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THE ACADEMIC GENEALOGY OF ARTHUR E. SCHWARTING, PHARMACOGNOSIST[1]

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ABSTRACT.—Arthur E. Schwarting is the person primarily responsible for the conversion of pharmacognosy from a descriptive botanical discipline to a dynamic biological-biochemical science beginning some 50 years ago. In an effort to understand the reasons for this revolutionary change, it was deemed of interest to examine some of the various factors, both proximate and remote, that may have influenced his actions. Schwarting's professors and their professors were obviously an important element in this development. Consequently, this paper explores his academic forebears back through some of the most famous names in American pharmaceutical eduction to distinguished European scientists and educators. They include one Nobel Laureate, Otto Wallach.

"It was a critical experience for me because I immediately began to imagine a radically different approach to presenting the subject, and I saw the need for research endeavors that were imaginative and experimental."

With these words, Dr. Arthur E. Schwarting, whose 75th birthday we are commemorating in this issue of the *Journal of Natural Products*, began to explain the development of his interest in the biochemical/biosynthetic aspects of pharmacognosy.[2] The "critical experience" of which he spoke was "the opportunity to meet and converse with pharmacognosists and to observe their scientific program at their annual meeting" in his last year of graduate study at The Ohio State University. Earlier, in his undergraduate years at South Dakota State University, he was influenced by a microbiologist and an organic chemist who introduced him to laboratory and library research. "This type of learning was in sharp contrast to the rigid pharmacy subjects that were largely descriptive and involved a great deal of memorization." In his graduate years, "a geneticist and an organic chemist extended the contemporary views of the plant sciences and plant chemistry. Both individuals promoted ideas that there was some order in the plant kingdom that was chemical in nature."

Thus it was that Arthur E. Schwarting introduced, and carried through in his teaching and research, the new, revolutionary concept of the biochemical classification of plants for instruction in pharmacognosy, a distinct deviation from the traditional teacher's version of the subject. Schwarting had a tremendous influence on the teaching of the science and is primarily responsible for its conversion from one dealing exclusively with taxonomy, morphology, and histology to one concerned with the biochemistry and chemistry of plant drug constituents. Most of the modern pharmacognostical theory and practice in this country is directly attributable to him.

Tracing back Schwarting's academic lineage, a project suggested by Jack L. Beal, professor emeritus of pharmacognosy at The Ohio State University, has been both a fascinating and a revealing quest. Figure 1 records the principal lines of the lineage over a period of approximately 200 years. We see that Schwarting's professor was L. David Hiner, who was a student of B.V. Christensen. Christensen, together with many other important pharmaceutical educators of the 20th century, studied under Edward Kremers. During his lifetime, Kremers was considered more of a phytochemist than a

[1]On the occasion of his 75th birthday 8 June 1992.

[2]Arthur E. Schwarting, personal communication, 30 June 1991.

