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CHAMP B. TANNER

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A Biographical Memoir by
WILFORD R. GARDNER

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CHAMP BEAN TANNER the scientist cannot be separated from Champ Tanner the individual. There was a transcendent integrity to his personality that permeated everything he did. He could be blunt, candid, and forthright, but he was never lacking in compassion and concern for students, colleagues, friends, and family. To know Champ was to know his inimitable wife, Kay, and to become adopted into their far-flung extended family as a full-fledged member.

Champ was born in Idaho Falls, Idaho, on November 16, 1920, of Mormon pioneer stock. His life exemplified the goal-oriented determination, regardless of physical or financial impediment, that was characteristic of his forbearers. His father, a construction engineer, died as a result of saving a coworker from drowning in an accident early in Champ's life, leaving his widowed mother to provide for Champ and his two younger brothers. His mother proved to be a remarkable woman, and there was little doubt that both nature and nurture were strong determinants in Champ's life course. She eventually obtained a position as professor of English at Brigham Young University when women professors at any institution were rare and when their work was never so highly valued as that of male colleagues. She became a legendary and beloved mentor and, much too late, was honored as one of the most outstanding teachers ever to serve on that faculty. Her high standards and appreciation for the English language were not lost on Champ, whose impatience with verbosity in convoluted writing made thesis writing a feared task among his students.

Champ was one of a large and talented group of young men who were identified early in their student careers by Tommy Martin, a second beloved and legendary figure at Brigham Young University. Tommy not only encouraged his students to go on to graduate school, preferably in soil science, but also managed to find graduate assistantships for most of them at outstanding eastern universities. Champ proved to be one of the best of this distinguished group. Professor Martin was very concerned that the military draft would require that Champ enter the service and thus interrupt Champ's education at a critical point. Following a fatherly interview, he suggested that Champ and his sweetheart, Catherine Cox (she is never called Catherine, always Katie or Kay), get married immediately. He suggested they could do so secretly and continue to live in separate domiciles until an appropriate time came to reveal the marriage to their parents. Champ's marital status would, Martin hoped, help to keep him out of the clutches of the military. As tempting as this suggestion was, it was not immediately accepted. Champ and Katie were married in the fall of 1941, prior to completion of his studies at Brigham Young University in the spring of 1942, without regard for any intentions of the local draft board.

It was under Professor Martin's influence that the promising freshman chemistry student traveled immediately to North Carolina State University to carry out graduate studies in soil science. Champ's description of his days at North Carolina is difficult to reduce to the page. His adviser was of the school of thought that did not want students to make any move prior to full consultation and permission. Champ, who had worked all of his young life to help support the family, was unaccustomed to sitting around awaiting instructions, especially when such instructions often seemed trivial and pointless. It took less than a year for him to decide that military service was not only inevitable but much preferred to his present status. By this time he had already enlisted in the Army Reserve, and in the fall of 1942 he was called to active duty with the Signal Corps. The training Champ received in the Corps in the rapidly developing field of radio and electronics was to serve him well in his later research career. In 1944 he was commissioned an officer and assigned duties as an automotive officer. He was discharged in August 1946.

Champ was disinclined to return to North Carolina, but, to the good fortune of soil science, he already had in hand an open offer of an assistantship at the University of Wisconsin. One of Champ's classmates at Brigham Young had gone to Wisconsin for graduate school. This friend was so effusive in his praise of Champ that Emil Truog, the friend's major professor at Wisconsin, wrote Champ while he was still in the service and offered him an assistantship, to be taken up at such time as he was free.

THE FORMATIVE YEARS

Emil Truog was one of that fabled class of professors of the era known best as benign tyrants. Truog was then chairman of the Department of Soils. Though his own training at Wisconsin culminated with the degree of master's of science in chemistry, by the time of his retirement he had mentored over 175 graduate students, most of whom took Ph.D. degrees. Truog was an acknowledged giant in the budding field of soil science. He was insightful, demanding, creative, opinionated, and compassionate. After his experience at North Carolina and in the military, the thought of a martinet as a major professor held no fears for Champ. Though Truog showed tremendous concern for all his students, Champ probably most nearly exemplified Truog's own philosophy about science. One of Champ's favorite Truogisms was: "Here you are swatting at mosquitoes while an elephant is trampling all over you!" Truog also preached that if you wanted to think clearly you should "get up with the birds." Champ went Truog one better, something not easy to do. He was almost always up before the birds and into the office well before daybreak, summer or winter. This habit was initially essential since Champ and his now growing family lived at Badger Village, a student housing complex near Baraboo, Wisconsin, some 35 miles from campus. One had to be up early to catch the bus to campus, and Champ never forsook this early habit.

