left in this solvent for a week or so at Dry Ice temperature. The ethyl chloride extracts the acetone. After this extraction has been completed, the muscle preparation is simply taken out of the solvent and is allowed to warm up to room temperature, whereupon the ethyl chloride evaporates. In order to avoid condensation of water, it is advisable to let the preparation warm up in a desiccator or in a small tube closed by a loosely fitting cork, or to allow the ethyl chloride to evaporate in the Deep-Freeze.

The preparation thus obtained is white but has the shape and appearance of the original muscle and is feather-light. On immersion into water, the muscle contracts violently to one-third to one-fifth of its original length. If the water does not penetrate uniformly, the muscle bends towards the more hydrated side, and may double up and break. Contraction can be demonstrated best by cutting up the preparation with a razor blade into thin strips and immersing these in water. The preparation can be kept for several weeks in the desiccator without loss of its contractility. When it is kept in an open vessel, it loses contractility in a few days.

One of us (A. S.-G.) introduced previously the method of glycerination (*1*). The glycerol-extracted muscle demands adenosine triphosphate and ions for its contraction, these having been washed out. The above "wet freeze-dried" muscle contains these constituents and so demands only the replacement of the extracted water (*2*).

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References and Notes

1. A. Szent-Györgyi, *Biol. Bull.* 96, 140 (1949).
2. This research has been sponsored by the National Heart Institute (grant H-2042 R), the National Science Foundation, the American Heart Association, the Muscular Dystrophy Associations, and Association for the Aid of Crippled Children, and the United Cerebral Palsy Foundation.

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Detection of Manganese-54 in Radioactive Fallout

During the 1956 nuclear test series at the Eniwetok Proving Grounds, fallout samples were collected and returned to this laboratory, where they were routinely submitted to gamma spectral analysis. A sample analyzed approximately 300 days after detonation revealed the presence of a gamma emitter with an energy of 0.84 Mev (*1*). Subsequent to this observation other fallout samples collected from the same operation also exhibited gamma

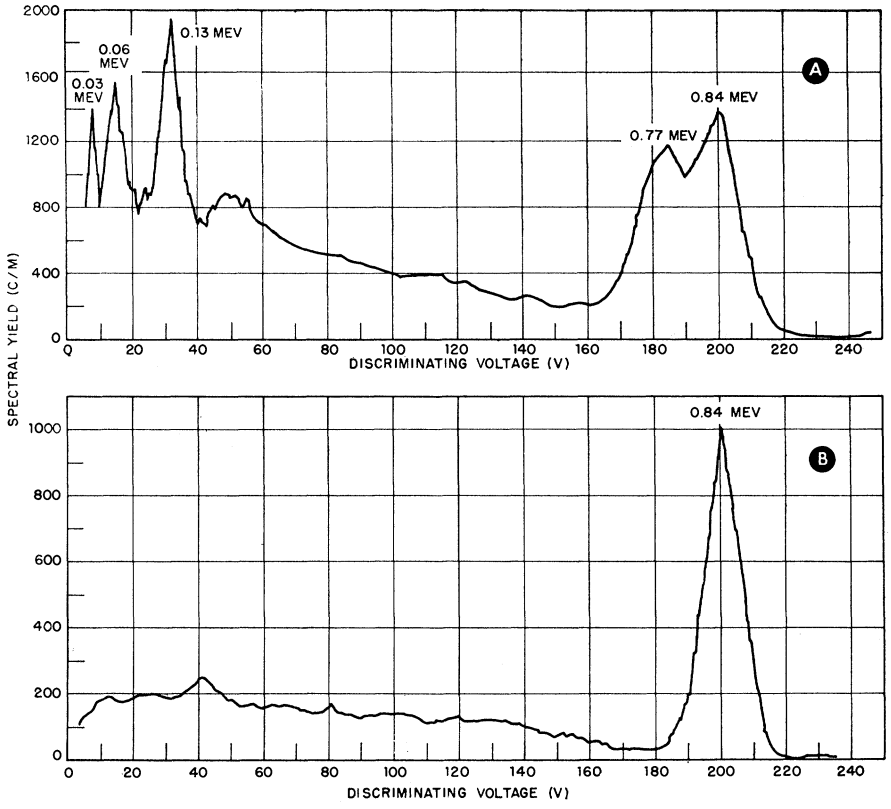

Fig. 1. *A*, Gamma spectrum of the gross activity in the fallout sample. *B*, Gamma spectrum of the activity in the isolated sample.

spectral peaks at this energy (*2*). Since gamma photons with energy of 0.84 Mev are not known to exist in fission products of this age, further study was undertaken to identify the gamma-emitter.