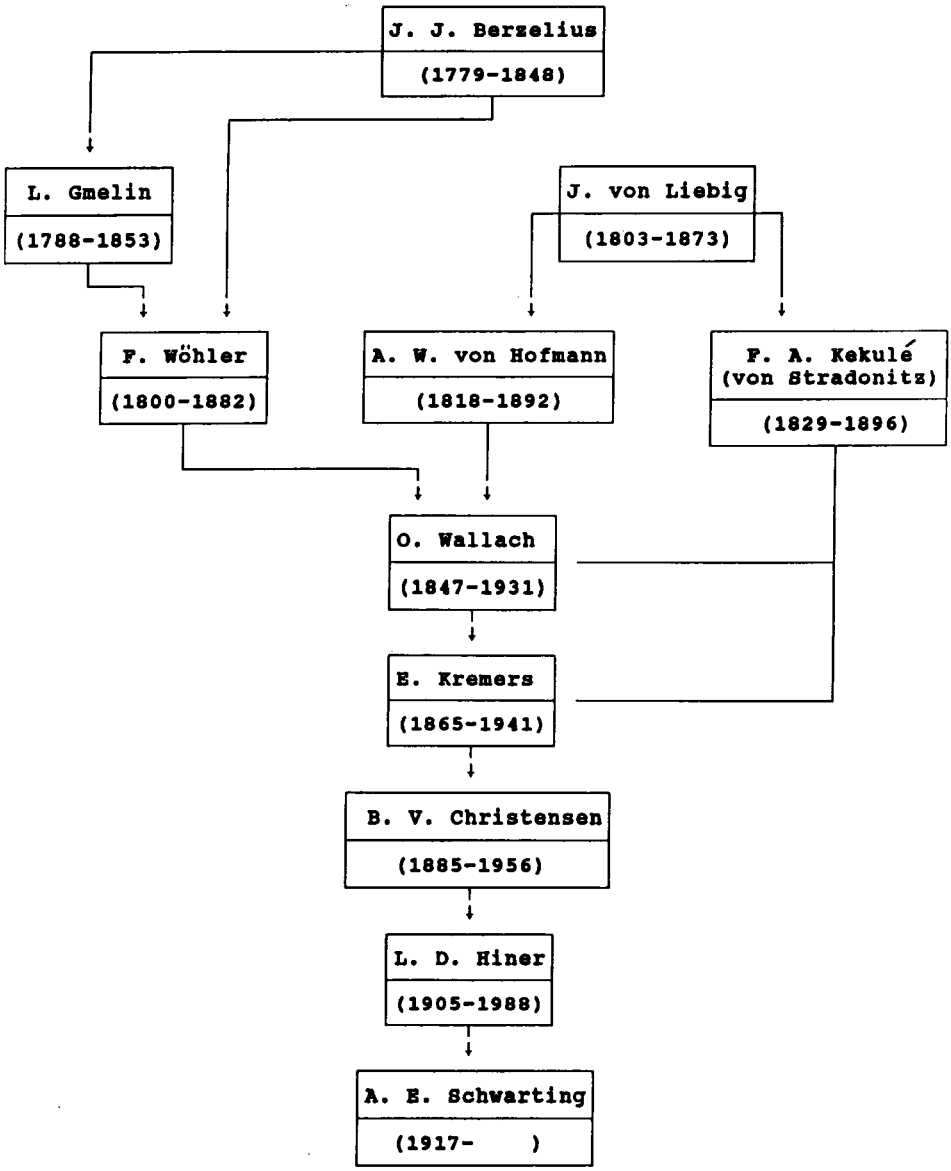

FIGURE 1. Academic lineage of Arthur E. Schwarting.

pharmacognosist. Only in late 20th-century nomenclature does he qualify for the latter appellation. Consequently, many of his students went on to distinguished careers in pharmaceutical chemistry and even in pharmaceutics.

Kremers provided the link between the above-named American academicians and the great German pharmacist-chemists of the 18th and 19th centuries. He was the student of Nobel Prize winner Otto Wallach. Wallach, in turn, traces his lineage to such greats as A.W. von Hofmann, Friedrich Wöhler, Friedrich Kekulé, Justus von Liebig, Leopold Gmelin, and ultimately Jöns Jakob Berzelius. To appreciate the academic forebears of Dr. Arthur E. Schwarting, it therefore becomes important for us to understand something of the contributions to science of each of these individuals. In this paper, the principal contributions of these individuals are outlined, and from the information provided, it is possible to trace their influence upon Schwarting in particular

and, consequently, upon modern pharmacognostical theory and practice. Consideration of them begins with the eldest, Jöns Jakob Berzelius.

JÖNS JAKOB BERZELIUS.—Jöns Jakob Berzelius was born at Väfversunda Sorgard, near Linköping, Sweden, on 20 August 1779. Both of his parents died when he was young, and he was brought up by his stepfather Anders Ekmarck. When Berzelius left gymnasium school in 1796, the headmaster's report indicated there was little hope for Berzelius. Upon the recommendation of the local bishop, Berzelius entered the University of Uppsala, but soon had to leave because of lack of funds. For a while, he was a private tutor, but when he won a small scholarship in 1798, he re-entered the University and graduated in 1802 with an M.D. He rapidly rose from a reader in chemistry at the Carlberg Military Academy in 1806 to a professor of medicine and pharmacy in 1807 in the School of Surgery in Stockholm. When Stockholm's Carolinian Medico-Chirurgical Institute was established, he gave up teaching medicine and surgery but continued to teach chemistry and pharmacy (1).

His scientific research involved many areas of chemistry. Berzelius was one of the founders of the theory of radicals; he devised the practical, present-day system of symbols of the elements and their use in formulae for the compounds; he was a pioneer in the determination of accurate atomic weights; he classified minerals on a chemical basis; he effected numerous improvements in analytical methods and the technique of the blowpipe. He discovered the elements cerium (with Hisinger), selenium, silicon, and thorium; he discovered xanthophyll in leaves. His findings go on and on.

In 1808, Berzelius published a popular textbook, *Lärbok i Kemien*, which went through five editions and several translations. He also published 27 volumes (1821–1848) of his *Jahres-Bericht*, an annual report on the progress of physics and chemistry. Berzelius was a recipient of the Copley Medal. He was married in 1835, and in the same year was made a baron and given a pension by King Charles XIV. Berzelius died in Stockholm on August 7, 1848.