During his graduate student days at Wisconsin, Champ and Kay demonstrated the determination with which they faced life and its adversities. An epidemic of poliomyelitis swept the country in 1950-51 and hit many college communities especially hard. Champ contracted the virus, and he and Kay battled it with both tremendous determination and optimism. Champ never fully recovered the use of his stomach muscles, but he never allowed the consequences to deter him from whatever physical task was at hand. Despite his disability, the Army insisted that his reserve classification status should remain "Erosion Control Specialist." The military underestimated Champ's determination and eventually capitulated to reality and a superior force and reclassified him.

Champ completed his Ph.D. degree in soil physics with M. L. Jackson (NAS, 1986) as his scientific mentor and E. E. Miller of the physics department as his adviser in physics and lifelong friend. Champ was certain that his illness would prevent completion of his graduate studies. Truog and the department saw it otherwise and assured Champ that his only responsibility was to overcome to the extent possible the illness that had beset him. As a result, Champ developed a loyalty to the soils department and to the University of Wisconsin that was unwavering. He felt a debt that he could never adequately repay. Nonetheless, over his career, repay it he did, many times over.

Champ found as he approached graduation that many institutions were leery of hiring as a faculty member someone with a possible physical disability. Job offers were few, despite the rapid growth of the field of soil physics. Again, Truog's unerring judgment came to the rescue. Truog had a policy of keeping the best graduate students at Wisconsin as the department built up following World War II. Since Wisconsin at that time was turning out many of the best soils students in the country, this was more than chauvinism: it was hard-headed pragmatism. It was almost inevitable that Truog offer Champ a position at Madison. He was clearly an exceptional individual, and his sense of obligation to the university in view of the support given him during his illness made his acceptance of an offer inevitable. Over the years Champ was to receive many feelers about moving elsewhere, but he never gave any encouragement. His loyalty to Wisconsin was unwavering.

THE SOIL PHYSICS YEARS

Champ's entry into academic life as a faculty member emulated that of his mentor, Truog. When his first graduate student, R. J. Hanks, could not find housing in Madison, Champ put the necessary plumbing in an upstairs bedroom and invited John and his wife to stay with them. While later students were able to find their own housing, the pattern was set. It was a rare visiting scientist in Madison who was not invited to stay with Champ and Kay. Once familiar with their hospitality and Kay's cuisine, they rarely declined subsequent invitations. They did this with the full knowledge that, unless they had their own transportation from Middleton to campus, they would have to rise no later than 5:00 a.m. Even then, they would find Champ waiting for them so he could start his day.

Champ's first work in soil physics was along rather classical lines. His first dozen or so papers were devoted mainly to improved methods for the characterization of the physical properties of soils and soil materials. He demonstrated early his flair for improving experimental equipment and techniques to which he turned his attention. He developed improved methods for measuring water retention by soil and for measuring particle size distribution, air-filled porosity, and permeability. This was a time during which the field of soil physics was exploding rapidly, with many universities developing teaching and research programs in this area. While the fundamental physical concepts were in place, experimental techniques for both laboratory and field were generally crude and imprecise. Champ made significant improvements in every technique he addressed but, more importantly, laid the foundation for his keen understanding of the physics of soil systems.

THE MICROMETEOROLOGY PHASE

It was not until he turned his attention to the energy budget of soils, however, that Champ truly showed his talent for originality in experimentation while focusing on the most basic problems at hand. The work by Penman at the Rothamsted Experiment Station in England had laid the theoretical basis for the understanding of evaporation from crops and soils. Champ was among the leaders of an ever-growing number of researchers attracted to this area of work. A rich collaboration was begun with his colleague, Verner Suomi, and a progression of outstanding students as they began to explore the rapidly expanding area of evaporation and transpiration from plants and soil as part of the larger effort on the earth's energy budget.

