Reisolations by picking cells from one of the pure cultures were made. Twenty cells were isolated and ten of them grew and oxidized the nitrites. If the percentage of cells which grow is the same in the isolations from crude cultures as from pure cultures it would indicate that only 30 per cent. of the cells in the enrichments were nitrite-oxidizers. The results are very satisfactory since it required only a few days to secure these cultures.

From this brief discussion it is seen that it is possible to secure pure cultures directly from enrichments by isolating single organisms; and when all the factors are considered, this method is more satisfactory for the nitrifiers than the plate method which does not usually yield pure cultures and which requires a great deal of time for carrying out.

Details of the method used and descriptions of the organisms isolated will soon be published.

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THE BORON CONTENT OF ORANGES

IN connection with a study of the relation between the boron content of irrigation water and a certain type of injury to citrus and walnut trees in southern California, it has been observed that these plants take up substantial quantities of boron which is deposited in the leaves. This fact has made it possible to diagnose cases of boron injury. Boron occurs as a natural constituent of practically all irrigation waters in southern California. In most of these waters the content of elemental boron ranges from .15 to .3 parts per million, while in those supplies that have caused trouble the boron content may range up to 2.5 parts per million. Orange trees irrigated with low-boron water have in their mature leaves from 50 to 150 parts per million of boron, based on the dry weight of the leaves. Those irrigated with high-boron water may show from 600 to 1,000 parts per million of boron to the dry weight of the leaves.

A very few analyses of fruits and of twigs or chlorophyll-bearing branches, chiefly of lemons, have indicated that most of the boron taken up by these trees is deposited in the leaves, but it has seemed worth while to ascertain whether or not there are appreciable differences in the boron content of the fruits produced by trees having pronounced differences in the boron content of their leaves. For this purpose a number of analyses have been made of fruits of navel orange trees grown under different conditions with respect to the boron content of the irrigation water and known to have very different proportions of boron in the leaves. In view of the fact that the skin of the orange is green when the fruit is young, it seemed desirable to make separate analyses of the skin and the pulp.

The fruits to be analyzed were picked from the trees in the early part of March, 1929, when they were fully mature. At the same time samples of mature leaves were picked from the same trees. The boron content of the irrigation water used in each grove had been determined previously by analyzing a series of samples taken at different times. In preparing the fruits for analysis the skins were removed and the pulp was dried in the presence of sodium and calcium hydroxides to prevent the loss of any boron by volatilization. The peel was dried without treatment. When the fruit material was thoroughly dry it was ground to a fine meal and the boron content was determined by the Chapin method, as modified and developed by Wilcox in the Limoneira Laboratory. The leaves were analyzed by the same method.

The essential results of these analyses are given in the accompanying table. Samples 1 and 2 were

THE BORON CONTENT OF IRRIGATION WATER AND OF THE LEAVES AND FRUIT OF NAVEL ORANGES IRRIGATED WITH THE WATER

	No. 1	No. 2	No. 3	No. 4
Irrigation water, boron, parts per million	.20	.35	1.25	2.45
Leaves, boron, parts per million	35	90	515	854
Ave. fresh wt. per fruit, grams:				
Pulp	133.2	95.6	119.3	141.7
Peel	61.9	44.0	69.6	61.3
Ave. dry wt. per fruit, grams:				
Pulp	17.0	13.6	13.6	15.3
Peel	14.8	12.0	15.0	12.5
Boron content, parts per million:				
Dry pulp	10	11	22	38
Dry peel	21	22	40	44
Boron content per fruit, mgs:				
Pulp	0.17	0.15	0.30	0.58
Peel	0.31	0.26	0.60	0.55
Whole fruit	0.48	0.41	0.90	1.13
As boric acid, per fruit, mgs:				
Pulp	0.97	0.86	1.71	3.31
Peel	1.77	1.48	3.43	3.14
Whole fruit	2.74	2.34	5.14	6.45

obtained from the vicinity of Riverside, California, where the boron content of the irrigation water is low. Samples 3 and 4 were obtained in the Santa Clara Valley where some of the irrigation waters have a high boron content. The boron content of the irrigation water is given in the table in parts per million, while for the leaves and fruits the boron is reported in parts per million of the dry weight of the material, and also it is expressed in terms of milligrams of boron in each fruit and as the equivalent of boric acid (H_3BO_3) in the individual fruit and in the peel and pulp of the individual fruit.

