

DR. MAX ALBERT BREDIG (1902-1977: A NOTE OF REMEMBRANCE)

CARLOS E. BAMBERGER
Oak Ridge National Laboratory
Oak Ridge, TN. 37830

On November 21st, 1977 the scientific community suffered the loss of a remarkable and beloved member, Dr. Max Albert Bredig. As all who have been privileged to know him agree Max was a magnificent human being and a first rate scientist whose experiments and theoretical interpretations were elegantly conceived and subtly crafted. I had the pleasure to know him and work with him for several years. Upon reflection I have come to resent one of his qualities, modesty, because it makes my task of writing about him more difficult. Fortunately, he has left indelible memories among many people and I am able to make use of them. Additionally, on the occasion of his 75th birthday on June 20th, 1977, he was interviewed by Ellison Taylor, a colleague and close friend for ORNL Review and by Linda Pearlstein, staff writer from the Oak Ridger. During these interviews Max related many aspects and anecdotes of his rich life; I now draw heavily from these accounts.

Max was born in Heidelberg, Germany, and raised in Karlsruhe where his father Georg Bredig was a well known professor and scholar who taught physical chemistry at the University of Karlsruhe. Max recalled that "the fact that I was my father's son had both handicaps and advantages. He was one of my teachers in physical chemistry at Karlsruhe University, but because of this, he would not allow me to hold an assistantship there because of the potential accusation of favoritism." Among the people who Max most admired and credited, together with his father, with shaping his future as a scientist was Kasimir Fajans who, according to Max, was Georg Bredig's greatest pupil, (Max in turn later became a post-doctoral fellow under K. Fajans at Michigan.)

Max obtained the equivalent of a master's degree from Karlsruhe Technological University in 1925, and a doctoral degree from the Kaiser Wilhelm Institute in Berlin in 1926. In Berlin he worked under Fritz Haber and H. Kallman at Haber's Institut für Physicalische Chemie, where he met Drs. Eugene Wigner, Leo Szilard and others without ever dreaming that they would meet again in a distant land many years later. In retrospect, those were the golden years of the physical sciences. Every Wednesday afternoon the Laue Physics Colloquium was held in Walther Nernst's Institute in Berlin and was attended by some of the world's best known scientists, Planck, Einstein, Laue, Nernst, Schroedinger, and many others.

Max's thesis was on the formation of gaseous ions in hydrogen by electron impact. This study involved the use of, among other instruments, a quadrant electrometer, which required a very quiet environment. Thus, it was assigned a room in the basement of the Director's, Dr. Haber, residence. This room was just above

Dr. Haber's wine cellar. On one occasion, when Max was away from his experiment for several hours, a water line broke and started to flood the wine cellar. Max returned just before the water level reached the labels of the wine bottles. After this near-catastrophe Dr. Haber introduced Max to Richard Lorenz as "the young man who puts water in my wine."

With his thesis completed in which he identified H_2^+ independently of Smyth and Hogness, Max went to work with Robert Pohl in James Frank's Institute at the Gottingen University in 1927. At Gottingen, Max started to work measuring the number of F-centers in crystals and it is there where he was initiated in crystallography, a specialty that became one of his areas of expertise and to which he always remained faithful.

He left Nazi Germany in 1937 with only his books, after being warned by colleagues that they did not know how long he would be able to keep his job as head of an x-ray diffraction laboratory for a Berlin firm which later became the parent company of American Cyanamid.

Max first went to Sweden to work with one of the sons of Nobel laureate Svante Arrhenius who was a friend of Georg Bredig. Max then went to England to a conference and subsequently to the United States. The years 1937-1938 were spent at the University of Michigan with K. Fajans who had emigrated earlier in 1936. From Michigan Max went to New York to work for the Vanadium Corporation of America where he was scientific assistant to the vice president in charge of development. During his stay in New York Max worked to get his 70 year old father out of Germany and his sister and brother-in-law out of the concentration camp at Gerse, France. With the help of good friends he succeeded in rescuing all; his father went first to Holland in 1939 for a few months and from there to America by means of a "pro forma" offer by Princeton University. While in New York, Max met Lydia to whom he was married in 1944; their son George is presently becoming a psychologist. Max recalled that in those days during the war he was classified as an enemy alien but was treated very well. The only restriction was that he could not travel by plane and had to report to the District Attorney whenever he traveled away from New York. It was probably in New York where Max met again W. H. Sullivan, then a radiochemist at the Clinton Laboratories (presently the Oak Ridge National Laboratory). Sullivan, who had been a doctoral student of Fajans at Michigan, introduced Max to Ellison Taylor, member and later, Director of the Chemistry Division of the Clinton Laboratories. Max came to Oak Ridge in 1946 and was hired by Eugene Wigner then Laboratory Director, formerly his senior in Berlin. On his coming to Oak Ridge, Max

