riods contain series of elements which all have 3 or 2 and 3 as their principal valences. The atoms of these elements are therefore incomplete. The electronegative atoms in such compounds, however, are always complete.

It is of interest to note that as long as atoms are incomplete there seems to be no tendency for them to have an even rather than an odd number of electrons. For example, the following ions all have odd numbers of electrons: $Cr^{+++}$, $Mn^{++}$, $Fe^{+++}$, $Co^{++}$, and $Cu^{++}$. This seems to indicate that the remarkable tendency, pointed out by Lewis, for most compounds to contain even numbers of electrons is due merely to the relative abundance of complete compounds as compared to incomplete ones. In other words, the even number of electrons in most compounds results from the tendency of Postulate 1 rather than from any more general tendency for electrons to form pairs.

Many of the compounds of this class, such as ZnO (zincite), $Fe_3O_4$, PbS, CuO, etc., show electric conductivity even as solids. This is undoubtedly caused by the relatively large number of electrons in incomplete sheaths. Of course we should not expect all compounds which contain such electrons to show conductivity, for the presence of the electronegative atoms might easily prevent the mobility of these electrons. We need to know much more than we now do about the arrangement of the atoms and their electrons in space before we can predict conductivity in particular cases of this kind.

3. EXCEPTIONAL CASES.—There are some substances or compounds whose structure is not adequately accounted for by the foregoing analysis. A few examples are: $N_2$, CO, $CN^-$, NO. The writer believes these have the single octet structure which he described in his earlier publications. It is probable that acetylene, $C_2H_2$, and the carbide ion $C_2^{--}$ (in $CaC_2$, etc.) have the same kind of structure. Pease has suggested that they may all have a triple bond structure.[6] This question merits careful study.

Another set of compounds that must have a special structure are various compounds of boron such as $B_2H_6$.

Most compounds containing molecules of $H_2O$, $NH_3$, etc., are readily accounted for by Postulate 3 but many of these should be considered by methods somewhat different from those developed here.

In double molecules such as $H_4O_2$ (in ice), $H_2F_2$, and in compounds such as $KHF_2$, etc., it seems that the hydrogen nuclei instead of forming duplets with electrons in the same atom, form duplets in which the two electrons are in different atoms. The hydrogen nucleus itself thus acts as a bond in such a case. Latimer and Rodebush[7] have made a somewhat similar suggestion in regard to hydrogen nuclei acting as bonds. They consider, however, that the hydrogen nucleus acts on two pairs of electrons: one pair in each of the two atoms. It seems to the writer much more probable that the hydrogen nucleus is no more able to attract four electrons than is the nucleus of other atoms. Since the first layer of electrons in all atoms contains only 2 electrons it seems probable that the hydrogen in this case also holds only two electrons and that these form the definite stable group which we have termed the duplet.

The writer plans to consider the quantitative aspects of these valence theories in subsequent papers. It is aimed to put Postulates 1 and 3 into a form that will permit at least rough calculations of the relative stabilities of various substances as measured, for example, by their heats of formation.

IRVING LANGMUIR
RESEARCH LABORATORY,
GENERAL ELECTRIC COMPANY,
SCHENECTADY, N. Y.,
June 29, 1921

[6] *Jour. Amer. Chem. Soc.*, 43, 991 (1921).

[7] *Jour. Amer. Chem. Soc.*, 42, 1431 (1920).

---

## PROFESSOR H. BRUCHMANN

THE men who gave such distinction to botany in Germany during the latter half of the nineteenth century, have mostly gone, the years since 1914 taking heavy toll of those who were left when war broke out. Among the last of the veterans was Professor Bruchmann whose death occurred on Christmas day, 1920.

A copy of the *Gothaisches Tageblatt* recently received by the writer contains an interesting sketch of his life, and shows the high esteem in which he was held by his fellow-townsmen in Gotha, where the greater part of his life was spent.

While Bruchmann is, perhaps, not so well known in America as some of his contemporaries, his work was of a very high order, and eminently worthy of recognition, and is quite indispensable to students of the Pteridophytes, which were his chosen field of study.

Helmut Bruchmann was born in Pollow, a small town of Pomerania, November 13, 1847. After his preliminary schooling he studied at Jena, where he became associated with Strasburger, who quickly recognized his abilities, and would gladly have kept him, as assistant in Jena, but financial reasons made it necessary to seek more remunerative employment.

In 1877 he accepted a position as teacher in the high school of Gotha, where he spent the remainder of his life. Later he received the title of professor.

Bruchmann's name will always be associated with his truly remarkable studies on the life history of the European species of *Lycopodium.* These familiar plants had hitherto baffled all efforts to trace their life history, and Bruchmann spent nearly twenty years at work before he published his monograph in 1898. This is a masterpiece of careful work, and its great value was quickly recognized. The patience required to complete this work will be appreciated when it is realized that in some species six to seven years elapsed before the first germination stages were evident and twelve to fifteen years before the prothallia were mature.

This monograph was followed by further investigations in *Lycopodium,* and also very important papers on the gametophyte and embryo of *Botrychium lunaria* and *Ophioglossum vulgatum,* the first connected account of the development of these ferns. These, with several notable papers on *Selaginella* comprise his most important contributions.

DOUGLAS H. CAMPBELL
STANFORD UNIVERSITY, CALIFORNIA

## SCIENTIFIC EVENTS

### FIELD WORK OF THE SMITHSONIAN INSTITUTION

THE Smithsonian Institution has issued its annual exploration report describing its scientific field work throughout the world in 1920. Twenty-three separate expeditions were in the field carrying on researches in geology, paleontology, zoology, botany, astro-physics, anthropology, archeology, and ethnology, and the regions visited included the Canadian Rockies, fourteen states of the United States, Haiti, Jamaica, four countries of South America, Africa from the Cape to Cairo, China, Japan, Korea, Manchuria, Mongolia, Australia, and the Hawaiian Islands.

In an outline of the year's work, the Institution says that

Secretary Walcott continued his geological work in the Cambrian rocks of the Canadian Rockies in the region northeast of Banff, Alberta. The work was hindered considerably in July and August by forest fires, and by continuous stormy weather in September, but the particular questions involved in the season's research were settled satisfactorily and some beautiful photographs of this wild and rugged region obtained. Other geological field work was successfully carried on in various states of the United States by members of the staff.

In astrophysical research the institution was unusually active. Through the generosity of Mr. John A. Roebling of New Jersey, the Smithsonian solar observing station located on the plain near Calama, Chile, was moved to a nearby mountain peak, where the observations will be unaffected by the dust and smoke, and a new station was established on the Harqua Hala Mountain, Arizona, probably the most cloudless region in the United States. From daily observations of the radiation of the sun at these two widely separated stations, it is hoped to establish definitely the value of the "solar constant" observations in forecasting weather. Dr. C. G. Abbot, director of the work, also describes the successful operation on Mt. Wilson, California, of a solar cooker devised by him. With this apparatus it was possible, using only the sun's heat, to cook bread, meat, vegetables, and preserves.

Mr. H. C. Raven represented the Smithsonian on an extensive collecting expedition through Africa from south to north. Although many difficulties were encountered, among others a railway wreck in which two members of the expedition