It would seem premature to assert that these observations characterize the chlorophyll-protein itself. In any event, the electrophoretic properties are closely correlated with the general colloidal behavior of the complex. We intend to publish an extended account of these investigations in the near future.

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EFFECTS OF OXYGEN ON RESPIRATION, FERMENTATION AND GROWTH IN WHEAT AND RICE

RICE seeds are capable of germinating in the absence of oxygen and the seedlings grow well when submerged in water containing little oxygen, whereas wheat is unable to germinate or develop under such conditions.[1] In an attempt to ascertain the physiological basis for this difference, a study was made of the influence of variations in oxygen tension (pO_2), from 0 to 20.8 per cent., on respiration, fermentation and growth in seedlings of each of these cereal grains.

Manometric measurements of the gas exchanges occurring in seedlings of wheat (*Triticum vulgare* var. Leap's Prolific) and of rice (*Oryza sativa* var. Early Prolific) were conducted at 30° C., using a Barcroft-Warburg apparatus according to the method of Dickens and Simer.[2] The seedlings had roots 5 to 8 mm long when germinated in the dark at 30° C. on moist filter paper; for this development wheat required 24 to 26 hours, rice 30 to 33 hours. Groups of uniform seedlings (25 wheat or 30 rice) were soaked for one hour in a 0.013 molar phosphate buffer adjusted to pH 5.8, containing 4 per cent. sucrose and having a K/Ca balance of 7.5/1. Then the seedlings of each group were placed on a bed of glass beads in the manometer vessel with their roots submerged in the buffer solution to a depth of 1 to 2 mm. Prior to each test of 1 to 1.5 hours' duration, the vessels were thoroughly flushed with the required gas mixture, prepared by partially replacing normal air with nitrogen.

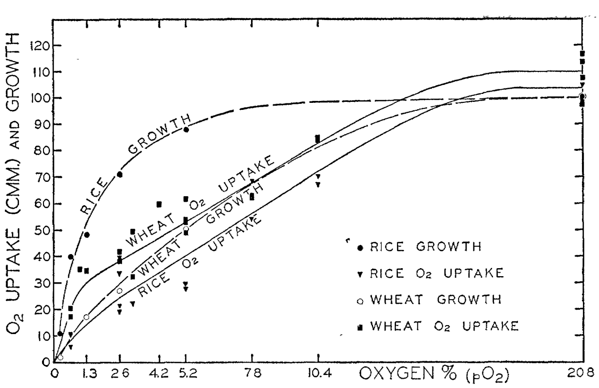

FIG. 1.

The results of the gas-exchange measurements are shown in Figs. 1 and 2, in which smoothed curves have been drawn in solid lines to show the trend of the experimentally determined points, each of which represents the average of 4 or 5 separate determinations. In 20.8 per cent. O_2 (air) the average activity of rice seedlings, as shown by CO_2 evolution, was found to be 87 per cent. of the average of wheat seedlings on the basis of dry weight of embryos. To facilitate comparison of the experimental data, the curves in all cases have been plotted for the activity of a number of seedlings (wheat, 6.4; rice, 13.3) calculated to produce 100 cmm of CO_2 per hour in 20.8 per cent. O_2.

In the growth experiments 225 twelve-hour-old seedlings of wheat and rice were allowed to develop for 96 hours at 30° C. on moist filter paper in gas streams containing from 0.25 to 20.8 per cent. O_2. Increment in dry weight of embryo (*i.e.*, of all the seedling except the endosperm) was used as a measure of growth. The curves depicting the results of the growth experiments are presented in Fig. 1, plotted on a scale of ordinates in which 100 represents the increment in embryo dry weight in 20.8 per cent. O_2.

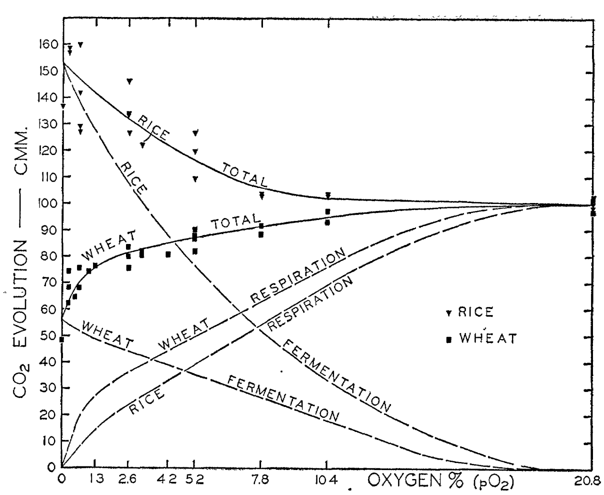

FIG. 2.

Inspection of the curves of Fig. 1 for O_2 consumption reveals the following relations: The O_2 intake by rice is less rapid than that by wheat over the range of O_2 tensions in which tests were conducted. With decrease in O_2 tension, the growth curve for wheat

[1] I. Nagai, *Tokyo Imp. Univ. Jour. Coll. Agr.*, 3: 109, 1916. C. Stich, *Flora*, 74: 1, 1891.