LEOPOLD GMELIN.—Leopold Gmelin's great-grandfather was an apothecary in Tübingen, Germany, in the early 1700s. Other members of this distinguished family were all professors of either pharmacy, botany, chemistry, or medicine, but Leopold is the best known. He was born in Göttingen on 2 August 1788. Gmelin was a student of Berzelius. From 1817 to 1851, Gmelin was a professor of medicine and chemistry in Heidelberg. He authored the *Handbuch der Chemie*, which was enlarged from two volumes to 19 volumes through numerous editions; in 1848 it was translated into English. Its successor is the Gmelin-Kraut *Handbuch der anorganischen Chemie*.

Gmelin's *Handbuch der Chemie* is considered to be better than Berzelius' *Lärbok* for several reasons. The former had references, was concise yet complete, and contained only a small amount of theory. Gmelin used a card index and was always relieved when a compound was shown to be nonexistent. Wöhler, his student, told Liebig in 1829, "L. Gmelin wird sagen: Gott sei Dank, daβ es eine Saure weniger giebt" (1). ("Leopold Gmelin would say: Thanks be to God that there is one less acid.")

Gmelin discovered potassium ferricyanide, cobalticyanides, and platinocyanides. With Tiedemann, he discovered taurine and pancreatin. Gmelin also discovered croconic and rhodizonic acids and introduced the names racemic acid, ester, and ketone (1). He is credited with being the first to recognize that organic chemistry is the chemistry of the compounds of carbon.

Leopold Gmelin died in Heidelberg on 13 April 1853.

FRIEDRICH WÖHLER.—Friedrich Wöhler was a student of both Gmelin and Berzelius and a close friend and colleague of Justus von Liebig. Wöhler was born in Eschers-

heim near Frankfurt am Main, Germany, on 31 July 1800. He studied medicine first at Marburg, but in 1821 went to Heidelberg to study under Leopold Gmelin who told him that he (Wöhler) knew so much chemistry he did not have to waste time attending lectures (1). Wöhler received his Doctor of Medicine degree in 1823 from Heidelberg, but on Gmelin's advice decided to be a chemist. For a year (1823–1824), Wöhler worked with Berzelius in Stockholm and then, from 1825 to 1831, he taught chemistry at the Municipal Technical School in Berlin. From this post, he moved on as a professor at the Technical School in Kassel. In 1836, Wöhler was appointed professor ordinarius of chemistry and director of the Chemistry Institute at the University of Göttingen. It is said that 8000 students passed through his laboratory (1). Until 1850, he was also General-Inspector of the Hanoverian pharmacies (2). During his time in Göttingen, he received the Copley Medal.

Wöhler was a chemist of high distinction. His scientific writings were numerous, and his research contributed much to the advancement of inorganic chemistry. For example, while still in Berlin, Wöhler made the monumental discovery that inorganic ammonium cyanate could be transformed into organic urea. In a letter to Berzelius in 1828 (3), Wöhler wrote, "I must tell you that I can make urea without the use of kidneys, either man or dog. Ammonium cyanate is urea." This finding conclusively disproved a widespread belief, vitalism, that a vital force, present only in living plants and animals, was necessary for the formation of organic compounds. The conception of intramolecular arrangement of the atoms developed from this discovery of Wöhler's (4). Among his other scientific achievements was the isolation of aluminum, beryllium, and an impure titanium.

Wöhler loved the beauties of nature and of all living things. He was a quiet, gentle man, free from self-assertion, and had a dry sense of humor. Though their temperaments were quite different, Wöhler became a close friend of Liebig whom he met soon after returning from Stockholm. Their friendship continued for more than 40 years, to the end of Liebig's life. A.W. Hofmann compiled two volumes of their correspondence (1). These letters, extending from 1829 to 1873, reveal the variety of subjects that interested the minds of both men and also relate many of the incidents of their lives.

Together, Wöhler and Liebig discovered the benzoyl radical, amygdalin, hydroquinone, and calcium carbide, and showed the analogy between carbon and silicon. Wöhler, in 1838, was co-editor with Liebig of the *Annalen der Chemie und Pharmazie* (2).

Wöhler died in Göttingen on 23 September 1882, nine years after his good friend, Justus von Liebig.

