn, "Life History of a New Fork-Tailed Cercaria," *Jour. Parasit.*, 13: 222, 1927.