from 10^{11} to 10^{12} LD_{50} per milliliter. When the crystals were sedimented by centrifugation at 1000 rev/min for 5 min, the supernatant fluids were found to contain from 0.1 (early in crystallization) to 0.01 (after maximum crystallization) of the infectivity of the supernatant plus the crystals. The crystal pellet accounted for considerably less than 0.1 of the total volume of the suspension. Thus, the calculated titer on a solid milliliter basis approximated 10^{13}.

Since a volume of 1 cm^3 can be calculated to contain about 4.6×10^{16} particles of 28-mμ diameter, and since the animal titration showed approximately 10^{13} infectious doses per cubic centimeter, it appeared that the ratio of the total number of particles to the number of infectious particles was apparently greater than 1000 to 1. That a similar discrepancy existed for the starting material is shown by the following.

On the basis of infectivity, the starting material contained 10^{12} particles per liter. Since more than half of the infectivity was lost in purification, at most, 10 μg of infective particles per liter should have been obtained. However, more than 100 times this quantity of homogeneous particles was crystallized. Apparently, in both the starting and crystalline materials, similar major discrepancies existed between the number of particles and the infectious doses. These discrepancies may be attributed to the inefficiency of the intraperitoneal titration system, the number of particles necessary to establish cellular infection, the degree of aggregation of virus particles, and the ratio of inactive to active virus particles.

When they were dried in air, crystals of either form disintegrated into an amorphous, hygroscopic residue. Therefore, no completely satisfactory electron micrographs showing crystals have been obtained from replicas. Figure 3 shows a pseudoreplica of crystal residue that has been dried on agar. This and other micrographs closely resemble those obtained by Breese and Briefs (*5*), which probably represented early crystal formation of the same virus. Almost complete aggregation of the virus has been seen throughout these preparations, with orderly alignment of particles 28 mμ in average arrayed diameter. Very little extraneous material has been seen in pseudoreplicas of these recrystallized preparations. The angles formed by hexagonal arrays of particles studied by electron microscopy were found to be the same as those of the hexagonal faces of the dodecahedrons.

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References and Notes

1. Clearing consisted of centrifugation at about 4000 rev/min for 20 to 60 min in an International refrigerated centrifuge (head No. 812).
2. Ultracentrifugation was performed in a Model L Spinco, applying a maximum force of 144,000 g for 60 min. Percentages indicate number of grams in 100 ml of solution. All procedures were carried out at 0° to 4°C. Partially purified preparations were stored at – 37°C for varying periods and were usually cleared after they had been thawed.
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9 March 1956

New Synthesis of Oxalic Acid

Results indicate that oxalic acid is formed when bicarbonates in aqueous solutions are exposed to beta or gamma radiation. Although the procedure appears less complicated than Wöhler's synthesis of this acid from cyanogen, which was the first "organic" synthesis from "inorganic" materials (*1*), the mechanism of the reaction is complex, since it involves the presence of water and possibly also oxygen to effect the carbon to carbon bondage of the carbon dioxide moiety.

Solutions of ammonium, calcium, and sodium bicarbonates and sodium and ammonium carbonates were prepared in various concentrations and irradiated in polyethylene bags. In order to allow complete penetration of the ionizing radiation, a large enough bag was used so that the thickness of the filled bag (approximately 250 ml) was nowhere greater than 6 mm. The samples were exposed to beta radiation by means of a 2 Mev van de Graaff electron accelerator. The dose rate was 2.10 Mrep per pass, and the total dosages to which the samples were exposed ranged from 2.10 to 52.5 Mrep.

The chemicals used were of standard analytic grade. Calcium bicarbonate was prepared by passing carbon dioxide through a water suspension of calcium carbonate. The samples, which were irradiated at room temperature, were withdrawn from the polyethylene bags, and the oxalic acid, which was precipitated as calcium oxalate, was regenerated and derivatized. Table 1 gives the characterization of oxalic acid for all series investigated.

These results were repeated when glass vials were used as containers. Owing to the porosity of the polyethylene bags, gas analyses were not attempted.

Oxalic acid was not detected on irradiation of sodium carbonate solutions. Blank tests, carried out with distilled water, were also negative. Formic acid was likewise not observed to form in these reactions. The formation of oxalic acid from ammonium carbonate is explained by the fact that ammonium carbonate is a mixture of ammonium bicarbonate, ammonium carbamate, and ammonia (*2*).