JUSTUS VON LIEBIG.—Liebig, born in Darmstadt, Germany, on 12 May 1803, acquired his interest in chemistry from playing with chemicals in the laboratory of his father, a dealer in drugs, dyes, oils, and chemicals. His school career at the local gymnasium was not successful and, consequently, in 1817–1818 he was apprenticed to the pharmacy of Gottfried Pirsch in Heppenheim (5). This did not appeal to him for very long, 10 months to be exact; so he persuaded his father to send him to the recently founded University of Bonn. When Kastner, the professor of chemistry at Bonn, moved to Erlangen, Liebig followed him, though Liebig described Kastner's lectures as illogical and without order. In Erlangen, he received his degree and then, at the age of 19, went to Paris where he was allowed to work in Gay-Lussac's laboratory. In 1824, when he was only 21, he was appointed, upon the recommendation of Humboldt, professor extraordinarius at Giessen; two years later he became professor ordinarius. Not only did he hold a professorship in chemistry but also in pharmacy (5). As a matter of fact, his first students in Giessen were pharmacy students. Many pharmacists received their degrees with Liebig

Liebig remained at Giessen for 26 years; in 1852 he was called to Munich. He was president of the Academy of Science in Munich in 1860. Liebig died 18 April 1873.

Liebig contributed much to chemistry and pharmacy, but, as Sir William Tilden said in his book *Famous Chemists* (6):

> . . . his great and permanent service to the world was not in the isolation and study of individual compounds or series of compounds, not in the conception of theories of chemical action, nor even in views which he promulgated concerning the operation of agriculture, the composition of food, the processes of digestion, or the source of animal heat. His great service consisted in showing how chemistry should be studied and how it should be taught . . . .

The laboratory he established in 1824 in Giessen became so famous that it was known as "a factory for the production of professors" (4)—von Hofmann, Perkin, Will, Strecker, Wilhelm Keller (later a pharmacist in Philadelphia), Gerhardt, and Kekulé, to name only a few.

The results of research carried out by Liebig and his students are too numerous to mention here, but there is one other of his activities which must be referred to, and that is his publications. His first editorship was of the periodical *Magazin für Pharmacie*, whose title changed in 1832 to *Annalen der Pharmacie*, and in 1840 to *Annalen der Chemie und Pharmacie*. After his death, the journal became *Justus Liebig's Annalen der Chemie* (5). Ever since it was created, the *Annalen* has been one of the main repositories of the most important research carried out in Europe, especially in Germany. When Liebig died in 1873, 165 volumes of the *Annalen* had already been published. With his friends Poggendorff and Wöhler, Liebig published between 1836 and 1856 the *Handwörterbuch* and in 1843 the *Handbuch der Chemie* (6). These publications along with the popular *Chemische Briefe* gave him a supreme position of influence in the scientific world.

Liebig possessed a charming manner and a warm heart; he was fond of children; his enthusiasm was contagious; his energy unbounded. His temperament was that of a reformer. He was impatient, however, with looseness of thought and inaccuracy of experiment. Kekulé, who worked in his laboratory, recorded Liebig as saying "If you plan to be a chemist, you must be prepared to ruin your health by hard study; nothing less will produce anything" (4).

Being impatient with illogical thinking and inaccurate experimentation, Liebig tended to be somewhat brusque in his controversial writings, causing bitterness in some people. Nevertheless, A.W. von Hofmann, one of his greatest pupils, said of his teacher, "No other man of learning, in his passage through the centuries, has ever left a more valuable legacy to mankind" (7). What better tribute than this could any professor want?

FRIEDRICH AUGUST KEKULÉ.—Friedrich August Kekulé, through his discovery of the tetravalence of carbon (1858) and the ring structure of benzene (1865), developed the theoretical basis of organic chemistry more than any other person.

> If the debt which pure science owes to Kekulé for his elucidation of the constitution of the benzene molecule is almost incalculable, the debt of chemical industry is not less great, for it is in the benzene theory that the industry of coal-tar dyes, synthetic drugs, photographic chemicals, etc., has its roots. (7)

Kekulé, at a celebration of the 25th anniversary of the publication of the benzene theory, gave an account of how he came to formulate it. During a period of residence in London in 1854, Kekulé was returning on a double-decker bus to his lodging in Clapham after visiting Hugo Müller at Islington. He fell asleep and, in a dream, saw carbon atoms whirling before his eyes, finally lengthening into a chain. When he awoke, he put the dream to a test, and thus the structural theory of the tetravalent carbon was born.

Later, when he was living in Ghent, he fell asleep while working at his desk and again had a dream.

> Again the atoms were gambolling before my eyes. This time the smaller groups kept modestly in the background. My mental eye, rendered more acute by repeated visions of the kind, could now distinguish larger structures, of manifold conformation; long rows, sometimes more closely fitted together; all twining and twisting in snake-like motion. But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes. As if by a flash of lightning I awoke. (7)

It was, of course, the picture he had seen of the snake that had seized its own tail that gave him the clue to the structure of the benzene molecule.

