Recent investigations on the absorption of K and Br by actively metabolizing excised root systems of barley like those used by Hoagland and Broyer[1] showed that Ca and other cations appreciably increased the rate of absorption of K and Br as shown by analysis of sap expressed from previously frozen roots. Data from a typical experiment of 10 hours duration are shown in Table I.

TABLE I

Solution	Absorption in milliequivalents per liter of sap	
	K	Br
.005N KBr	24.7	15.9
.005N KBr + .001N $CaSO_4$	28.6	23.5
.005N KBr + .005N $CaSO_4$	30.9	24.8
.005N KBr + .025N $CaSO_4$	37.2	30.1

Potassium absorption from KNO_3 and K_2SO_4 solutions was also increased by Ca.

In several experiments it has been found that Ca may increase K absorption by 80 and Br by 100 per cent. without affecting the rate of CO_2 production.

Barley roots responded to Ca during simultaneous K and Br absorption regardless of their initial Ca content. Roots grown in the preliminary period in nutrient solutions saturated with $CaSO_4$ responded fundamentally the same as roots grown at lower Ca levels when subjected to study over a subsequent experimental period. Pretreatment of roots for 4 hours in saturated $CaSO_4$ solution produced no change in the rate of K and Br influx from dilute KBr solutions as compared with control roots kept in distilled water during the pretreatment period.

Roots maintained at several controlled temperatures from 10° C to 30° C all responded to the presence of Ca in the solution by increased rates of K and Br absorption.

Calcium was always more effective than Mg and Mg more effective than Sr of like concentration in increasing the absorption of K and Br. Ba produced effects which depended upon the concentrations used, dilute solutions producing increases in K and Br absorption and more concentrated solutions producing decreases. Mixtures of Ca and Mg sulfates produced increases in salt absorption of the same general magnitude as did these salts used singly. This indicates that Ca and Mg are not performing independent functions but are performing some common function, Ca being more efficient than Mg.

These results suggest the possibility that Ca and kindred cations can increase the permeability of the plasma membrane to K and Br during concurrent salt accumulation.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

USE OF COMPLETE FERTILIZERS IN CULTIVATION OF MICROORGANISMS

SOMETIMES experimental work requires the use of very large quantities of a culture containing microorganisms. For example, in the studies conducted by the authors on the physiology of feeding of oysters as much as 90 gallons of a rich culture of plankton were needed every day for a period of several weeks. Obviously it was impractical and virtually impossible to grow such large quantities of microorganisms by employing standard laboratory technic and using a culture medium such as Miquel's. Therefore, a different method was sought. A large number of commercial fertilizing mixtures were tried, and several of them gave excellent results.

The use of various fertilizing substances in fish ponds and small lakes has long been practiced in Europe. Recently a number of American workers, notably Wiebe[1] and Swingle and Smith,[2] contributed to our knowledge on the use of fertilizers in increasing the fish production of small bodies of fresh water. As a rule, after the addition of fertilizers, a significant increase in phytoplankton occurred. This in turn was followed by a prolific growth of zooplankton.

The fertilizing mixtures used in our studies are known as complete fertilizers. They are usually designated by a formula such as 5–3–5; 6–3–6; 10–6–4, etc., which indicates percentages of compounds of nitrogen, phosphorus and potash. Many of these fertilizers contain large quantities of organic components such as cottonseed meal, castor pomace, soya-bean meal and steamed bone meal. There are also traces of copper, zinc, manganese, boron, iron and some of the other elements. Of the numerous mixtures tried the fertilizers 5–3–5 and 6–3–6 gave the best results. Both these fertilizers are used by tobacco growers. The relative value of each fertilizer was determined in a series of controlled laboratory experiments of growing cultures of *Chlorella* and *Nitzschia* in media prepared from each fertilizer.

For laboratory work a medium containing 1 gram of fertilizer in 1,000 cc of filtered sea water always gave excellent results. In growing *Nitzschia* and

[1] D. R. Hoagland and T. C. Broyer, *Plant Phys.*, 11: 471–507, 1936.

[1] A. H. Wiebe, *Bull. Texas Game Fish and Oyster Comm.*, 8: 1, 1935.

[2] H. S. Swingle and E. V. Smith, *Trans. American Fish Soc.*, 68: 126, 1939.

Chlorella this concentration very often gave better results than when Miquel's solution was employed. Concentrations 1:5,000 and even 1:10,000 were also found satisfactory. In preparing a medium a comparatively large quantity of fertilizer should be ground, and from it the needed quantity taken and placed in the water. This will insure relative uniformity of the samples. When very large quantities of fertilizer are used, as is often the case in field experiments, no grinding is necessary. Using these fertilizers, exceedingly rich cultures of *Chlorella, Nitzschia closterium* and *Prorocentrum triangulatum* were grown in large outdoor tanks having the capacity of several thousand gallons. In addition to the forms mentioned above many other microorganisms were successfully grown in our media under laboratory conditions and in the outdoor tanks. Chlorophyll-bearing and colorless flagellates grew exceptionally well, while Ciliates such as *Colpidium, Glaucoma* and *Paramecium* produced good cultures.

There are several advantages of using complete commercial fertilizers for maintaining stock cultures in the laboratory and for growing mass cultures of microorganisms under field conditions. In the first place, the method is very simple, consisting of only one step of adding one gram or less of the fertilizer to a liter of sea or fresh water. Secondly, some of the substances composing the fertilizers enter into solution almost immediately, thus providing nutritive materials for newly started cultures. Its other components, however, require different periods of time before they are converted into the substances which can be utilized by the cultured organisms. Because of such a delayed but continuous supply of nutritive materials the cultures remain viable and active for many months, thus eliminating the necessity of frequent transfers for the maintenance of stock cultures. Cheapness of the material used in the method is another important advantage. One pound of fertilizer costing from 3 to 5 cents is sufficient for making almost 500 liters of culture medium.

It is thought that the suggestions offered in this brief article are especially pertinent at this time. Because of the war condition it is becoming more difficult to buy the chemicals usually needed in the preparation of solutions for the cultivation of microorganisms. Some of the ingredients may not be available at all. Therefore, the use of commercial fertilizers, which at present are easily obtainable, may solve the difficulties of many investigators.

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AN INEXPENSIVE, QUANTITATIVE PUMP

THE apparatus shown in Fig. 1 was devised to meet the need for a convenient and relatively accurate means of adding specified quantities of reagents in routine analyses. Though not recommended for precise measurements, it will deliver quantities as small as 1 ml with an error of 1 per cent. or less if care is taken to exclude bubbles from the system, and the valves are properly adjusted.

The side hole in the 6 mm tube may be blown in the usual way, but care must be taken to shrink its margins flush with the rest of the wall. It should be 1 to 2 mm in diameter. The 6 mm tube is telescoped into

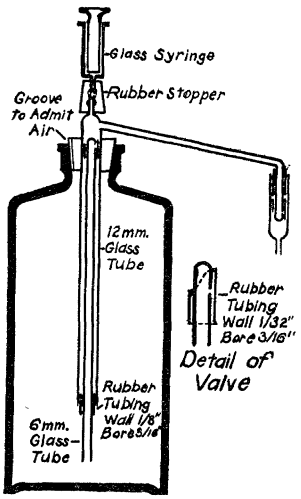

FIG. 1.

the 12 mm tube to allow the device to be used in bottles of various depths. If the 12 mm sheath is made 7 inches long and the 6 mm stem 8 inches, the apparatus can be adjusted to fit ordinary bottles varying from a quart to a gallon in size.

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