difficult operation. It was to this problem that Mr. Roller turned his attention last winter.

Hansteen in 1898 had reported an attempt to sterilize Lemna by washing—testing for bacteria by the effect on egg albumen. We were quite unable to free the plants of bacteria by this method—whatever the effect on the albumen, some bacteria always grew on a nutrient agar. This would be expected, and we found in later experiments that plants which were bacteria free on the surface—no growth showing for five or six days on agar—when macerated, produced colonies abundantly.

In his sterilization experiments Mr. Roller tried ultra-violet light and a large number of antiseptics at various concentrations, and finally developed a technique which killed the micro-organisms both inside and outside the plant—no growth is developed on any medium yet tried for the bacteria whether the plant is macerated or not. We have grown the sterile Lemna through some twenty-five to fifty generations in the inorganic solution and they are reproducing normally and continue to look healthy. The first unexpected result was that the rate of reproduction of the sterile plants was greater than that of the non-sterile plants in the sterilized inorganic medium.

A second unexpected result was that the addition of sterile organic extracts of soil and manure (optimum concentrations) to the sterile inorganic medium with the sterile plants resulted in a decreased rate of reproduction compared with the sterile checks in the purely inorganic medium; the non-sterile plants, with the same sterile additions of organic matter, reproduced faster than the non-sterile plants in the sterilized inorganic solution—a confirmation of the work we have mentioned above, and as Ashby has also reported. Without bacteria the organic matter seems to depress the rate of reproduction, although we have not yet found whether this is due to a variation in the optimum concentration of the organic matter under the sterile conditions.

At the same time cultures were run in which the sterile plants had added to them, both in the sterilized inorganic solution and in the sterilized solution with organic extracts, an infusion of live bacteria from soil. The inorganic solution with the bacteria tended to decrease the rate of reproduction of the Lemna; where the organic matter was present the rate was greater than in the same solution without the bacteria, but it did not altogether overcome the original depression caused by the organic matter—the rate was distinctly lower than the checks for the sterile plants in the sterile inorganic medium.

In the sterile medium with sterile plants we have so far failed to get stimulation of the rate of reproduction of the Lemna by adding sterile organic extracts which certainly increase the rate when the plants are non-sterile. Details of this work with the effects on dry weight and ash will be reported later after some of the debatable points are examined further, but the present state of the problem is distinctly interesting.

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OCCURRENCE OF GERMANIUM AND ARSENIC IN METEORITES[1]

THE only record of a non-terrestrial occurrence of germanium is due to Rowland[2] who obtained spectroscopic evidence of this element in the reversing layer of the sun. Investigations carried on in this laboratory established the fact that germanium is of wide distribution in so far as the earth's crust is concerned.[3] On deciding to extend these investigations to meteorites, six specimens were selected representing siderites, siderolites and aerolites. The specimens were subjected to arc spectral excitation by a method described elsewhere,[4] and the spectrograms were examined in the range between λλ 3040 and 2530 angstroms. In all cases the germanium lines λλ 2651.6 and 2651.1 were definitely, though faintly, visible. These lines are extremely helpful in recognizing germanium: in addition to their being highly persistent they lie in a range where the dispersion of the prism spectrograph is considerable, thus minimizing difficulties due to overlapping of lines, especially when specimens of complex composition are examined.

On the basis of these observations it is to be concluded that traces of germanium are present in the following meteorites:

1. Siderite from Toluca, Mexico.
2. Siderite from Welland, Ontario. (Fell 6: 30 A. M., December 14, 1807.)
3. Siderolite from Admire, Lyon County, Kansas.
4. Siderolite from Llano del Inca, Atacama, Chile. (Found in 1888.)

[1] Presented at the forty-third meeting of the American Astronomical Society, Harvard College Observatory, January 1, 1930. The investigation upon which this announcement is based was supported by a grant to S. L. Boothroyd and Jacob Papish from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University.

[2] Rowland, *Amer. Jour. Sci.*, 41: 243, 1891.

[3] See Papish, *Econ. Geol.*, 23: 660, 1928; 24: 470, 1929. Additional work is ready for publication.