"Let us learn to dream," he wrote, "but let us beware of publishing our dreams before they have been put to the proof by the waking understanding" (3).

Kekulé was born in Darmstadt, Germany, on 7 September 1829. At the age of 18, Kekulé entered the University of Giessen as a student of architecture, but as Gmelin influenced his student Wöhler, so Liebig, through his lectures, influenced Kekulé to abandon architecture in favor of chemistry. A year's study in Paris completed his training in chemistry, after which he held private research positions in Switzerland and in London. In 1856, Kekulé returned to Germany and became a privatdocent at the University of Heidelberg; in 1858 he became professor of chemistry at the University of Ghent and in 1865 was professor ordinarius of chemistry in Bonn. Also in 1865 he received the Copley Medal. The first edition of his well-known *Lehrbuch der organischen Chemie* was published in Erlangen in 1859 (8); from 1861 to 1887 it was published in Stuttgart. After the German Emperor ennobled him, he took the name of Kekule von Stradonitz, dropping the accent on the final e of his name (7). Overwork affected his health, and Kekulé died in Bonn on 13 July 1896.

AUGUST WILHELM VON HOFMANN.—Liebig had many students, but, as has already been mentioned, one of his greatest was August Wilhelm von Hofmann, born in Giessen, Germany, on 8 April 1818. In the life of von Hofmann, it can be seen again how great the influence of a professor can be on his students. Perhaps it is a common pattern throughout all of academia; it is certainly apparent in the biographies presented in this paper. Hofmann entered his hometown university in 1836, intending to study law; however, after meeting the commanding personality, the enthusiasm, and the vigor of Liebig, Hofmann changed his mind and studied chemistry.

First an assistant in the chemical laboratory in Giessen, he next was professor extraordinarius of chemistry at the University of Bonn (1845–1848). Then he accepted an invitation to become the first director of the newly founded Royal College of Chemistry in London. There he taught many who were to become the leading English scientists of the Victorian era; but after 17 years, he was, in his words, "seized with a profound homesickness for the spiritual heights of a German university" (7) and therefore accepted, in 1865, a position as professor ordinarius of chemistry and director of the Chemistry Laboratory at the University of Berlin. In 1867 he founded the Deutsche Chemische Gesellschaft (since 1946 the Gesellschaft Deutscher Chemiker). This group established, in 1902, the Hofmann Medal for outstanding performance in the area of experimental chemistry. As a tribute to his memory, the Hofmann Haus was opened in 1900 to house the Society's headquarters. It was completely destroyed in World War II.

Perkin, the discoverer of mauve, and Griess, the discoverer of the azo reactions, were assistants in his London laboratory. The coal-tar dye industry is said to have been born in that laboratory (4) because of Hofmann's work on aniline (1843) and benzene (1865) as well as his preparation of various dyes, although Kränzlein in 1935 (9) in his biography of the pharmacist F.F. Runge, wrote, "The world can consider Runge the

first inventor of coal tar dyestuffs without by this taking away anything of the immortal fame gained in the same field by A.W. Hofmann and his pupils . . . ."

Hofmann was, of course, a member of the Berlin Academy and many other societies. In 1875 he received the Copley Medal, and on his 70th birthday, Hofmann was raised to the rank of a nobleman of Prussia. He died in Berlin on 5 May 1892.

Hofmann's three-volume work *Zur Erinnerung an vorangegangene Freunde*, a collection of lectures in which he memorialized friends, is famous. A similar lecture, written about Hofmann after his death, published in the *Journal of the Chemical Society* in 1896, reads in part as follows:

> As a teacher he was singularly interesting and lucid . . . . Enthusiastic as an investigator of scientific problems, he could impart his enthusiasm, if not his genius, to others . . . . His genial and charming manner, high flow of spirits and originality in conversation and correspondence secured for him devoted friends. (7)

OTTO WALLACH.—"Messiah of the Terpenes." Winner in 1910 of the Nobel Prize in chemistry.

With only these two short but graphic phrases, it is not difficult to recognize the man whom they describe—Geh. Reg.-Rat Prof. Dr. Dr. med. h. c. Dr.-Ing. e. h. Otto Wallach, born 27 March 1847, in Königsberg, Prussia; died 26 February 1931 in Göttingen where he, as a young student of Wöhler's, heard his first chemistry lecture and where 26 years later, having gone full circle, he held the same professorship that Wöhler had held, and also where he, after retirement from the faculty, continued his research until his death at the age of 84.