Since Mn^{54} has a relatively long half-life (291 days) (*3*) and a single gamma energy of 0.84 Mev (*4*), an analytical scheme was adapted for its isolation. The chemical method consisted of the following steps. Manganese carrier, together with cerium and zirconium hold-back carriers, was added to the dissolved fallout sample, and the whole was oxidized with sodium chlorate. The insoluble manganese dioxide was reduced and solubilized with sodium bisulfite and hydrochloric acid. The solution was scavenged with the aid of basic ferrous acetate (*5*) to remove interfering nuclides. Manganese was precipitated as the ammonium phosphate and ignited to the pyrophosphate for evaluation of chemical recovery. The resulting precipitate was gamma-counted with a sodium iodide-thallium activated crystal detector and resubmitted to gamma spectral analysis.

Figure 1 shows the gamma spectrum of the activity in the gross sample as well as the gamma spectrum of the activity in the sample isolated by chemical separation. The reliability of the analytical procedure was evident, and the presence of Mn^{54} was confirmed. Its radiations persisted and were more sharply defined after chemical separation, by which the energy peaks characteristic of fission products were completely eliminated. Furthermore, the gamma spectrum of the isolated sample activity was exactly superimposed on the spectrum of an authentic sample of Mn^{54}. Aluminum and beryllium absorption curves were taken to establish the identity of the isotope unequivocally. The absorption characteristics were the same as those of the Mn^{54} standard.

Manganese-54 gamma activity (in counts per minute), corrected for chemical recovery, was compared with the gross gamma activity (in counts per minute) of the fallout sample. This radionuclide represented about 40 percent of the total gamma activity. Moreover, calculations indicate that megacurie quantities of this nuclide were produced at the time of detonation.

Stable manganese and iron are possible precursors of Mn^{54} in the presence of high-energy neutrons. The probable nuclear reactions are

$$Mn^{55}\ (n, 2n)\ Mn^{54}$$

and

$$Fe^{54}\ (n, p)\ Mn^{54}$$

The appearance of readily detectable quantities of Mn^{54} again emphasizes the importance of considering induced radioactivities in fallout (*6*). Because of the biological importance of manganese as a trace element, we contemplate an in-

vestigation of the possible incorporation of Mn^{54} into living systems that are subjected to fallout from thermonuclear explosions.

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References and Notes

1. Appreciation is expressed to M. Eichen of our laboratory for assistance in the operation of the gamma spectral analyzer.
2. D. Macdonald, personal communication.
3. E. W. Backofen and R. H. Herber, *Phys. Rev.* 97, 743 (1955).
4. G. R. Bishop *et al.*, *Phil. Mag.* 45, 1197 (1954).
5. G. E. F. Lundell and J. I. Hoffman, *Outlines of Methods of Chemical Analyses* (Wiley, New York, 1948).
6. H. V. Weiss and W. H. Shipman, *Science* 125, 695 (1957).

26 July 1957

Gibberellin-Stimulated Cambial Activity in Stems of Apricot Spur Shoots

Sachs and Lang (*1*) found that gibberellin increased the number of cell divisions in the subapical region of the shoot of *Hyoscyamus niger*. To our knowledge this is the only report to date of gibberellin stimulating cell division. In this paper, evidence is presented that gibberellin can increase the cell division rate in the cambial zone under certain circumstances. It may be significant that the cambial zone, like the subapical region of a shoot, is normally conditioned for mitotic activity.

In investigations by one of us (J.C.C.) of various macroscopic effects of gibberellin on the growth of the vegetative and reproductive structures of the apricot (*2*), considerable growth in diameter of stems of spur shoots and of branches 1 year old or older was noted. This growth caused longitudinal splitting of the bark. By contrast, stems of the long shoots formed in the current season showed no apparent growth in diameter. Scaffold branches of trees of *Prunus armeniaca* cv. Royal had been sprayed on April 10 with a 1000 mg/lit solution of a gibberellin (*3*) containing 0.05 percent Tween 20. For studies of the microscopic aspects of the gibberellin-induced increase in stem diameter, segments of stems of three typical spurs from control and from treated branches were fixed 5 weeks after treatment in formalin-acetic acid-alcohol. Sections were cut at 40 μ on a freezing microtome and were stained with safranin and fast green. Transverse sections were taken at a distance of 3/16 to ¼ in. below the terminal bud, and longitudinal ones from segments below that region.