brought and established x-ray diffraction as a useful technique; he worked in this area for about 3 years and then became head of the Solid State Section, Physics Division at the request of Alvin Weinberg, at this time Research Director of the ORNL. After a year and a half Max moved back to the Chemistry Division as Associate Director (from 1950 to 1967) and returned to work on x-ray diffraction. This did not last long as Max was asked to become the liaison between the several divisions performing research for the Molten Salt Reactor Experiment. This prompted him to work again with molten salts, a subject he had had an earlier experience while on a post doctoral assignment at Göttingen. Max, together with H. Bronstein and A. Dworkin, made a very thorough and complete, almost encyclopedic study of systems consisting of molten metallic halides and metals. He remained in this field for nearly 20 years, continuing even after his retirement in 1967, as a full-time consultant at ORNL.

It was at that time that I met Max. He was heating some molten salts in a test tube, and, upon my asking, explained with his characteristic enthusiasm that he was verifying what somebody had found: the partial miscibility of molten fluoroborates and fluoberyllates of alkali metals. I introduced myself as one of the team who had found the immiscibility, and from that moment we started an acquaintance which later developed into collaboration and friendship. Some years later I sought his help in identifying a compound whose x-ray diffraction pattern had defied analysis by others. Max held the film against the light and recognized three particular lines which reminded him of apatite. Further, more careful examination revealed that the compound in question was $\text{Sr}_7(\text{CrO}_4)_3\text{OH}$. From this moment on I never ceased to be amazed by his vast knowledge, vitality, enthusiasm and inquisitive mind. These qualities always made me seek his advice; he would give it in good will, although not sparing any criticism if called for.

Max's career, he said in his last interview, had thus come full circle, from x-ray diffraction to molten salts

and back again to x-ray diffraction and he offered two reasons for a major commitment to basic research:

"First, there is an inborn drive in mankind to know more and more about nature; this is a fundamental drive that needs to be satisfied. And secondly, what one day has been a purely academic, unapplied problem can, years later, unforeseeably, become a most important influence on the well-being of people and the development of technology."

"I agree with Alvin (Weinberg, former ORNL director)—the remedy for the evils of technology is MORE technology, not less. Basic research is a luxury I've indulged in," Max said; "I don't want to degrade the other way of thinking, but (basic research) is a weakness of mine, and it saddens me to think that society is turning away from it."

Dr. Bredig published about 100 papers, was a member of the American Chemical Society, the American Association for the Advancement of Science, the American Crystallographic Association and the Tennessee Academy of Sciences. He had a mineral Ca_2SiO_4 bredigite named in his honor in 1948.

Of his professional activities that spanned well over 50 years he was probably best known for his pioneering studies on the interaction of molten metallic halides with their metals.

Max's approach to research, while meticulous in detail, was that of a scholar and artist who could intuitively grasp from a vast knowledge what made essential scientific sense.

As a person Max was warm, friendly, never malicious and always generous. His friends remember his love and knowledge of music, playing and improvising at the piano, we also recall his inclination to resort to his well stocked library, even during a party, to prove some argument and his fondness of puns whether they were in English or in German. But what we will remember foremost is the twinkle in his eyes whenever he found some interesting publication or heard a comment of interest.

JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE

VOLUME 56, NUMBER 4, OCTOBER, 1981

COUNTY RECORDS OF VASCULAR PLANTS IN TENNESSEE

GENE S. VAN HORN AND LARRY G. WILLIAMS

*University of Tennessee
Chattanooga, Tennessee 37402*

ABSTRACT

County records are cited for 65 species of Pteridophytes, Gymnosperms, Magnoliidae, and Carophyllidae.

INTRODUCTION

The most thorough, contemporary study of the distribution of vascular plants on a county-by-county basis in Tennessee is the "Atlas of the Vascular Plants of Tennessee," which is currently being developed (Wofford and Evans, 1979a, b; Wofford, 1980)). The study

is based largely on the collections of the two largest herbaria in Tennessee, those at the University of Tennessee at Knoxville and at Vanderbilt University, as well as published records. For any study at the state level to be as complete as possible it is necessary for botanists at institutions with smaller herbaria to report their records. The end result will be a much more detailed and complete list for the state. This paper is a contribution toward that goal.