In characteristic fashion, Champ first examined critically the methodology and instrumentation used in the field. This pattern was to be repeated several times in his career. He would almost invariably find ways to improve the precision and reliability of a measurement. He emphasized to his students in the strongest possible terms that instruments had to be "kept honest" or they would give the researcher misleading or incorrect results. Manufacturers' calibration curves were never to be trusted and were always to be verified or corrected. The amount of water used by crops had become a very controversial issue by this time. It had become well recognized that glass-house measurements did not duplicate external conditions adequately and that only field measurements were meaningful. Most data available were inferred from soil water content measurements. For many reasons such measurements lack precision and, even worse, do not account for drainage from the soil profile. Direct measurements offered the best hope of resolving the issues. Over the next decade almost every known or proposed experimental technique was investigated. The ratio of vapor flux to heat flux above a plant canopy is a critical quantity in many theories, and much effort around the world was focused on these flux measurements. Champ was one of the leaders in this effort. Stomatal conductance measurements were improved. Net radiation measurements above crops and bare soils were addressed and improved. In a highly active area of research, Champ's efforts often went beyond those of most colleagues. He designed and built two very precise weighing lysimeters. One was a cylindrical metal tank about 5 meters in diameter, and the other was a rectangular tank, about 2 by 3 meters. Both were over about a meter deep and were filled with soil packed to simulate a soil profile. A suction drainage system combined with a very precise weighing mechanism permitted measurements of evapotranspiration over periods of time as brief as 15 minutes. All the more remarkable was the fact that Champ kept these installations functioning for over fifteen years, despite the problems of winterizing the equipment to ensure survival through the bitter Wisconsin winters. As a legacy of his polio, pleurisy was a constant threat as he worked underground beneath the lysimeters. Nevertheless, Champ always gave every detail his personal attention.

On the other end of the measurement scale was the eddy correlation method, in which the heat content of individual wind eddies is correlated with the movement of individual eddies. This requires high-speed wind velocity and thermal measurements. Virtually every aspect of evaporation and transpiration received the Champ Tanner touch, and a large cadre of well-trained students began to be graduated. Champ was a leader in setting up a joint program with a number of midwestern universities to provide field instrumentation and experiments for biologists.

By 1965, workers in the field had worked out the general physics of water loss from cropped surfaces and were beginning to explore some of the more esoteric issues. Champ felt that he had pushed the problems of transport in the lower atmosphere about as far as he could. There were many unsolved problems, but the complexity of the plant canopy convinced him that something more than straightforward transport equations would be required to deal with this situation. Simply coupling the stomatal resistance with a canopy resistance term worked remarkably well in many cases, but he found it a very unsatisfactory approach.

During the 1960s and early 1970s Champ was one of the major driving forces behind an exciting experiment in cooperative research between the University of Wisconsin and the Agricultural Research Service (ARS) of the U.S. Department of Agriculture. This joint effort resulted in the establishment of the Hydrology Research Group, staffed by Champ, E. E. Miller, G. W. Thurtell, and W. R. Gardner from the university and P. A. C. Raats, C. Dirksen, and R. Amerman from the USDA. This assembly of scholars attracted an outstanding group of visiting scholars, postdocs, and graduate students. Seminars were not to be missed, as almost every facet of any subject of interest to any participant could lead to stimulating and enlightening debates. The entire group was singularly productive. Though it was an unquestionable scientific and educational success, it was too fragile to survive the mindless random motion characteristic of the Washington bureaucracy, and during one of many reorganizations of the ARS it was simply dissolved.

THE PLANT PHYSIOLOGY PHASE

Partly because it was not clear how to push the transport problems forward and partly as a result of an extremely stimulating sabbatical spent with John Passioura in Australia, Champ turned his attention from the plant environment to the response of the plant to its environment. Once again, he started with the literature, reading critically virtually every paper published in English on plant-water relations, making notes as though he were reviewing them for publication. Within a few months it would be hard to argue that any plant scientist had as thorough a knowledge of the literature of plant response to water stress and of the weaknesses in the experiments as did Champ. No physical measurement was ever too difficult for Champ to attempt, and he was soon into the business of building thermocouple psychrometer and plant pressure chambers.

While Champ loved understanding physical systems for understanding's sake, he always had a pragmatic end in view. His work with the lysimeters resulted in data designed to improve irrigation efficiency in order to reduce the leaching of fertilizer to ground water. Not content to work with easy plants, Champ chose to work with potatoes, an important crop in the central Wisconsin sand plains. He did not stop at measuring the water status of the plant leaves but set himself the task of observing directly the turgor of the potato tubers. Loss of turgor at a critical period could result in misshapen and less valuable potatoes. Measuring tuber elongation in situ did not daunt Champ, despite the need for minimal disturbance. The task of observing with precision minute droplets of exudate forced out of the tubers in laboratory pressure chambers in order to measure their turgor was approached with confidence. With the encouragement and advice of Arthur Kelman, Champ attacked the question of the relation between the plant water status or the water status of the tuber and certain tuber diseases.

