(3) The permanent secretary's financial report for 1933 was presented and ordered audited, after which it is to be laid before the council.

(4) The permanent secretary's budget for 1934 was presented and ordered referred to the council at the Boston meeting for final action.

(5) The director of the press service, Austin H. Clark, reported on arrangements for the Boston meeting and discussed with the executive committee plans of the work in general and in relation to the coming meeting.

(6) The director of exhibits, F. C. Brown, reported on preparations for the Boston exhibit, and was authorized to make a trip to Chicago to ascertain if any exhibits at the Century of Progress were suitable and available for future exhibits of the association.

(7) It was voted that Dr. Henry Crew be added to the present exhibit committee.

(8) Dr. T. H. Morgan was named the association's representative on the committee of review, as provided in the deed of trust of the Marine Biological Laboratory.

(9) The report of the committee on patents, trademarks and copyrights was presented, with the recommendation that it be published by the association. The executive committee instructed the permanent secretary to provide for printing the report as the first in a new series. The matter of format and other details was left in the hands of the chairman and permanent secretary.

(10) The executive committee accepted an offer from The Science Press to print and sell the report of the committee on patents, trademarks and copyrights.

(11) The permanent secretary was authorized to secure estimates for printing the next volume of summarized proceedings.

(12) Under the terms of the emeritus annual membership fund established last year, the following were selected as members for the year 1934: Dr. Beverly T. Galloway, U. S. Department of Agriculture, Washington, D. C.; Professor Clarence P. Gillette, Fort Collins, Colorado; Professor John Lane Van Ornum, Washington University, St. Louis, Missouri.

(13) The application of the Minnesota Academy of Science for affiliation was approved and referred to the council for information.

(14) A communication was presented from Dr. Arnold Kruckman, of the Tennessee Valley Authority, asking the aid of the association in acquiring further knowledge of the territory covered by the authority. The executive committee advised that if possible a symposium on various phases of conservation be organized for the Boston meeting and that such symposium bear upon the fundamental features of the project. The permanent secretary was instructed to write accordingly and to state that the association desires to be of service in carrying out the plans in the Tennessee Valley.

(15) Reports of the Fifth Pacific Science Congress were presented by the delegates, C. A. Kofoid and T. W. Vaughan. The committee expressed its appreciation of the work of these delegates.

(16) The committee adjourned at 3:30 P. M. to meet in Boston, Tuesday evening, December 26, at the Statler Hotel.

HENRY B. WARD
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

PHYSIOLOGICALLY BALANCED CULTURE SOLUTIONS WITH STABLE HYDROGEN-ION CONCENTRATION

ONE of the important problems in the culture of higher plants in artificial media is that of maintaining the hydrogen-ion concentration of the culture solution within limits favorable to growth. Even when high concentrations of dissolved phosphates are used as chemical buffers, the solution may need to be passed through the culture vessel at a very high rate if the pH value is to be held within a narrow zone. The purpose of this note is to emphasize the advantage of employing physiologically balanced solutions which, under the influence of absorption and excretion of substances by the plant, tend to maintain a constant hydrogen-ion concentration.

The observations of several investigators, particularly those of Jones and Shive,[1] have clearly indicated that this means of stabilizing the reaction of culture solutions may be of considerable practical value. The effectiveness of this method has recently been demonstrated in a detailed study of the influence of the ionic ratio of NO_3 to NH_4 on the reaction change produced by wheat plants during various phases of their development. Initial pH values of 4.3, 5.1 and 6.0 were secured by means of suitable proportions of H_3PO_4, KH_2PO_4 and K_2HPO_4. A wide range of NO_3/NH_4 ionic ratios was obtained by varying the proportions of KNO_3 and $(NH_4)_2SO_4$, KNO_3 and NH_4NO_3, and $Ca(NO_3)_2$ and NH_4NO_3; but the total nitrogen concentration was kept the

[1] L. H. Jones and J. W. Shive, "Influence of Wheat Seedlings upon the Hydrogen-ion Concentration of Nutrient Solutions," *Bot. Gaz.*, 73: 391–400, 1922.

same in all solutions. Twenty-five wheat plants were grown in each culture vessel containing 8,600 cc of solution. The solutions were renewed every eight days. Daily records were made of the hydrogen-ion concentrations of the solutions during a culture period of 102 days.