Percentage yields of oxalic acid were calculated as 100 times the number of grams of oxalic acid formed per gram of solute. G values (number of molecules

Table 1. Identification of oxalic acid.

Test	Theoretical	Found
Neutralization equivalent $CHO \cdot 2HO$	63	62.5 ± 1.0
Oxalic acid dihydrate, mp °C	100* (*1*)	100 ± 0.2
Oxalic acid, mp °C	189.5* (*3*)	190 ± 0.2
Benzylthiuronium oxalate, mp °C	193* (*4*)	193 ± 0.2
Aniline blue formation (*5*)	+	+
Infrared spectrum of calcium oxalate†		

* Mixed melting points with authentic materials showed no depression. (All melting points were carried out on Kohfler hot stage.)

† Spectrum agreed with standard calcium oxalate curve.

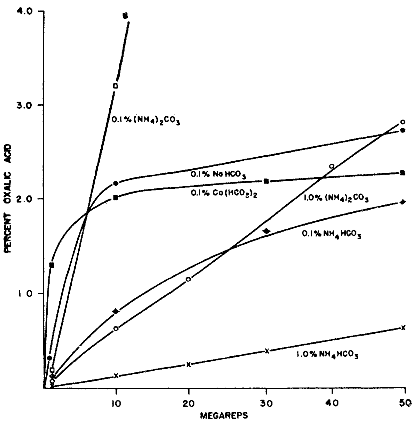

Fig. 1. Oxalic acid yield versus irradiation dose.

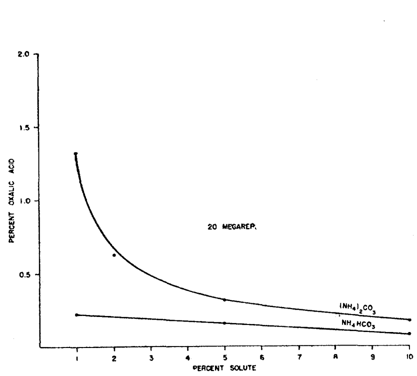

Fig. 2. Oxalic acid yield versus concentration of solution.

formed per 100 ev where 52.4×10^{18} ev is equivalent to 1 Mrep) may be obtained by simple calculations from values in Figs. 1 and 2.

It was qualitatively determined that gamma irradiation at similar dosages also results in the formation of oxalates from the afore-mentioned bicarbonates and ammonium carbonate.

The yields of oxalic acid, obtained by permanganate oxidation, for varying concentration and dosage levels are presented in Figs. 1 and 2, respectively.

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5 December 1955

Paradamite, a New Zinc Arsenate from Mexico

A suite of minerals from the Ojuela Mine, Mapimi, Durango, Mexico, was received recently for examination. The principal minerals identified were legrandite, $Zn_{14}(OH)(AsO_4)_9 \cdot 12\ H_2O$; plattnerite, PbO_2; murdochite, $Cu_6\,PbO_8$, and a new species having the composition $Zn_2(AsO_4)(OH)$, which has been named paradamite (*1*). The material was collected by George Griffith, and submitted for study by George Burnham. The type specimen is in the U.S. National Museum, catalog number 107443.

A chemical analysis of paradamite gave ZnO, 56.22; FeO, 0.45; Fe_2O_3, 0.12; As_2O_5, 40.17; H_2O (+), 3.44; H_2O (−), none; sum 100.40 percent (G. Switzer, analyst). The theoretical composition of $Zn_2(AsO_4)(OH)$ is ZnO, 56.77; As_2O_5, 40.09; H_2O, 3.14. Paradamite is triclinic and is a dimorph of adamite, which is orthorhombic. It is also the arsenic analog of tarbuttite, a triclinic form of $Zn_2(PO_4)(OH)$.

Paradamite occurs in sheaflike aggregates of triclinic crystals and in somewhat rounded and striated equant crystals up to 5 mm in size. It has a perfect {010} cleavage. It is transparent and pale yellow in color, with a white streak. The luster is vitreous and, on the cleavage, pearly. Optically it is biaxial (−) with $2V = 50°$, $\alpha = 1.726$, $\beta = 1.771$, $\gamma = 1.780$ (±0.002). The specific gravity is 4.55 ± 0.02. Paradamite was found with mimetite and adamite on a matrix of limonite but not on the same hand specimen as legrandite, plattnerite, or murdochite.

Properties of paradamite, tarbuttite, and adamite are compared in Tables 1 and 2 (*2*).