After Wallach's first semester of study with Wöhler in 1864, he went back to Berlin to attend the lectures of A.W. von Hofmann, who had just come back from London. However, because laboratory conditions were crowded and unfavorable in general, Wallach soon returned to Wöhler's laboratory in Göttingen. He received his Ph.D. degree from the University of Göttingen in 1869. Later that year he became an assistant to Wichelhaus in Berlin, but the next spring took an assistantship with Kekulé in Bonn. After a year there, he returned once more to Berlin where he was the chemist in the Martius and Mendelssohn-Bartholdy chemical factory. Chlorine fumes forced him out of this job, and, upon Kekulé's request, he returned in the spring of 1872 to Bonn. There, in 1873, he became a privatdocent and, in 1876, a professor extraordinarius of chemistry.

In 1879, Wallach succeeded pharmacist Friedrich Mohr as lecturer in pharmacy in Bonn, and thus, largely because of his lectures on pharmacy, Wallach's attention was turned to the chemistry of the volatile oils (10).

In the fall of 1889, Wallach returned to Göttingen to succeed Victor Meyer as director of the Chemical Institute of the university. He held this position until he retired in 1915.

The "Messiah of the Terpenes," as Wallach was titled by Friedrich August Flückiger, published a comprehensive review of all of his research (he had 129 papers in the *Annalen* alone) in a book titled *Terpene und Campher* in 1909. It was so well received that a revised edition was published in 1914.

Edward Kremers, Wallach's first American student, wrote:

> One of the principal achievements of Wallach's work and that of his contemporaries has been to bridge over that wide gap between aliphatic and aromatic and thus to cause us to drop, all too slowly and reluctantly, the dualistic classification as applied to organic systematics . . . . The work of Wallach and his contemporaries has no less paved the way to a better understanding of biochemical processes of plants . . . . The plant physiologist may regard plant perfumes and plant pigments as of minor importance, yet it must be admitted that our aesthetic enjoyment of nature depends as much, if not more, on the color and the fragrance of plants as on their form. (11)

Kremers traveled to Bonn in the fall of 1888 to attend the lectures of Kekulé and at the same time to work in Wallach's laboratory. When Wallach accepted the call to Göttingen, Kremers and 11 other students of Wallach moved in with him. ". . . He permitted me to work in the new organic laboratory, recently built by Victor Meyer, long before the opening of the fall semester," Kremers wrote (11). Eighteen years later, in 1907, Kremers visited Wallach and found him to be as full of life as ever. Even after World War I when Wallach could find no assistant and could not afford to buy the common reagents because they were so high priced, he still found a way to do work in his laboratory.

Kremers observed that: "What discouraged the man of well nigh seventy-three years even more was the loss of many of the young men whom he had trained during the previous decade and, even worse, the hatred, envy, and lack of understanding which he encountered. Mental depression caused the enthusiastic investigator of 70 years suddenly to grow old" (11).

Wallach, however, had no bitterness in his heart "toward a citizen of the country that had overthrown the German Empire." Kremers continued: "If ever I took pride in his remarkable scientific successes, which received international recognition through the bestowal of the Nobel Prize, I experienced even more satisfaction from his noble attitude at the close of the World War. Well may the student strive to emulate his master, irrespective of race or nationality, if his teacher be a man like Wallach . . ." (11).

EDWARD KREMERS.—Edward Kremers (1865–1941) did indeed strive to emulate his teacher. After only two years of work with Wallach, he received his Ph.D. degree from the University of Göttingen in 1890. That fall, he returned as an instructor of pharmacy at the University of Wisconsin "with the holy zeal of a missionary" (12), determined to change pharmaceutical education in America. Though his work of reform began immediately, his big opportunity came rather quickly and unexpectedly in the spring of 1892 when Professor Frederick B. Power, head of the School of Pharmacy, left to accept a position in industry; the 27-year-old Kremers was chosen to succeed Power. Power's title had been "professor of pharmacy and materia medica," but Kremers became "professor of pharmaceutical and pharmacognostical chemistry," a deliberate change, indicating a new program in American pharmaceutical education which would expand upon that developed by Prescott at the University of Michigan School of Pharmacy. It was not long (1892) until Kremers had established a 4-year elective course in pharmacy, the first in America and in the world.

Other developments concerning pharmacy education which can be credited to Edward Kremers, directly or indirectly, are: (1) the affiliation of many of the private colleges of pharmacy with state universities, and (2) the organization, upon his suggestion, of boards of pharmacy into a national group that would meet jointly with the Conference on Pharmaceutical Faculties (later the American Association of Colleges of Pharmacy). This, he hoped, would stimulate cooperation between the schools and the boards of pharmacy (12). Indicating their approval of such a suggestion, the National Association of Boards of Pharmacy made Kremers its Honorary President in 1939.

