there has not been any appreciable change and that the method is accurate. Therefore it seems justifiable to conclude that sections run near shore along clear ranges can be used confidently to show changes of depth.

Changes in Scripps and Newport Canyons: Using the range method, soundings have been made in the case of Newport Canyon off Newport, Calif., in 1934, 1935 and 1937 (Section 1) and in Scripps Canyon near La Jolla in 1935 and 1937 (Section 2). Both of these canyons have heads coming into the shallow water

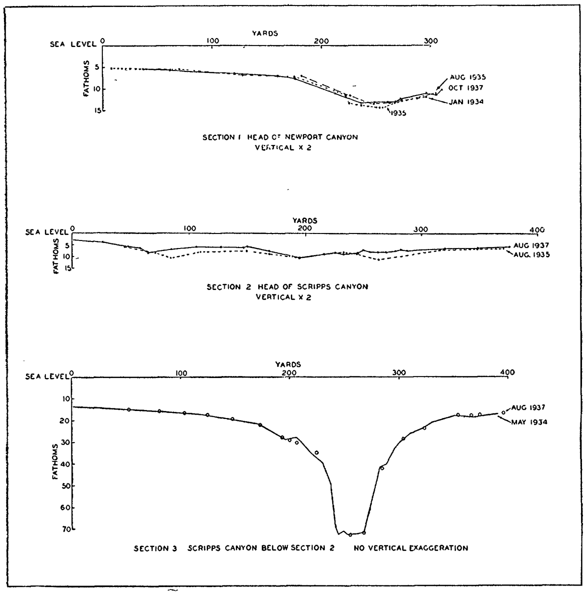

FIG. 1. Sections showing relation of old soundings along ranges to recent soundings at the heads of Newport and Scripps Canyons. Note that there has been deepening followed by fill in the case of Newport Canyon. Also note that the deeper section of Scripps Canyon shows no appreciable change except on the left hand side near the break in slope. In Section 3 the new soundings are shown by circles. Note that the first two sections have vertical exaggeration, while the third is true scale.

near the coast. Altogether five sections were compared, three at Newport and two in Scripps Canyon. All these comparisons showed changes. Between 1935 and 1937 the changes were principally those of decreasing depth, indicating that there had been fill in both of the canyons. This is in contrast with the deepening which is indicated in the comparison between 1934 and 1935 at Newport. Previous soundings in Scripps Canyon which, unfortunately, were not based on the same ranges suggest that here also there had been deepening.

Shifting depths at Redondo Pier: The pier at the city of Redondo extends out into the head of a submarine canyon. Here considerable changes of depth are reported. Fill takes place gradually over a year or more and then deepening succeeds as a rapid process consuming not over several hours. The last observed deepening, which occurred in May of this year, changed depths of six feet to thirty-one feet. These changes took place during calm weather with only moderate-sized rollers. A previous deepening, however, had occurred during a sudden wind storm.

Significance of these depth changes: Several tentative conclusions seem to be warranted from the observations made to date. First, it is evident that the canyon heads do receive sediment from time to time, but that they remain unfilled because this sediment is subsequently removed. Secondly, the cause of the removal, judging from the Redondo Pier case, must be of the nature of a submarine slip or mud flow. Thirdly, the channels at the head of the submarine canyons appear to be subject to some moderate shifting in position.

It is still difficult to say how far down the canyon the depth shifts are transmitted. The available data in Scripps Canyon, part of which is shown in Section 3, do not indicate that it is very extensive. On the other hand, the shifting at the head may be more frequent and rapid, whereas there may be shifting of sediment at depth at long intervals. A case of such shifting is indicated in the Sagami Bay submarine canyon by the comparison of the soundings before and after the great earthquake.[2]

It is hoped that repeated checking of a number of sections in the future will make it possible to tell to what extent the deepenings are the result of unusually large waves and to what extent they are due simply to the flowing of muddy sediments down the canyon floor when the sediments have been deposited to such an extent as to exceed the angle of rest.

FRANCIS P. SHEPARD
SCRIPPS INSTITUTION OF OCEANOGRAPHY

TEMPERATURE AND STARCH-SUGAR CHANGE IN SWEET POTATOES

THE effect of temperature on the starch-sugar change in Irish potatoes is well known.[1] In sweet potatoes it has not been so completely studied, although it is known that sugar accumulates at the expense of starch at low temperatures and that this begins to take place at a higher temperature than in Irish potatoes. The work of Hasselbring and Hawkins[2] shows that sugar increases in sweet potatoes at 6° to 7° C. to a greater extent than at 12° to 30° C.

The present authors have completed a careful study of the physiological and chemical changes in sweet potatoes of the Triumph variety at controlled tempera-

[2] F. P. Shepard, *Jour. Geol.*, 41: 527–536, 1933.