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Notes

1. Publication of this paper was authorized by the secretary of the Smithsonian Institution, Washington, D.C.
2. A detailed crystallographic description of the new mineral is in preparation.

17 November 1955

Table 2. X-ray powder diffraction data for paradamite, tarbuttite, and adamite (copper Kα radiation, $\lambda = 1.5418$A, camera radius = 114.59 mm).

Paradamite		Tarbuttite		Adamite	
d (A)	I	*d* (A)	I	*d* (A)	I
6.33	10	6.19	10	5.99	8
5.44	6	5.44	5	5.47	1
4.77	2	4.60	5	4.96	10
3.99	3	3.88	1	4.29	8
3.71	10	3.71	8	3.79	6
3.34	5	3.28	6	3.31	1
3.16	6	3.09	4	3.06	3
3.08	7	2.99	7	3.00	10
2.99	9	2.88	8	2.71	9
2.84	9	2.78	9	2.64	6
2.76	1			2.59	5
2.73	1	2.71	2		
2.57	6	2.54	5	2.54	5
2.53	1				
2.49	8	2.48	6	2.47	10
2.45	3	2.42	7	2.43	8
2.39	3	2.36	6	2.36	7
2.32	1	2.29	1	2.09	2
2.18	2	2.22	2	2.01	2
2.13	1	2.10	3	1.97	4
2.11	7	2.06	7	1.92	3
2.08	5	2.02	3	1.89	3
1.99	1	1.95	3	1.86	2
1.95	1			1.82	1
1.91	2			1.78	1
1.88	1			1.75	2
1.84	1	1.85	4	1.72	4
1.82	2	1.82	2	1.67	5
1.79	4	1.80	2	1.64	3
1.76	2	1.74	4	1.62	7
1.72	4	1.71	4	1.60	3
1.67	3	1.60	3	1.58	5
1.58	4	1.58	1	1.52	5
1.55	2	1.54	2	1.49	5
1.54	4				
1.51	3				
1.48	4	1.48	1		

Table 1. Physical properties of paradamite, tarbuttite, and adamite.

Property	Paradamite (Mapimi Mexico)	Tarbuttite (Broken Hill, N. Rhodesia)	Adamite (Mapimi, Mexico)
Crystal system	Triclinic	Triclinic	Orthorhombic
Optical	(−) $2V = 50°$ $\alpha = 1.726$ $\beta = 1.771$ $\gamma = 1.780$	(−) $2V = 50°$ $\alpha = 1.660$ $\beta = 1.705$ $\gamma = 1.713$	(+) $2V = 88°$ $\alpha = 1.722$ $\beta = 1.742$ $\gamma = 1.763$
Cleavage	{010} perfect	{010} perfect	{010} good, {010} poor
Specific gravity	4.55	4.12	4.43
Color	Pale yellow	Colorless to pale yellow	Colorless, pale yellow, light yellowish green, bluish green

Loss of Nutrients from Plant Foliage by Leaching as Indicated by Radioisotopes

That nutrients can be absorbed by the foliage of plants from sprays has been adequately demonstrated through the use of radioisotopes (*1*). The results obtained by many workers (*2–6*) indicate that nutrients may also be lost from leaves. However, the implication is that these losses in large part occur as the plant approaches maturity. By use of isotopically labeled nutrients, it is now possible to study the magnitude of these losses, the nature of the compounds lost, and the physiological factors that may affect the rate of loss (*7*).

Young, rapidly growing plants were allowed to absorb phosphate and potassium solutions labeled with P^{32} and K^{42} through the roots, or P^{32}-labeled phosphate through the bases of cut stems. The plant material was then leached under a mist of distilled water for 4 to 48 hours, and the runoff (leachate) was collected. The leachates were then passed through anion or cation exchange resin columns (*8*), and the collected ions were eluted with 5-percent NaOH or HCl. The eluates were evaporated to dryness, made to a standard volume, and the radioactivity of aliquots was ascertained. Bean (*Phaseolus vulgaris*), sweetpotato (*Ipomoea batatas*), or poinsettia (*Euphorbia pulcherrima*) plants lost no significant quantities of root-absorbed P^{32}. However, cuttings of bean and rose (*Rosa spp.*) lost 1.5 and 12.8 percent respectively, of the labeled phosphate that had previously been absorbed through the bases of cut stems during a 4-hour period. Ten-day-old bean plants that absorbed