[4] See Papish, Brewer and Holt, *Jour. Amer. Chem. Soc.*, 49: 3028, 1927.

5. Aerolite from Estacado, Crosby County, Texas.
6. Aerolite from Allagan, Allagan County, Michigan. (Fell July 10, 1899.)

The two siderites, of which the writers possessed a comparatively large quantity, were subjected to chemical treatment for the purpose of extracting germanium from them. The procedure was as follows.

Twenty-six grams of the Toluca siderite and sixteen grams of the Welland siderite were introduced into separate Pyrex distilling flasks connected to water-cooled condensers and provided with glass receivers cooled with ice. An excess of hydrochloric acid was added to the meteorites through dropping funnels. The reaction, which was violent, was allowed to proceed to completion. The solutions in the flasks were kept boiling till each was reduced to about one half of its initial volume. In this manner the germanium in the soluble portion was afforded an opportunity to form the tetrachloride, which is a fuming liquid boiling at 86° C., and as such to condense in the cooled receiver together with a preponderating amount of hydrochloric acid. The distillates were next saturated with hydrogen sulphide and allowed to stand several days. The precipitated sulphides were collected on small filter papers; the papers and contents were placed in porcelain crucibles and treated with nitric acid. The excess of acid was driven off with the aid of heat, and the viscous residues were examined spectrographically for the presence of germanium. The results were gratifying. The residue obtained from the Toluca meteorite yielded a spectrum which contained the following germanium lines: λλ 3039.1, 2754.6, 2709.6, 2691.3, 2651.6, 2651.1, 2644.2, 2592.5 and 2533. The more persistent of these lines, namely, λλ 3039.1, 2651.6 and 2651.1, were also visible in the spectrum of the Welland meteorite, though their intensity was much lower. This decrease in number and intensity of the spectral lines is to be ascribed to the fact that the quantity of germanium extracted from the Welland meteorite was smaller than that extracted from the Toluca meteorite.

The controversial views expressed by Merrill[5] regarding the presence of arsenic in meteorites made it desirable to look for this element in the two siderites. When the siderites were dissolved in hydrochloric acid and the solutions distilled for the extraction of germanium, it was anticipated that arsenic, if present, would also distil over, as the trichloride. Accordingly, when the distillates were saturated with hydrogen sulphide and the resulting precipitates oxidized with nitric acid, the excess of acid, as already stated, was driven off till *viscous* residues were obtained. It was feared that if the residues were taken down to dryness, or ignited, the arsenic, if present, would be expelled. The spectrograms of these residues contained the arsenic line λ 2780.2. An additional spectrographic examination in the more refrangible range revealed the presence of the following lines also due to arsenic: λλ 2349.8 and 2288.1.

To obviate errors that might result from use of reagents and apparatus, "blank" tests were made as follows. A volume of hydrochloric acid equal to that used in connection with the siderites but somewhat more dilute was distilled in a manner similar to that already described. As a matter of fact, in one case the apparatus employed for this purpose was the same that was used in the work on the Toluca siderite. The distillate was saturated with hydrogen sulphide. As usual a slight opalescence, undoubtedly due to precipitated sulphur, made its appearance. Since there was not enough of this precipitate to be retained by a filter paper, a few milligrams of copper sulphate dissolved in a minute quantity of water were added. The copper sulphate was found on previous examinations to be free from germanium and arsenic, at least in quantities detectable spectroscopically. The precipitated copper sulphide is an ideal adsorbent for traces of other sulphides. The solid material thus obtained was removed by filtration, oxidized with nitric acid as before and examined spectrographically. No lines of germanium or arsenic were observed.

[5] Merrill, *Memoirs Nat. Acad. Sci.*, Vol. 14, 1st Memoir, p. 8, 1925.

SUMMARY

1. Spectroscopic evidence has been obtained of the occurrence of germanium in certain siderites, siderolites and aerolites.

2. Judging from the number and intensity of spectral lines the germanium in these meteorites is present in traces.

3. Germanium has been extracted from Toluca and Welland siderites.

4. Arsenic has been extracted from Toluca and Welland siderites.

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