Kremers the reformer was also well-known as an author and historian. With Frederick Hoffmann, Kremers was co-editor from 1896–1900 of the *Pharmaceutical Review* (the *Pharmazeutische Rundschau* from when Hoffmann founded it in 1882 until 1896); from 1901–1909, Kremers was the editor. He published about 150 pharmaco-historical papers and can be considered the "most important early exponent of the preservation and interpretation of the history of American pharmacy" (9).

In addition to the articles he wrote and his advocacy of collecting and preserving pharmaco-historical documents, Kremers was instrumental in getting the American

Pharmaceutical Association, in 1904, to establish a Section on Historical Pharmacy within that organization. He stimulated the University of Wisconsin to build its pharmaco-historical library. Also, between 1930 and 1941, he founded and edited *The Badger Pharmacist*, the first American journal devoted to the history of pharmacy. In 1940, with Dr. George Urdang, he published *History of Pharmacy: A Guide and a Survey*. In its preface, Kremers credits Urdang with the actual writing and documentation of the material; Kremers collected the necessary source materials and devised the organization of the book.

Kremers' ideas for improving pharmaceutical education in America were accepted in large part because of his reputation as a scientist as well as an historian and author. Graduating in 1886 from the Department of Pharmacy of the University of Wisconsin as a Ph.G. (Pharmaceutical Graduate), he continued to work at the school as Professor Power's assistant. Two of his investigations on the volatile oils won for him the Ebert Prize in 1887. That fall Kremers registered in the General Science Course of the University and graduated with a Bachelor of Science in 1888. Kremers confessed this accomplishment was good for his ego because it made him "the equal" to those students who looked down on the "pharmics" who had to complete only 4 terms instead of the 12 needed for a baccalaureate degree. This could perhaps explain his later determination to make the profession of pharmacy equal to all other professions (12). Until his death in 1941, Edward Kremers remained a scientist, a reformer, author, and historian, devoted to his profession of pharmacy.

BERNARD VICTOR CHRISTENSEN.—Among the more than 50 Ph.D.s who earned their degrees under Kremers' instruction was Bernard Victor Christensen (1885–1956). Born on a farm near Westfield, Wisconsin, of immigrant parents (his father from Norway, his mother from Germany), he received most of his schooling in Wisconsin. He became an instructor in pharmacy at the University of Wisconsin in 1923, received a Master's Degree there in 1925, and a Ph.D. in 1927 (13). That year Christensen went to the University of Florida as professor of pharmacognosy and pharmacology. In 1933, he became director of the institution's School of Pharmacy, and in 1939 accepted the deanship of the College of Pharmacy at The Ohio State University, a position he held until 1955.

Christensen, of course, was a member and officer of many social, professional, and honorary organizations: American Pharmaceutical Association, President, 1941–42; American Association of Colleges of Pharmacy, President, 1949–50; charter member of the American Institute of the History of Pharmacy; member of the American Council on Pharmaceutical Education; member of the Board of Directors, American Foundation for Pharmaceutical Education, Rho Chi, Sigma Xi—to name a few.

Rufus A. Lyman, editor of *The American Journal of Pharmaceutical Education*, wrote the following when Dr. Christensen became president of the American Association of Colleges of Pharmacy:

> We can rest assured there will be no backward movement nor any standing still in the pharmaceutical educative process with the vision of Bernard Victor Christensen, the force that turns the propellor, and with his good right hand on the rudder to guide the boat the coming year. (13)

Dr. Christensen wrote four books on the collection and cultivation of medicinal herbs; his scientific papers dealt primarily with the methods and procedures in biological standardization of drugs (13). While in Florida, he won the Ebert Prize for pharmaceutical research. It was also while in Florida that Dr. Christensen had a student named L(ovell) David Hiner.

L. DAVID HINER.—Lovell David Hiner was born in Platte, South Dakota, on 6

May 1905. He received his B.S. in 1929 from South Dakota State College where he attended on a football scholarship; he earned both his M.S. and Ph.D. degrees from the University of Florida in 1931 and 1938, respectively. From 1933 to 1940, Hiner was back at South Dakota State College where he rose to the rank of professor and head of the department. In 1940 he moved to The Ohio State University where his major professor, Dr. Bernard V. Christensen, was dean of the College of Pharmacy. Hiner remained at Ohio State until 1947, at which time he accepted the deanship of the newly formed College of Pharmacy at the University of Utah. Though the College at first occupied the top floor of the women's gymnasium (Hiner always claimed it was the only college of pharmacy with two swimming pools and a basketball court) (14), in 1966 Hiner's dream came true—a new pharmacy building next to the medical center was completed and dedicated. He retired in 1970 and died on 6 April 1988.