These results show that there is a direct relation between the boron content of the irrigation water and that of the leaves, and that the same relationship holds with respect to the fruit, both for the peel and pulp.

The proportion of boron to dry weight is much lower in the fruit than in the leaves and the differences are much less. But it seems clear that not all the boron taken up by the orange tree from the soil solution is deposited in the leaves.

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The band spectrum of ozone in the visible and photographic infra-red: OLIVER R. WULF (introduced by C. G. Abbot). Photographs of the spectrum of ozone have been taken over the range 10,000 Å to 4,000 Å, using a 33-meter absorption path and ozone-oxygen mixtures of low ozone concentration at one atmosphere pressure. The visible bands exhibit regularities but are diffuse and show no tendency to form heads. In the infra-red a new series of weak bands has been found.

Significance of recent cosmic ray experiments: R. A. MILLIKAN and I. S. BOWEN. The experiments reviewed are (1) those of Millikan on the influence of nuclear mass on the absorption coefficients of cosmic rays; (2) those of Millikan, Bowen and Chao on the absorption coefficient of monochromatic Th C″ rays; (3) those of Regener and of Millikan and Cameron on the absorption coefficient of cosmic rays at great depths in water; (4) those of Millikan and Cameron on the absorption coefficients of cosmic rays at great altitudes, and (5) those of Bothe and Kolhörster on the absorption coefficients of the beta rays accompanying cosmic rays. There have been but three possible ways suggested for accounting for the foregoing results. The enormous energies demanded by them are obtained (1) from cosmic electrical fields, (2) from the annihilation of matter, (3) from the building up of the heavy elements out of the light. The requirements of each of these theories are discussed and experiments suggested to decide between them.

Prediction of trans-Neptunian planets from the perturbations of Uranus: E. W. BROWN. The prediction of the place of a trans-Neptunian planet by Percival Lowell is shown to be due mainly to a mathematical relation which depends on the number of years during which the planet Uranus has been observed. This fact is brought out by a new analysis of the work of Lowell published in 1915. It is shown that this relation has the effect of giving a prediction of the place of an unknown planet whether the planet has any real existence or not. If the same methods had been used with the additional observations of Uranus which have been made since Lowell completed his work, the predicted place in the sky would have been changed by some twenty-five or thirty degrees. In calculating the disturbance of the motion of one planet by another, the astronomer has to use a measuring rod, the shape, size and position of which can be changed to fit the observations. The reason for this is that he does not know the exact shape, size or position of the orbit of the disturbed planet until he has obtained them from the observations. If the planet has been observed for a long time, the discovery of a new body which alters its motion will affect the measuring rod very little. But if the period of observation covers less than two revolutions of the planet round the sun, it may alter it considerably. Uranus had been continuously observed up to the time Lowell completed his work for about 130 years. In this interval it made only one and a half revolutions round the sun. Consequently, the measuring rod could be so adjusted that the apparent effect of an exterior planet during that time is very small, although the planet may be quite large. A small planet will produce little effect in any case. Thus small deviations of Uranus during that time may mean the existence of an exterior planet or no such planet at all. If we assume that a large planet exists it is shown, without any further use of the observations, that it will be predicted as nearest to or furthest away from Uranus in the middle of the interval, that is, about 1848. The same assumption gives a prediction that the planet will be nearest to or farthest away from the sun near the same date. These are almost exactly the dates found by Lowell and they give the chief factors in the predicted place. The result would be the same, however small the mass. Hence, it gives no indication as to whether the planet exists. The rest of Lowell's prediction depends on a few unreliable observations which were found in astronomical records made before it was known that Uranus was a planet and not a star. We already know that the planet is too small to satisfy these early observations, whether they are good or bad. It follows that the discovery of a new planet near the predicted position must be regarded as accidental, or perhaps as the first of others to be found beyond the orbit of Neptune. Although it seems impossible to give Lowell the credit of having predicted a new planet, his work undoubtedly stimulated a search for one. The value of a scientific hypothesis is not to be judged by its truth but by the impulse which it gives to the search for truth.

Note on the preceding paper: D. BROUWER (introduced by Ernest W. Brown).