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RICHARD BALDWIN TURNER

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A Biographical Memoir by
MARSHALL GATES

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BY MARSHALL GATES

RICHARD B. TURNER was born in Minneapolis, Minnesota on October 7, 1916 to Hubert Michael Turner and Jessie Baldwin Turner, both highly cultured people and educators. Their son's entire life and career reflected this heritage. Hubert Turner was born in 1882 in Hillsboro, Illinois. After graduating from the University of Illinois in 1910, he stayed on as an assistant instructor for two years while taking graduate work in mathematics, physics, and electrical engineering. Here he met Jessie Baldwin, a teacher and graduate of the university in botany. They were married in 1912 while both were members of the faculty of the university.

After an interlude in Minneapolis, where Dick was born, the family moved to New Haven in 1918 where Hubert Turner took up an appointment as assistant professor of electrical engineering at the Sheffield Scientific School at Yale. His entire subsequent career was spent at Yale; he became internationally known in the field of electrical communication engineering. He was a member of the American Institute of Electrical Engineers, the International Union of Scientific Radio Telegraphy, the Franklin Institute, the Institute of Radio Engineers, the American Standards Association, and the American Association for the Advancement of Science.

He retired from Yale in 1952 and died of a heart attack while living at the Yale Faculty Club in 1965.

Dick's mother, Jessie Baldwin Turner, was born in Deer Park, Illinois. She maintained her interest in botany in New Haven, where she was a member of the Fern Society and had a collection of over one hundred varieties of ferns. Both parents collected rocks, shells, and stamps and were avid bird watchers. They were widely read and well informed, of high principles, interested in both world and local affairs, and maintained a home in which intellectual values were fostered. Dick's only sibling, Elizabeth, died at age nine, and he was raised as an only child from then on. He spent all his childhood in New Haven, strongly influenced by his parents and the college community. He attended Susan Sheridan Junior High School and New Haven High School, graduating in 1933. He was a bright and inquisitive child, excelling in mathematics, physics, and chemistry. Both parents supplemented and enriched his formal education by tutoring him at home.

Turner was also a talented musician and during these years played the piano, clarinet, and trombone. This talent for and love of music was to remain with him all his life; he particularly enjoyed Dixieland jazz and was adept in this style with the clarinet. While at Harvard he played in the college band. Like most boys of his age, he was keenly interested in athletics, and he also enjoyed sailing and woodworking. In later years he found time to combine the last two avocations, building a sailboat that he and his family greatly enjoyed using. He was also an avid reader, particularly in history, and was editor-in-chief of his school newspaper, *The Sentinel,* his junior and senior years.

In 1934 Turner entered Harvard, graduating in 1938. He remained at Harvard for graduate studies, first under William F. Ross, then with Louis F. Fieser, under whom he completed his Ph.D. in 1942. He remained at Harvard for another year working under a National Defense Research Committee contract, then went to the Mayo Clinic in 1943 to work with the group assembled by E. C. Kendall to examine the chemistry of the adrenocorticosteroids. After two years at the Mayo Clinic, Turner in 1945 joined a synthetic group at MIT carrying on a wartime project on the synthesis of antimalarials under the direction of Arthur C. Cope. He remained with this group until 1948, when he returned to Harvard as a research fellow of the American Cancer Society, for the first time working alone or with one or two technicians on problems of his own inception. He remained there until the fall of 1951, when he took a position as assistant professor of chemistry at Rice University, rising through the academic ranks to associate professor (1953) and professor (1956). He remained at Rice for the rest of his career.

In 1952 Turner married Halina Deschko, a native of the Ukraine who had come to this country after World War II. She had graduated from Mt. Holyoke and the Simmons College School of Social Work. They had three children: Richard, Jr., Tamara, and William. Richard, Jr., is an architect and his younger brother, William, is also entering this field; Tamara's professional interests lie in anthropology. Turner was a devoted husband and father and spent much time with his family in spite of the heavy demands of his professional career.

Turner was an unusually able teacher and lecturer. His presentations, both in the classroom and at symposia and meetings, were sharp, incisive, rigorous, and polished, and he was invited to present his work widely both here and abroad.

THE SCIENTIFIC WORK OF R. B. TURNER

Aside from the work he carried out for his Ph.D., Richard Turner's first significant contribution to chemistry came from the two years he spent with Kendall's group at the Mayo Clinic. A series of six papers on the general subject of steroids derived from bile acids appeared in the period from 1946 to 1952. Using $\Delta^{9,11}$ cholenic acid as a raw material, efficient methods were developed for the preparation of the important 11-ketocholanic acid and a number of its close relatives and the subsequent degradation of 11-ketocholanic acid to 11-ketoetiocholanic acid by removal of the bile acid side chain. This work was crucial for the preparation of the first partially synthetic samples of Kendall's compound A for clinical trials. During the course of this work, stereochemical assignments were made to twenty-five bile acid derivatives substituted in ring C.

Turner's interest in steroids and related compounds endured in somewhat modified form throughout his career. He was the first to synthesize C^{14} labeled cholestenone and testosterone (1947), and sporadic publications on a variety of problems related to steroids appeared from then until 1960. During the period from 1954 to 1958, Turner and his coworkers carried out structural studies on the cardiotonic steroid ouabagenin, derived from the glycoside ouabain long used as an arrow poison by the East African Somalis. They were able to locate the remaining uncertain hydroxyl group at C11 and were able to correlate ouabagenin and strephanthidine, another cardiotonic aglycone, by conversion of both to a common derivative still retaining the hydroxyl group at C14 and the butanolide ring.