[1] H. Müller-Thurgau, *Landw. Jahrb.*, 11: 751, 1882; C. O. Appleman, *Md. Agric. Exp. Sta. Bull.*, 167: 327, 1912; E. F. Hopkins, *Bot. Gaz.*, 78: 311, 1924.

[2] *Jour. Agr. Res.*, 5: 509, 1915.

tures. The results, which have considerable practical application, will be published in detail elsewhere, but it will perhaps be of interest to present briefly some of the findings at this time.

Both cured and uncured roots were studied at 50°, 55°, 60°, 65° and 70° F. in constant temperature rooms. Besides other determinations, frequent analyses were made for reducing sugars, total sugars and starch. The percentages of reducing sugars are low and remarkably constant in all cases throughout the storage period; practically all the values fall between 0.2 and 0.4 per cent.

Changes in the amounts of sucrose may therefore be taken as a measure of the rate of starch degradation at the different temperatures. The percentage of sucrose in the freshly harvested roots is about 2.5 per cent. In contrast to the reducing sugars, a marked and regular change in the amount of sucrose takes place, depending on the temperature and time. During the curing period (85° F.) sucrose increases in a very regular fashion to 3.3 per cent. Then, when thus cured, potatoes are placed at the various constant temperatures, sucrose continues to increase at 50° and 55° F. and to decrease at 60°, 65° and 70° F. In the uncured lots, sucrose begins to increase from the beginning of the storage period at 50° and 55° F., while at 60°, 65° and 70° F. there are at first increases, reaching maxima at about 20 days, 12 days and 10 days, respectively, followed by decreases.

The change in sugar content with time is very uniform and remarkably constant for this type of experiment. This is brought out by plotting log-log values for the uncured samples at 50° F., and for cured samples at 50° F. during and after the curing period. In all three cases straight lines are obtained from which the equations of these curves may be found. For example, for uncured roots at 50° F. we have the equation

$$\log y = 0.28 \log x + 0.355$$

where y is the percentage of sucrose and x the time in days, or

$$y = x^{0.28} \cdot 10^{0.355}$$

In Fig. 1 the straight line represents the logarithmic values and the curved line, which is constructed from the equation, percentages of sucrose plotted against time. The plotted points are actual experimental data. Similar equations represent the other two cases. At the other temperatures uniform results were obtained, but since the curves passed through maxima, no attempt was made to analyze the data in this manner. It is interesting to note that there is some sugar accumulation at all temperatures studied. At the higher temperatures, however, it quickly reaches a maximum and then declines. As the temperature decreases, the maximum is higher, not so sharp and

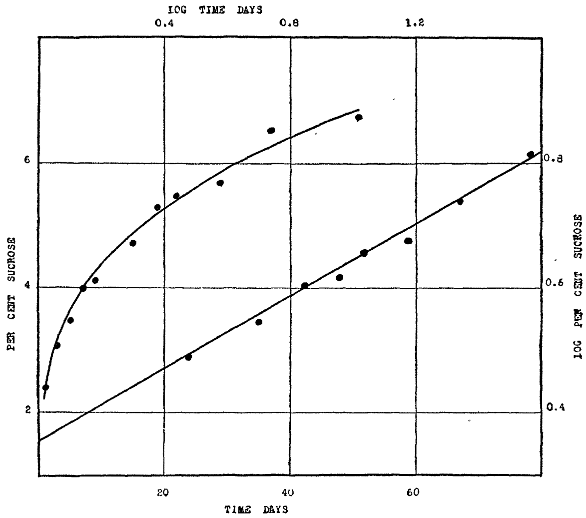

Fig. 1

occurs after a longer period of storage. This is true even at 55° F. At 50° F. there is practically no maximum reached in a 50-day period, although our data show a slight falling off between 50 and 70 days.

Another important point about the data is that they show wide differences in sugar accumulation between 55° F. and 60° F., thus separating two temperature ranges, one of high and one of low starch conversion. This divergence is shown by both cured and uncured lots and indicates that there is a critical range between 55° and 60° F. Such a critical temperature range exists in the Irish potato,[3] only in this instance the range is lower, 35° to 40° F. The fact that there are wide differences in the critical temperatures for starch conversion for different plants is well illustrated by the starch-sugar change in the banana. Here, as is well known, starch conversion takes place rapidly at high temperatures (70° to 80° F.) during ripening. At 50° F. there is practically no starch hydrolysis, although the fruit may finally soften.[4] This is just the reverse of what takes place in the sweet potato with a critical range probably between 60° and 65° F. From this one might suggest physiological similarities of the sweet potato to the banana on the one hand and to the Irish potato on the other. The sweet potato accumulates sugar to a greater extent than the Irish potato, and at a higher temperature, but much less and at a much lower temperature than the banana. Our results show that it will also accumulate some sugar at high temperatures (85° F.), like the banana. Hence, with respect to starch conversion the sweet potato would appear to occupy an intermediate position between these other species.