Dr. Hiner's scientific work dealt with the cultivation of *Ephedra sinica* in South Dakota, the establishment of a medicinal plant garden at South Dakota State College, and the development of the so-called Hiner heart chamber, an apparatus used in demonstrating the action of cardiac stimulant and depressant drugs on a frog's heart (15).

ARTHUR E. SCHWARTING.—When Dr. Hiner moved to The Ohio State University in 1940, a young man who had just received his B.S. in pharmacy that year from South Dakota State College went with Hiner for graduate study in pharmacognosy. That young student, born on 8 June 1917, in Waubay, South Dakota, was Arthur Ernest Schwarting, who revolutionized the teaching of pharmacognosy in the United States by classifying drugs according to the chemistry of the drug's active constituents and by supplementing the taxonomic, morphologic, and histologic features of the drugs with chemical and biochemical material (16). Hiner, who used the more classic taxonomic approach in his teaching, was shocked when, upon asking his young Ph.D. candidate how he planned to organize and teach a course in pharmacognosy upon graduation, Schwarting replied by explaining his chemical approach. For almost five decades now, this approach to the teaching of pharmacognosy has been accepted throughout this country and, indeed, the entire world.

Schwarting did, in spite of his unexpected and revolutionary response to Hiner's question, receive his Ph.D. in 1943 and move on to his first faculty position at the University of Nebraska. There, this master teacher and researcher opened up to his students a whole new world of alkaloid biosynthesis, terpene chemistry, and the like. Through his enthusiastic, and even evangelistic, teaching, pharmacognosy became a fascinating science to them. Like Justus von Liebig, Arthur Schwarting's great service consisted in showing how pharmacognosy should be studied and how it should be taught. He soon had many disciples. When Schwarting joined the faculty of the University of Connecticut School of Pharmacy in 1949, this writer (VET) accompanied him and became the first student to receive a Ph.D. degree under Dr. Schwarting's direction.

For 17 years, from 1960 to 1976, Schwarting was editor of *Lloydia* (to become the *Journal of Natural Products* in 1979). In this capacity, too, he initiated changes, both quantitative and qualitative, to turn the journal into an outstanding research publication.

In 1970, Schwarting became dean of the School of Pharmacy at the University of Connecticut. He was president of the American Association of Colleges of Pharmacy in 1971–72, during which time he instigated the idea of a study by an outside commission to determine the state of practice and the education which would best serve future pharmacy professionals. The idea was adopted by the AACP in 1972; past-president Schwarting raised the money for such a study, and thus, the Study Commission of Pharmacy, chaired by Dr. John S. Millis, was organized. Its report appeared in 1975.

In 1968–69, Dr. Schwarting spent a sabbatical leave in Munich, Germany, where he worked in the institute of Prof. Ludwig Hörhammer. He was one of the authors of *Introduction to Chromatography*, 2nd edition, in 1968. He was on the Board of Directors of the American Foundation for Pharmaceutical Education from 1974 to 1980. Some of his awards are as follows: American Pharmaceutical Association Foundation Research Achievement Award, 1964; University of Connecticut Alumni Association Award for faculty excellence, 1965; and the Centennial Achievement Award from The Ohio State University, 1970.

In 1980, Dean Schwarting retired; in 1981 the title of professor emeritus was conferred upon him by the University of Connecticut. He and his wife, Bobbie, now reside in Florida.

Dr. Arthur E. Schwarting has more academic descendants than anyone in the field of pharmacognosy in the United States. His Ph.D. students include: Varro E. Tyler, James E. Dusenberry, Ara G. Paul, Chand K. Atal, David Carew, John Staba, Lee Schramm, Ralph Blomster, Krishan Khanna, John Leary, Mahmoud El-Olemy, John P. Rosazza, Robert Doberstein, Mai-Lee Swenberg, and Rolf Hörhammer. Two educators who received their M.S. degrees from Dr. Schwarting before going elsewhere for the Ph.D. degrees were Melvin Gibson and William Kelleher. Other M.S. students were Leon R. Pacifici, Ali A.R. Al-Askari, When-Hwei Lui, and Peter E. Daddona.

Few educators in the United States today have an academic lineage as illustrious as that of Arthur E. Schwarting. It includes one Nobel Prize winner and many others equally meritorious whose significant contributions to science predate the establishment of that award in 1901. Because of the fast pace of modern life, young scientists in particular often fail to appreciate even the identity, let alone the work, of the giants on whose shoulders they stand. Such an appreciation is particularly important in a science which began with the first treatment of disease by human beings. It is only proper that we, today, should understand the past for many reasons but, most of all, for the inspiration it provides in our quest for knowledge and the benefits that knowledge brings to all people.

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