A general interest in the structure and synthesis of natural substances, of which the above work in the steroid field was one manifestation, continued to occupy Turner throughout most of his career. Determination of the structure and completion of a synthesis of cassaic acid and a synthesis of phyllocladen were published in the period from 1959 to 1966, and he and his coworkers had begun a synthetic approach to the diterpenoid alkaloids at about this time. At the time of his death, Turner and his coworkers were at work on a synthesis of marasmic acid and had completed construction of the carbon skeleton in its correct stereochemical form. Various syntheses of intermediates used in the extensive antimalarial program carried out during the later stages of World War II comprise the work Turner carried out while in the group headed by Arthur C. Cope in the period from 1945 to 1948. Synthetic work in the naphthoquinone field with Louis F. Fieser formed the subject of his doctoral dissertation as well; these results were published in 1947.

In a penetrating and important early paper, Turner, in collaboration with Dorothy Voitle, established the structure of Δ^1-1-acetyl-2-methylcyclohexene as the *s-cis* conformer; this was done by a study of its uv absorption and that of a number of more rigid α,β-unsaturated ketones and provided an explanation of the lowered extinction coefficients in such substances.

Turner's bibliography contains contributions on a wide variety of subjects (synthesis, structures of natural products, use of radioactive carbon in labeling important hormones, conformational analysis, instrumental methods as probes of structure, stereochemistry, and such diverse biochemical subjects as the mechanism of uptake of radioactive iodine by thyroid tissue and the biochemistry of aldosterone), but by far the most important contribution he and his colleagues made was their use of heats of hydrogenation as a tool to study a variety of problems having to do with the comparative stabilities of a wide variety of olefins, estimates of strain energies and conjugative interactions, conformational problems, and others. This work brought order based on quantitative results to a large and important area of organic chemistry that theretofore had been characterized by conjecture, hypothesis, and speculation.

It is perhaps inappropriate to review this work in detail here, but the following important results and conclusions arose directly from it:

- The question of homoallylic resonance in such substances as norbornadiene, barrelene, and *cis, cis, cis*-1,4,7-cyclononatriene was resolved once and for all. They are devoid of such resonance.
- The relative stabilities of various double-bond isomers of cholestene were established on a quantitative basis (Δ^2 is the most stable).
- The relative stabilities of *cis* and *trans* isomers of cyclooctene, cyclononene, and cyclodecene were quantitatively determined. In any given pair, the *cis* isomer is more stable, *cis*-cyclodecene having the lowest enthalpy of hydrogenation of any alkene examined.
- Reliable values for the stabilization energies of a number of theoretically important cyclic polyenes were established. Among those studied were cyclooctatetrene; 1,3,5-cyclooctatriene; azulene; heptafulvene; heptafulvalene and its dihydro derivative, tropone; tropylium ion; and acepleiadylene.
- The relative stabilities of exo and endo olefins in five-, six-, and seven-membered ring systems were determined. In all cases, the endo isomer is the more stable. There had been claims, albeit somewhat ambiguous, that could have been interpreted as indicating a greater stability for the exo isomer in five-membered rings.
- The order of stability for substituted olefins was established unambiguously. This work also showed the importance of planarity for olefin stability; *cis*-di-*t*-butylethylene has the highest enthalpy of hydrogenation of any simple olefin examined, nearly 10 kcal/mole higher than its *trans* isomer.

- The essential correctness of a single most stable conformation for cyclodecane, suggested by Dunitz, was established by the demonstration of the necessity for a transoid conformation in 1,1,4,4-tetramethylcyclodecen-7.
- The well-known stabilizing effect of alkyl groups on carbon-carbon double-bonds was shown to be independent of the nature of the alkyl group and therefore not readily accounted for on steric grounds.
- The strain energies of a number of theoretically interesting small ring compounds were determined. 1,3-Dimethylbicyclo[1.1.0] butane has the remarkably high value of 67 kcal/mole.
- The conjugative stabilization in 2-methyl-1,3,5-hexatriene was shown not to be the result of strengthening of sp^2-sp^2 bonds relative to sp^3-sp^2 bonds, but to be consistent with the resonance hypothesis. By inference, this finding should also apply to 1,3-butadiene and 1,3,5-hexatriene and similar substances.
- The triple-bond strain in cyclic alkynes was determined. It is large in cyclooctyne, about 2.9 kcal/mole in cyclononyne and negligible in ten- and twelve-membered rings.
- Reliable quantitative evidence on strain and conjugative interactions in such substances as the cyclohexadienes and the cycloheptadienes, as well as in the cyclooctatrienes, was provided. These data will have to be taken into account in any discussion of such medium-size ring systems.
- Quantitative evidence for transannular interactions in medium-size rings, both saturated and unsaturated, was accumulated.

In this large and important field Turner perceived the need for reliable quantitative data, selected the substrates to be examined with a keen eye for the significance of the findings, provided the methodology for obtaining them, measured the quantities with precision, and interpreted the results with rigor and sophistication.

The importance of this work as a whole attracted much attention, and led to fruitful collaboration with other well-known chemists both here and abroad. The most extensive such collaboration was between Turner and William von E. Doering. They and their collaborators published five joint papers.

Finally, it is remarkable that nearly 20 percent of Turner's papers were published under his name alone. He was a gifted experimentalist and enjoyed laboratory work. He continued to carry on experimentation with his own hands right up to the time of his death.

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