This investigation has been conducted by the Carbohydrate Research Division, U. S. Bureau of Chem-

[3] E. F. Hopkins, *Bot. Gaz.*, 78: 311, 1924.

[4] E. F. Hopkins, Unpublished Report, United Fruit Company, Boston, Mass.

istry and Soils, and financed by a grant of funds from The Chemical Foundation, Inc., of New York.

E. F. HOPKINS
J. K. PHILLIPS
THE CHEMICAL FOUNDATION
LAUREL, MISS.

THE URINARY EXCRETION OF INGESTED RADIOACTIVE SULFUR

THESE experiments are the beginning of a study of sulfur metabolism in which radioactive sulfur is used as a "tracer." Radioactive sulfur is particularly well adapted for this purpose because its "half-life" of several weeks is long enough for relatively extended biological and chemical experiments. Before proceeding to the study of organic sulfur compounds it was necessary to know the course taken by inorganic sulfates.

In our first experiments we followed the rate of appearance in the urine of radioactive sulfur after its ingestion in the form of sodium sulfate. The subject, a man, on an approximately constant diet ingested, in the form of sodium sulfate, 202 mg of sulfur containing radioactive sulfur. The urine was collected in the following periods: For the purposes of a control, twenty-four hours before the experimental day; the first experimental day was divided into two periods, one of 9 hours of which the last 4 were after the last of the sodium sulfate had been ingested, and a second 15-hour period. The urine was collected for two days after this first experimental day.

The urine of the control day showed no detectable radioactivity; 15 per cent. of the radioactive material appeared in the urine in the first 9-hour period of the first experimental day, 32 per cent. in the second 15-hour period. There was no detectable amount of radioactivity in the urine of the two days following.

The excess urinary sulfur on the experimental day over the average of the other three days was approximately 80 per cent. of that ingested. Yet only 47 per cent. of the radioactive material was excreted.

More experiments will be necessary in order to arrive at other than tentative conclusions; but these results suggest that when added sulfate enters the tissues, there is an exchange with the sulfate in the tissues, and its excretion is correspondingly retarded.

The radioactive sulfur was prepared by the bombardment of elementary sulfur with fast deuterons from the cyclotron of the Radiation Laboratory at the University of California. This material was oxidized to sulfuric acid and then converted to sodium sulfate. All the urinary sulfur was converted to barium sulfate, and the radioactivity was measured in this form with a Lauritsen quartz fiber electroscope.

HENRY BORSOOK
GEOFFREY KEIGHLEY
DON M. YOST
CALIFORNIA INSTITUTE OF TECHNOLOGY
EDWIN MCMILLAN
UNIVERSITY OF CALIFORNIA
BERKELEY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A FLEXIBLE GAS THERMOREGULATOR

GAS heat frequently possesses advantages for constant temperature devices. A simple but positive regulator for accurate thermal control employs the expansive properties of air to operate a mercury valve controlling the flow of gas from the main to the burner.

The chamber for air expansion consists of a cylindrical or spherical flask to the neck of which is sealed an 8 mm tube, which is bent to form a complete loop. A side tube, sealed on beyond the loop, serves as the gas inlet and the open end of main tube carries a smaller sliding tube which functions as a valve seat and gas outlet. By filling each limb of the loop a little less than half full with mercury and floating a short piece of stirring rod with a tapered end on the mercury in the gas limb of the loop, a mercury valve is formed with glass to glass contact at the valve seat. Blowing a small hole in the small glass outlet tube for a bypass and mounting the outlet tube in a stopper through which it can slide completes the device. The assembly is shown in Fig. 1.

The regulator operates by heating to 10–15° C. higher than the operating temperature. The expanding air pushes all the mercury into the gas limb and then escapes past it. By cooling to the operating temperature the mercury is equalized in the two limbs. Sliding the outlet tube through its stopper down to the glass float sets the temperature adjustment. Subsequent temperature changes will open or close the valve and cause a compensating heating effect. The bypass keeps the burner lighted when the valve shuts off the main flow of gas. In normal use the valve remains partly open and greatest sensitivity is secured by allowing the bypass to carry the major volume of the gas. As the valve is then operating at a small fraction of its full capacity, a greater volume of gas can be passed to offset cooling.

The temperature maintained varies slightly with changes in atmospheric pressure but is independent of changes in room temperature. The glass to glass contact in the valve avoids the usual mercury-glass contact with its resultant splashing of mercury causing