RESULTS

The following county records are additions to the

first three parts of the "Atlas of the Vascular Plants of Tennessee" (Wofford and Evans, 1979a, b; Wofford, 1980). Specimens from the herbarium of the University of Tennessee at Chattanooga (UCHT) and the herbarium at Tech Aqua Biological Station were examined. If the collector's name is preceded by an asterisk the voucher specimen is located at Tech Aqua.

Adiantaceae

Adiantum pedatum L.: DeKalb Co. (*Sagittarians, 102; *Willard, 32)

Aspleniaceae

Onoclea sensibilis L.: Sequatchie Co. (McGilliard, s.n.)

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw.: Hamilton Co. (McGilliard, s.n.)

Ophioglossaceae

Botrychium virginianum (L.) Sw.: DeKalb Co. (Farrar, 12)

Pinaceae

Pinus taeda L.: DeKalb Co. (Rucker, 64)

Aizoaceae

Mollugo verticillata L.: DeKalb Co. (Morgan, 30)

Annonaceae

Asimina triloba (L.) Dunal: DeKalb Co. (Farrar, 10; *Hunter, 8060), Hamilton Co. (Cress, 4), Sequatchie Co. (McGilliard, s.n.)

Aristolochiaceae

Asarum canadense L.: Hamilton Co. (McGilliard & Cross, 50; McGilliard, s.n.)

Berberidaceae

Caulophyllum thalictroides (L.) Michaux; Hamilton Co. (Crawley, s.n.; McGilliard, s.n.)

Jeffersonia diphylla (L.) Pers.: Grundy Co. (McGilliard, s.n.)

Podophyllum peltatum L.: DeKalb Co. (*Fowlkes, 6), Hamilton Co. (McGilliard, s.n.; Van Horn, 306), Monroe Co. (Koeniger, s.n.; Overall, s.n.), Sequatchie Co. (Butt, 28)

Cactaceae

Opuntia compressa (Salisbury) Macbride; Marion Co. (Chance, 3), Moore Co. (Farrar, 27)

Caryophyllaceae

Cerastium brachypodum (Englem.) Robinson: Hamilton Co. (Colby, s.n.)

C. glomeratum Thuillier: Grundy Co. (McGilliard, 959), Hamilton Co. (Harper, 64; Wilhoite, 10)

C. holosteoides Fr. var. *vulgare* (Hartm.) Hylander: Hamilton Co. (McGilliard, s.n.)

C. semidecandrum L.: Bradley Co. (Huff, 24)

Dianthus armeria L.: Hamilton Co. (McGilliard, 1085; Van Horn, 901)

Lychnis alba Miller; Hamilton Co. (McGilliard & Lawson, s.n.)

Saponaria officinalis L.: Hamilton Co. (Cunningham, 126; McGilliard, 1055)

Silene antirrhina L.: DeKalb Co. (Hodapp, 43; Rucker, 54)

S. rotundifolia Nuttall: Hamilton Co. (Van Horn, 481)

S. stellata (L.) Aiton f.: Hamilton Co. (Van Horn, 920)

Stelaria media (L.) Cyrillo: Marion Co. (Shepard, 50; Taylor, s.n.)

Chenopodiaceae

Chenopodium album L.: Hamilton Co. (Bowers, s.n.)

Fumariaceae

Dicentra canadensis (Goldie) Walp.: Monroe Co. (DeVore, s.n.; Garrett, s.n.)

D. cucullaria (L.) Bernh.: Monroe Co. (Overall, s.n.)

D. eximia (Ker) Torr.: Hamilton Co. (McAlister, s.n.). This collection may have been from a cultivated source, since no location other than county was noted. There is no record in the herbarium other than this 1931 collection.

Lauraceae

Sassafras albidum (Nuttall) Nees: Hamilton Co. (Bowers, s.n.; Shepard, 40), Marion Co. (Fryar, 74), Polk Co. (Henshall, 6)

Magnoliaceae

Liriodendron tulipifera L.: Hamilton Co. (Potts, 49; Van Horn, 793)

Magnolia acuminata L.: DeKalb Co. (*Rigland, Walker, & Hart, s.n.; *Sagittarians, 123), Sequatchie Co. (Cross & McGilliard, s.n.)