From casual inspection of the sections it was obvious that xylem development had been greatly stimulated by the treatment (Fig. 1), whereas phloem development appeared to be unaffected. In transections of treated and control spurs, ocular micrometer measurements were made of radial diameters of the secondary xylem, arbitrarily distinguished as the predominantly small-celled xylem outside the series of large vessels which are presumably of primary origin. Because of tangential stretching and radial compression of phloem in treated spurs, the radial thickness of that tissue was not measured. The numbers of cells per radial row were counted in both vertical and horizontal systems of the secondary xylem and also in those systems of all the phloem between the primary phloem fibers and the cambium; the position of the cambium was determined on an arbitrary basis. Since the vascular tissue cylinders are wider in the vicinity of leaf traces, all counts and measurements were made on the side of the stem opposite that in which the three traces to the nearest leaf appeared. For each treated or control spur, one radial measurement and one count of cells in the vertical systems of xylem and phloem were made in each of ten nonserial sections. In the case of numbers of xylem and phloem ray cells in radial sequence, two counts were made in each of ten sections. Ray cell constitution may be a better indication of previous mitotic activity of the cambium, since intrusive growth commonly found in xylem of the vertical system (*4*) would exaggerate the actual numbers of cells counted in transections, and since ray cell initials in the apricot apparently do not undergo as many divisions, if they undergo any, as the initials of the vertical systems, as evidenced by the greater radial diameters of the ray cells. The mean values for the measurement and cell count data are given in Table 1. Deviations from means of cell counts were inevitably high (the greatest was 31 percent) where the means were less than 10, but dropped to less than 10 percent where the means were greatest.

Table 1. Xylem and phloem development in stems of spur shoots from apricot branches sprayed with gibberellin and from control branches.

Shoot	Radial diam. (μ)	Secondary xylem: Mean No. of cells along radial diam.		Phloem: Mean No. of cells along radial diam.	
		Vertical system	Horizontal system	Vertical system	Horizontal system
		Controls			
A	144	16.4	9.9	20.1	6.4
B	133	13.2	10.6	19.2	6.0
C	164	18.9	12.8	18.1	7.3
		Treated shoots			
A	605	60.1	37.8	19.4	7.8
B	999	91.3	55.7	20.3	8.1
C	863	80.2	52.2	18.4	7.9

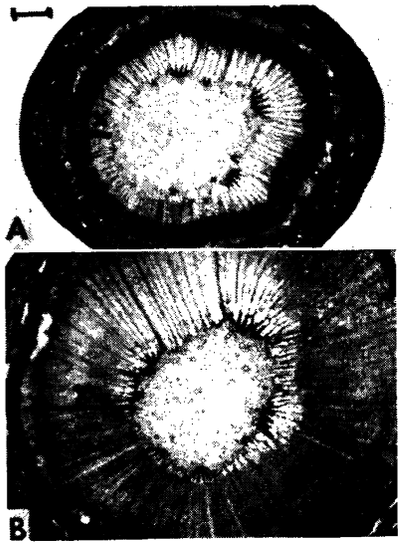

Fig. 1. Transections of stems of spur shoots of apricot showing xylem development in a spur from a control branch (*A*) and in one from a branch sprayed with gibberellin (*B*). *X*, xylem. The scale line at the upper left represents 120 μ.

Larger numbers of cell counts per sample might have changed the means by a point or two but would scarcely have shifted them to different orders of magnitude.

The great discrepancy between treated and control spurs in the radial diameters and numbers of cells along the radius of their xylem cylinders shows indirectly that gibberellin stimulated considerable division in cells of the cambial zone. Particularly significant is the increase in numbers of cells along the xylem rays. This rules out the possibility that increase in diameter of the secondary xylem resulted largely or exclusively from greater elongation and intrusive growth of cells of the vertical system. Indeed, the similarity of ratios of mean numbers of cells of the vertical system to corresponding means for the rays (1.7, 1.2, and 1.5 for the three controls; 1.6, 1.6, and 1.5 for the three treated spurs) suggests that there may have been no essential difference in intrusive growth between treated and control samples. The data from cell counts in the phloem show that gibberellin had little or no effect on stimulating addition of new cells to that tissue. It would be tempting to consider that gibberellin might have influenced differentiation indirectly by affecting the polarity of cambial divisions. However, the emphasis on initiation of xylem rather than phloem elements could be merely an exaggeration of the particular phase of the natural growth pattern affecting all spurs at the time of gibberellin treatment (*5*). Perhaps treatment at a different date would stimulate phloem development commensurate with xylem development.