Champ also studied the water relations of alfalfa, another difficult plant structure with which to deal. One of his favorite experiments dealt with the effect of direct solar radiation on onion umbels during flowering. This problem appealed to him very much because, geometrically, it was a sphere sitting atop a cylinder. Where else in the plant kingdom could one find an experimental arrangement so conducive to simulation? One of those simulations consisted of a styrofoam sphere covered with different densities of sequins, in order to achieve variable roughness. He and his students found the actual heat transfer from the onion umbel to the atmosphere to be greater than the theoretical, but, more importantly, they showed that the "sun scald" observed in the onion seed fields in Idaho resulted when solar radiation and wind were from the same direction. This project brought Champ almost as much fun as his favorite project on heat transfer. Always open to challenging problems whatever their context, he collaborated with colleagues from animal science to work out the temperature distribution and evaporative heat exchange in the scrotal system of the boar. Under pressure, he would confess that his approach was less “hands-on” than was normal for him.

Champ was also a keen student of science. F. H. King had held the first chair of agricultural physics in the United States, and Champ was fully conversant with all his work and felt a strong kinship with King. The two careers spanned a century of soil physics in the United States, and between them there were few important problems in the field that they did not address and did not bring more physical science to.

Champ had a unique ability to synthesize information from an extremely diverse set of experiences, theories, speculations, and observations. His career contributions are probably best summed up in the 1983 review paper with Sinclair. In simplistic terms they showed that the production of total dry matter by a plant was directly proportional to the water transpired and inversely proportional to a mean saturation deficit of the atmosphere. While C3, C4, and CAM plants all differed, their transpiration efficiency, countless generations of plant breeding, advertent or inadvertent, had served to change these efficiencies hardly at all. While this oversimplifies the actual situation, the conclusions pointed out clearly the directions that future research must take, if the relation between crop water use and crop growth was to be altered in desired directions. The heated controversy that had characterized soil physics and crop physiology for decades was now resolved.

THE FINAL YEARS

Champ was honored with a named professorship at Wisconsin, appropriately named after Emil Truog. He also received the Soil Science Research Award from the Soil Science Society of America and the Outstanding Achievement in Biometeorology Award from the American Meteorology Society. At one time he was an associate editor of journals in three distinct disciplines. He often expressed the complaint that editors seemed to send him only the most difficult papers to review. He was quite correct in this. If an editor had a paper that was certain to rouse the ire of an important and contentious scientist, it was a sure bet that Champ would get it for review.

His work hours were legendary. His standards of science and personal integrity were almost unrealistically high. His willingness to debate politics with even the most ardent partisan, coupled with the unfailing generosity and hospitality of the Tanner home, meant that an evening at the Tanner home was a never-to-be-forgotten experience. The stories his students now pass on to their students may sound apocryphal to those who did not know Champ. But it was impossible to exaggerate where Champ was concerned. He was entirely without guile and what you saw was what you got. The Tanners' youngest son, Clarke, a gifted pianist with a promising career ahead of him, died of leukemia just before he was to accept a music scholarship at Milton College. Despite such heartaches and his own physical limitations, Champ never lost his zest for life and learning that buoyed up all those who knew him.

At a time in his life when he might well have followed the tradition of many of his colleagues and started slowing down and enjoying the fruits of his labors, Champ remained entirely true to his character. He was elected to the National

Academy of Sciences in 1981, the first such soil scientist thus recognized. He took this not so much as a well-deserved honor but as a call to duty. He worked conscientiously to seek out and nominate others deserving of recognition. He accepted appointment to the Board on Agriculture of the National Research Council and played a very active role on the board. Finally, although he detested paperwork with great fervor, his loyalty to his campus and his department compelled him to accept the chairmanship of the soils department. He undertook this assignment in the only way he knew how, with thoroughness, candor, and selflessness. A series of key retirements threatened to tarnish the luster of what had been one of the top such departments in the world. Champ set about a vigorous effort to obtain positions and fill them with the best scientists available. At the same time he continued working with his students.

Champ found great satisfaction in working with his oldest son, Bert, who, trained in geophysics, eventually entered the private sector with a small, creative company producing data logging and processing systems. His middle son, Myron, trained in hydrology, also directed his talents to the private sector. The Tanners had two daughters, Taffy and Terri, whose own careers have demonstrated that they inherited both the capabilities and the standards of their parents. Both of Champ's brothers, now deceased, were talented engineers.

On the occasion of his retirement, Champ's colleagues honored him with a Symposium on Biophysical Measurements and Instrumentation at the annual meeting of the American Society of Agronomy in November 1988. Selected papers from the symposium were printed in the journal *Theoretical and Applied Climatology* (vol. 42, 1990). Despite the knowledge that his pancreatic cancer was almost certain to prove fatal, Champ maintained his work schedule to the limit of his physical ability and did as much as he could to put his personal and professional affairs in order. His life's work included some 150 technical articles, book chapters, and reports, as well as more than three dozen theses supervised.

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