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.

of CO_2 will flush out any air present in the rubber tubing and the 3-inch hypodermic needle. The needles are then inserted through the rubber vaccine stopper into the 250 cc medicine bottle containing 100 cc of medium, and 10 cc of the patient's blood. The valve is then turned so that the CO_2 will flow into the syringe, pushing up the plunger until the required amount is indicated on the barrel. The valve is once more adjusted so that the CO_2 will flow from the barrel of the syringe into the medicine bottle, displacing

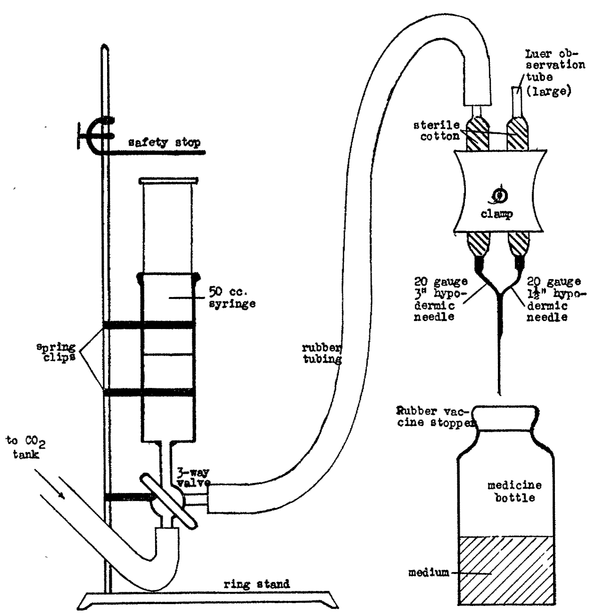

FIG. 1.

air which is forced from the bottle through the shorter hypodermic needle.

The weight of the plunger is sufficient to force the CO_2 out of the syringe if the plunger slides smoothly. Only a smoothly sliding syringe should be used if the volume is to be accurately measured. A safety clamp above the plunger will prevent it from shooting out when the CO_2 pressure becomes greater than the required ½ pound gauge pressure.

The three-way valve may be fused to the syringe or it may be fused to a collar which slips on the syringe. The latter is preferable since syringes of different sizes may then be used. The apparatus can then function in other ways. For example, without the needles, it may be used for conducting a measured amount of O_2 into an anaerobic jar during the preparation of staphylococcus enterotoxin. It may also be used to supply CO_2 to anaerobic jars for the culture of the gonococcus on solid media.

The needles may be sterilized as a unit together with the clamped Luer tubes.

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TRAPPING SNAILS OF THE GENUS CAMPELOMA

AN efficient method of collecting the snail *Campeloma* sp. in streams was found during a study of the life history of the trematode worm *Cercariaeum constantiae* Mueller. Since *Campeloma* habitually burrows, the collection of these snails in quantity by screening consumes much time and is hard work. While collecting these snails in the Huron River near Ann Arbor, Michigan, I noted that they were frequently found in considerable numbers around dead and decaying organic matter. To determine the time required to accumulate a quantity of snails, a dead fish weighing a pound was placed in the mud where earlier collections had been made. Ten days later, an area of approximately one foot square and six inches deep around the fish yielded 78 *Campeloma*, a number far exceeding those taken in similar, but unbaited, situations.

Dr. G. R. La Rue suggested the use of dung in place of dead fish, as he believed that these snails might be coprophagous and become infected by eating trematode eggs voided in feces. Accordingly, small cloth packets of feces were planted in the muck and found to be equally as effective as the dead fish, and more conveniently handled. Dung of dog, cat, ferret, muskrat and chicken was tried. After a few preliminary experiments, chicken dung was used exclusively. It was dried before use, which eliminated objectionable odors and permitted it to be packaged in quantity and stored to be used as needed. Dried dung was as effective as fresh.

To make a snail trap, a quantity of dried chicken dung is placed in the center of a cloth nine inches square, the corners twisted together and tied with heavy cotton twine, leaving free enough to tie to a stake. Double thickness of washed cheesecloth is ideal; heavier cloth resists rotting for a longer time but also retards the passage of the fecal extract. The twine should be capable of resisting rotting in water, since these packets remain effective until their contents are gone. The packets are tied to stakes and placed in suitable habitats for *Campeloma*.

Choice of location is important. In streams these snails frequent shallow, mucky situations and plantings should be made here; gravel areas in deep water should be avoided. When properly planted, the packet should be half-buried in mud with the stake projecting above the water level far enough to be easily recognized. In areas frequented by many people, the plantings should be inconspicuous to prevent possible interference. This can easily be accomplished by using dark-colored cloth and stakes made of tree branches; in summer, willow is especially suitable because the leaves remain green and willow looks natural along the banks of streams.