would indeed be of great value in a great institution like the American Museum and would amply repay the labor of preparing such an exhibit, for the material for such a hall could easily be selected from the duplicate specimens without making any considerable drain on the exhibit halls proper, which should be devoted to the ethnographic exhibit. But to adopt this as the type and standard of installation for the entire department seems, when one considers the greatness of the collections and the size of the building of this institution, utterly incongruous. In view of the commanding position which this institution holds in America, its example is bound to have a very great influence on all of our public institutions, and one has the right to expect from it work of the highest scientific value, and to expect that through its exhibition halls it shall appeal primarily to the intelligent scientific world.

GEORGE A. DORSEY

THE FORMATION OF LAKE SUPERIOR COPPER

TO THE EDITOR OF SCIENCE: The report of the meeting of the Geological Society of Washington and of the paper from the Geophysical Laboratory of the Carnegie Institution on the artificial production of silver and copper in your number of March 8, 1907, leads me to think I should, in justice, publish extracts from a letter received by me from Dr. G. Fernekes, of the Houghton College of Mines, left undated, but received some weeks ago. In a paper on the theory of copper deposition (annual for 1903, p. 249, etc.) emphasis was laid on the probable importance of chloride solutions in copper formations. Then when I read of Stokes's work in *Economic Geology* (Vol. I., p. 644) I suggested to Dr. Fernekes that he extend it to what seemed to me probable conditions of copper formation. He has been engaged in experiments, including an extensive series of tests of mine waters and minerals, along this line, not yet finished, concerning which I will not pretend to report in full, but just quote one extract to show the kind of results he is getting. An apparatus like that of Stokes's was used. Of course the experiment is not precisely the same as the experiment made in the Geophysical Laboratory, and there is no direct question of priority involved, but they are closely parallel and entirely independent. It is up to me to say this as a 'mutual friend.'

ALFRED C. LANE

I have therefore again tried the action of $FeCl_2$ on $CuCl_2$. When these two salts react on each other in an almost neutral solution, free acid is given off according to the following reaction:

$$2FeCl_2 + CuCl_2 \rightleftarrows Cu + 2FeCl_3$$

$$FeCl_3 + 2H_2O \rightleftarrows Fe(OH)Cl + 2HCl$$

If we constantly neutralize this acid by some alkali such as $Ca(OH)_2$ we can change the above reversible reaction into one which will proceed but in one direction, namely, from left to right as above. On trying this I was pleased to see that every trace of copper was precipitated from the solution and of course calcium chloride was formed as a by-product. I immediately upon this tried calcium silicate as a neutralizing agent, and was delighted in seeing all the copper precipitated. Natural wollastonite was the calcium silicate employed. The by-product in this case was, of course, besides calcium chloride, silica (quartz). The whole thing is now cleared up. That is, three factors were active in bringing about the deposition: copper chloride (or copper silicate and HCl); calcium and sodium silicates, as neutralizing agents; and then minerals with ferrous iron in them.

* * * As to the aluminum: the same happened to it as to the iron. After all the copper was precipitated and the solution was neutral it was thrown out as an extremely basic salt. A trace of chlorine is detectable in most of the minerals around here. How beautifully we will check up with Pumpelly's observations.—The mineral now gone; and the greenstone, etc. * * *

* * * Will send you once more corrected sheet of analyses and further notes as to tests of Cu and Ni thereon.

Yours,

(Signed) G. FERNEKES

RADIUM IN BIOLOGICAL RESEARCH

A Radioactive Microscopic Slide.—In the course of experiments on the effects of the rays of radium on plants it became desirable to observe directly the reaction of the living protoplast to these rays. For this purpose the principle of Lieber's radium-coating was applied in the preparation of a radioactive microscopic slide. A solution of any desired concentration of radium bromide of known activity is made in a suitable solvent, and applied to the surface of the slide near the center. When the solvent evaporates a film of the salt is left on the slide. The film is protected by a coating of a specially prepared substance. Living cells may now be mounted as on an ordinary slide, and their response, if any, to the stimulus of the rays observed. The coating has the advantage, not only of being sufficiently transparent to light, but easily transparent to the β and γ rays, and in less degree to the α rays also.

Slides of various styles and modifications have been prepared on the above principle by Mr. Hugo Lieber, of H. Lieber & Co., New York City, and their efficacy is now being tested in the laboratories of the New York Botanical Garden. Thus far only plant cells have been studied in this way, but the device could doubtless be used in studying the cleavage of eggs, and other activities of animal cells.

To Discharge Electrified Paraffin Ribbons.—Every user of the microtome has experienced the annoyance arising from the electrification of the paraffin ribbons. The trouble may be easily avoided by any device that will conduct away the charge of electricity as rapidly as it accumulates. If the air were a perfect conductor, the trouble would not arise, but its conductivity is greatly increased through ionization. This ionization may be conveniently accomplished by supporting, near the place where the microtome-knife cuts the sections, a celluloid rod, covered on one end with Lieber's radium-coating. These rods have been used with great satisfaction by the writer to avoid the difficulty mentioned.

C. STUART GAGER
NEW YORK BOTANICAL GARDEN,
NEW YORK CITY

SPECIAL ARTICLES

ELEMENTARY SPECIES AND HYBRIDS OF BURSA[1]

THE rearing of over 20,000 pedigreed specimens of *Bursa Bursa-pastoris* (L.) Britton, has demonstrated the presence of at least four elementary species, all of which breed true when self-fertilized or crossed within the limits of the same elementary form. From over thirty hybrid families the fact is derived that these several elementary forms hybridize in strictly Mendelian fashion, each form which went into the cross coming out again in the perfectly pure extracted dominant or recessive form of the parents.

The existence of elementary forms in nature within the recognized limits of the species, differing from one another as do the elementary species of *Bursa*, in the possession of definite characters that behave as hereditary units, presents a condition that is not unique, but one which has an important bearing upon some of the questions that have been recently discussed. Several atypic plants have appeared in the cultures, which have bred true to their atypic characters, when the assumption that they were due to chance crosses would have required that they split into the atypic and typic forms in the ratio 3:1. These occurred in families of which the pollination was not guarded and their status as mutants is in consequence not considered sufficiently secure to be presented in detail at present as proofs of mutation. The fact that throughout these cultures the differentiating characters behaved as units in the Mendelian sense appears to me indubitable evidence that the several elementary species have arisen through mutation and hybridization.

On the basis of allelomorphic differences between different species these elementary species of *Bursa* represent the closest possible relationship between forms belonging to distinct types, since they are seen in most cases to differ from each other by a single distinguishing unit or by two units at most. The fact that *Bursa Bursa-pastoris* is everywhere recognized as a variable species, and the presence of several distinct forms in each of the localities from which material was derived for these studies, show that these elementary species generally grow in actual contact with each other. There is neither geographical isolation nor complete physiological isolation, yet these nearly related elementary forms

[1] Extract from paper read before the joint meeting of Section F and Section G, A. A. A. S., New York City, December —, 1906.