It was found that with low NO_3/NH_4 ratios the pH values of the solution decreased rapidly under the influence of the plants and approached in extreme cases a pH value of 3.0. With high ratios, on the other hand, the pH values increased rapidly, tending to reach a limiting value of 6.5. When a NO_3/NH_4 ratio of suitable value was used, however, a physiologically balanced solution was obtained in which the hydrogen-ion concentration tended to remain approximately constant during the eight-day period between solution renewals. By balancing the partial concentration of NO_3 (the absorption of which removes H-ions from the solution) against that of NH_4 (the absorption of which removes OH-ions from the solution), the various conditions that tend to decrease the acidity may be exactly opposed by conditions that tend to increase the acidity. This method was found to be far more effective than that of attempting to stabilize the solution by greatly increasing the phosphate buffer content.

To maintain a higher pH value, it was necessary to use a higher ratio of NO_3 to NH_4. As the plants grew older, they gradually changed in their ability to alter the reaction of the solution. For the most accurate control of the pH value throughout the life cycle of the plants, it was therefore necessary to employ progressively lower NO_3/NH_4 ratios. Nevertheless, an approximately constant pH value could be maintained throughout the culture period by using a suitably selected intermediate NO_3/NH_4 ratio. Thus a very satisfactory stabilization of the pH value was obtained when NO_3/NH_4 ionic ratios of 50/50, 85/15 and 95/5 were used for maintaining pH 4.3, 5.1 and 6.0, respectively. The average changes in reaction after 8 days of contact with the roots were 0.23 pH, 0.21 pH and 0.08 pH, respectively. The composition of the solution for pH 5.1 is as follows: 0.00670 m KNO_3, 0.00059 m $(NH_4)_2SO_4$, 0.00255 m KH_2PO_4, 0.000079 m K_2HPO_4, 0.00394 m $CaCl_2$, 0.00263 m $MgSO_4$, 0.00005 m $FeSO_4$, 0.00005 m $K_3C_6H_5O_7$. In addition the solution contains 0.11 ppm. Mn, 0.07 ppm. Zn, 0.05 ppm. B, 0.002 ppm. Cu, 0.09 ppm. Al, 0.005 ppm. Li, 0.12 ppm. Na, 0.01 ppm. As, 0.1 ppm. Si, 0.01 ppm. Ni, 0.01 ppm. Co and 0.01 ppm. I.

The results of this study demonstrate clearly that the use of a physiologically balanced culture solution provides an effective and practicable means of stabilizing the hydrogen-ion concentration of the solution, and they indicate that excellent growth of the plants may be secured in a culture solution of this type if due attention is given to the total concentration as well as to the relative proportions of the solution constituents. This method may be recommended for many different kinds of physiological studies in which culture solutions with controlled pH values are required. The general utility and significance of physiological balance as a means of stabilizing the reaction of culture media appear to be worthy of much greater emphasis than they have been given in the literature of physiology, pathology, mycology and bacteriology.

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SPECIAL ARTICLES

THE EVOLUTION OF CEREBRAL LOCALIZATION PATTERNS[1]

THE localization of functions within the brain has been a topic of acute controversy since the beginning of inquiry into the organization of the central nervous system. Without attempting a review of the observations, experiments and speculations in this field, it is evident that the problem has recently entered a new phase with the elaboration of new methods of inquiry and new fundamental conceptions of nervous processes. The divergencies of opinion are to-day more acute and dogmatic than ever before, ranging all the way from a modernized phrenological localization in mosaic patterns of mental faculties of one sort or another to the equally ancient denial of any localization whatever in the cerebrum. On the last point an experimental psychologist has recently written, "Physiology must abandon any theory of cortical activity that rests upon localization of function."

The anatomist, embryologist, physiologist, psychologist and clinician views the problem from his own angle and in the light of his own experience. Too often his general conclusions are derived only from the meager data visible to him within his own contracted horizon. There is truth in each of these partial views, and before a satisfactory solution can be hoped for we must all learn to liberalize our own opinions by looking at the question as judiciously as we can from all points of view. This may justify the presentation of an aspect of the problem which has received scant attention—the phylogenetic approach.

[1] This research was aided by a grant to the University of Chicago by the Rockefeller Foundation.