culture of the University of California. They represented stock ordinarily yielding the most uniform seedbed.

The seeds had been dried previous to shipment. Before treatment, they were soaked in distilled water for fifteen minutes, then left in a completely moisture-saturated atmosphere for twelve hours. They were then dried on filter paper and exposed at once. They were treated on March 8, and planted on March 16 in seed flats, a mixture of one third sharp sand, and two thirds peat moss being used, the seeds being covered with pure sharp sand. The first sprout was seen on April 14.

Two plants showed flower buds in the last week of May. They matured rather slowly, and were not ready to open until the sixth of June, when, though diminutive, they proved to be quite normal in form. The plants still carried the first pair of leaves intact, as is usual with citrus seedlings of this age. One plant was normal in leaf and flower coloration, and the leaves were nearly normal in form, though somewhat elongate and diminutive. The other seedling, however, was extremely deficient in chlorophyl—an effect not uncommonly observed in citrus seedlings—and the flower was imperfectly pigmented, being of a yellowish white color similar to the leaves. The stamens, however, were golden. The green plant received a two-minute exposure, the white, an eight-minute treatment under the same conditions. Both showed buds at the age of a little over a month. The root system of both plants was very deficient.

The apparatus used in the work was a water-cooled tungsten-target Coolidge tube, operated at 30 milliamperes current and 200 kilovolts. The seeds were exposed at 50 centimeters focal distance. The seedlings were propagated in the electrically heated greenhouse of the Research Laboratory.

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NECROBIOTIC RAYS

THE protective action of ultra-violet rays on the protoplasm of human red blood corpuscles and plant cells described in the author's recently published papers[1] could be explained by a synthetic action of ultra-violet rays on the products of a decomposition produced by poisons and hypotony in protoplasm. Thus, according to the well-known equivalence law of photochemical reactions one could expect ultra-violet rays to be produced in the decomposition of the principal compounds of protoplasm in the process of death.

Indeed, the production of ultra-violet rays was observed by the author in all investigated cases of cell death. It seems, however, that some of these rays have a smaller wave-length than any ultra-violet rays known at present. It would therefore seem expedient to call all the rays produced by dying cells necrobiotic rays in general.

These rays were observed by means of silver bromide, which is decomposed by them. In first experiments suspensions of unicellular organisms or pieces of multicellular organisms which have a large surface (yeast cells, Elodea leaves, flower petals, etc.) in water were mixed with potassium bromide and silver nitrate in an absolutely dark room, killed by ether, and exposed to diffuse sunlight. The suspensions in which the cells had been killed after the formation of silver bromide showed a quicker darkening than the suspension in which the cells had been killed before the formation of silver bromide.

In other experiments the cells were killed by heating, and after the addition of potassium bromide, silver nitrate and ether these suspensions always showed a slower darkening than living suspensions to which the same substances had been added. If, after the addition of the substances mentioned, the suspensions were filtered, the liquid obtained showed a pinkish color without being exposed to light if the cells were killed after the formation of silver bromide, but remained colorless if the cells were killed before this formation. The color was considerably increased after the addition of a developer.

That the rays which had decomposed the silver bromide in the above experiments have a rather short wave-length is seen from the fact that they do not affect ordinary photographic plates which had been protected from the liquid by quartz plates sealed with wax. The rays affected, however, a dilute suspension of silver bromide which had been introduced in quartz tubes closed with glass stoppers into a suspension of yeast, which was then killed by different poisons.

It is evident that ultra-violet rays can be emitted also in very energetic physiological processes which are accompanied by the decomposition of the principal compounds of living matter. It is therefore not surprising that living cells and tissues may emit them in such a very small amount that they may not be detected by silver bromide, but in an amount sufficient to produce an acceleration of certain processes in the cell, as, for instance, cell division. This is the reason why we may venture to say that the so-called mitogenetic rays are really necrobiotic rays.

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[1] W. W. Lepeschkin, SCIENCE, 73, 568, 1931; *Protoplasma*, 14, 11, 1931; *Amer. Jour. of Botany*, July issue, 1932.