[2] M. Dixon, "Manometric Methods," pp. 61–67. London: Cambridge University Press. 1934.

falls rapidly, and it roughly parallels the curve for O_2 consumption. In rice the relation is very different: As the O_2 tension is decreased, the growth curve remains relatively high in spite of a rapid and continuous decrease in the O_2 intake.

Fig. 2 shows not only total evolution of CO_2, but also its components—respiration CO_2 and fermentation CO_2. In preparing these curves, it was assumed that all the activity of seedlings tested in 20.8 per cent. O_2 (air) was respiration (aerobic) and that in this O_2 tension little or no fermentation (anaerobic) occurred.[3] The respiratory quotient (CO_2/O_2) for activity in air was calculated, and it was assumed that this quotient remained constant for respiration (aerobic) in all O_2 tensions. Knowing the respiratory quotient, and having measured O_2 absorption and CO_2 evolution over the range of O_2 tensions, the amounts of respiration CO_2 and fermentation CO_2 could be calculated for any O_2 tension as follows:

cmm $O_2 \times$ respiratory quotient = cmm respiration CO_2.
cmm total CO_2 − cmm respiration CO_2 = cmm fermentation CO_2.

Applying this method to the smoothed curves for total CO_2 (Fig. 2) and O_2 (Fig. 1), the curves shown by broken lines in Fig. 2 were obtained.

From Fig. 2 it may be seen that as the O_2 tension decreases, the experimentally determined curve for total CO_2 output of wheat falls, whereas there is a rise in the corresponding curve for rice. The curves for CO_2 produced in respiration (aerobically) are similar in form to the O_2 activity curves of Fig. 1 from which they were calculated; wheat shows higher respiratory activity than rice. Inspection of the curves of Fig. 2 representing CO_2 produced in fermentation (anaerobically) shows far greater activity in rice than in wheat. As the O_2 tension is decreasing from 10 to 0 per cent., the fermentation in rice increases rapidly, until the CO_2 output by fermentation in 0 per cent. O_2 reaches 150 per cent. of the total CO_2 evolution in air. With the corresponding decrease in O_2 tension the increase in fermentation in wheat is much more gradual, and in the complete absence of O_2 the CO_2 output attains a level only 50 per cent. as high as the total CO_2 output in air.

Approximate I/N ratios (total CO_2 output in $N_2 \div$ total CO_2 output in 20.8 per cent. O_2) for wheat and rice are 0.5 and 1.5, respectively; and Meyerhof quotients[4] for O_2 tensions above 0.25 per cent. are from 1.5 to 2.0 for rice and 0.2 to 0.5 for wheat. Both the I/N ratios and the Meyerhof quotients indicate that a marked Pasteur effect (or O_2 inhibition of fermentative processes) occurs in rice, whereas this effect is relatively weak in wheat. Under the conditions of these experiments the anaerobic mechanism of rice in the complete absence of oxygen is approximately three times as active as that of wheat. With increase in O_2 tension, the values of the F/R ratio (ratio of fermentation to respiration where O_2 is present, 0.25 per cent. or higher) range from 7.3 to 0 for wheat and from 50 to 0 for rice.

We may conclude that in the absence of O_2 rice is capable of germination because it possesses a strong mechanism for fermentation, whereas wheat, with its feebly functioning anaerobic system, is unable to germinate. Even in rice, growth soon ceases in the complete absence of oxygen. With a very low O_2 supply rice is able to accomplish more nearly normal growth than wheat in spite of the fact that rice is less capable than wheat of using the low concentration of O_2 in respiration. The superiority of rice over wheat in ability to grow in a low O_2 concentration is dependent upon the possession by rice of a very strongly developed fermentation (anaerobic) system that more than compensates for a respiration (aerobic) system that is even weaker than that of wheat. It is expected that a more detailed analysis of these data will be published elsewhere.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS TO DELIVER A MEASURED AMOUNT OF CO_2 FOR BLOOD CULTURES

THE importance of blood cultures in the diagnosis of Brucellosis in man necessitates a simple apparatus for providing a CO_2 atmosphere for these cultures. The apparatus described here (Fig. 1) can be made from materials usually stocked in any hospital laboratory.

The CO_2 is drawn from a tank with a reducing valve and conducted through a rubber tube to a three-way valve, and from this to either a hypodermic syringe or a Luer observation tube connected to a 20-gauge, 3-inch hypodermic needle. This needle has been bent and fused to a 20-gauge, 1½-inch needle, which in turn is fastened to another Luer observation tube opening to the outside. The three-way valve may be adjusted so that the barrel of the hypodermic syringe is connected with the tube leading to the longer hypodermic needle.

The three-way valve is first adjusted so that a stream

[3] D. Burk, Cold Spring Harbor Symposia on Quantitative Biology, 7: 420, 1939.

[4] K. C. Dixon, *Proc. Cambridge Phil. Soc.*, 12: 431, 1937.