M. macrophylla Michaux; Hamilton Co. (McGilliard, s.n.), Sequatchie Co. (McGilliard, s.n.)

Menispermaceae

Cocculus carolinus (L.) DC.: DeKalb Co. (*Edwards, 11; Hooper, s.n.)

Papaveraceae

Sanguinaria canadensis L.; Franklin Co. (Karstens, 23), Hamilton Co. (Devore, s.n.), Polk Co. (Collins, 233)

Phytolaccaceae

Phytolacca americana L.: Hamilton Co. (McGilliard, 1124; Van Horn, 918)

Polygonaceae

Polygonum arifolium L.: Hamilton Co. (Bowers, s.n.)

P. convolvulus L.: Hamilton Co. (B. B., s.n.)

P. erectum L.; Hamilton Co. (Bowers, s.n.)

P. pensylvanicum L. var. *pensylvanicum*: Hamilton Co. Bowers, s.n.; McGilliard, s.n.)

Rumex acetosella L.: Hamilton Co. (Bowers, s.n.; Van Horn, 902)

R. crispus L.: Bradley Co. (Huff, 67), Hamilton Co. (Bowers, s.n.; Cunningham, 99), Jackson Co. (BreMiller, 14)

R. obtusifolius L.: Hamilton Co. (Van Horn, 480)

Portulacaceae

Claytonia caroliniana Michaux; Sequatchie Co. (Butt, 19)

C. virginica L.: Hamilton Co. (Hatmaker, 8; Van Horn, 744)

Ranunculaceae

Actaea pachypoda Ell.: DeKalb Co. (*Fowlkes, 70), Hamilton Co. (Wong, s.n.)

Anemone virginiana L.: DeKalb Co. (Ferrar, 34; Hoover, 56)

Aquilegia canadensis L.: Hamilton Co. (Garrett, s.n.; Pitt, 26)

Cimicifuga racemosa (L.) Nuttall; DeKalb Co. (*local flora class, 6/19/73), Hamilton Co. (McGilliard, s.n.; Van Horn, 457)

Clematis dioica L.: Hamilton Co. (Van Horn, 1250)

C. versicolor Small: Hamilton Co. (Cunningham, 123)

Consolida ambigua (L.) P. W. Ball & Haywood: DeKalb Co. (Rucker, 45), Putnam Co. (BreMiller, 16)

Delphinium tricorne Michaux; Grundy Co. (McGilliard, 963)

Hepatica nobilis Miller var. *acuta* (Pursh) Steyermark: Hamilton Co. (DeVore, s.n.; Garrett, s.n.)

H. nobilis Miller var. *obtusata* (Pursh) Steyermark: Hamilton Co. (Colby, s.n.)

Myosurus minimus L.: Hamilton Co. (Van Horn, 1661)

Ranunculus abortivus L.: Hamilton Co. (Tapper, 8; Mahaney, 144), Monroe Co. (Gowan, 11; Van Horn, 1401)

R. acris L.: Hamilton Co. (Baulerle, 40)

R. bulbosus L.: Hamilton Co. (Turner, 15)

R. carolinianus DC.: Hamilton Co. (McCurdy, 22)

R. fascicularis Muhl. ex Bigel.: Hamilton Co. (McGilliard, s.n.; Van Horn, 196)

R. ficaria L.: Hamilton Co. (Adler, 348)

R. pusillus Poir.: Hamilton Co. (Bowers, s.n.)

R. recurvatus Poir.: Hamilton Co. (Crooks, 109b; Evans, 35)

Thalictrum dioicum L.: Hamilton Co. (McGilliard, 15; Van Horn, 224), Sequatchie Co. (Smith, 34)

T. revolutum DC.: Hamilton Co. (McGilliard, s.n.)

T. thalictroides (L.) Boivin: Rhea Co. (Bland, 10)

LITERATURE CITED

- Wofford, B. G. and A. M. Evans. 1979a. Atlas of the Vascular Plants of Tennessee. I. Pteridophytes and Gymnosperms. Journ. Tenn. Acad. Sci. 54(1):32-38
- _____. 1979b. Atlas of the Vascular Plants of Tennessee. II. Magnoliidae: Aristolochiales, Magnoliales, Nymphaeales, Papaverales, Piperales, Ranunculales. Journ. Tenn. Acad. Sci. 54(2):75-80
- Wofford, B. E. 1980. Atlas of the Vascular Plants of Tennessee. III. Caryophyllidae: Caryophyllales, Polygonales. Journ. Tenn. Acad. Sci. 55(4):110-114