Book Reviews

Zest and Productivity

The Wind and Beyond. Theodore von Kármán, Pioneer in Aviation and Pathfinder in Space. THEODORE VON KÁRMÁN with LEE EDSON. Little, Brown, Boston, 1967. viii + 376 pp., illus. $10.

The USAF Scientific Advisory Board. Its First Twenty Years, 1944–1964. THOMAS A. STURM. U.S. Air Force Historical Division Liaison Office, Washington, D.C., 1967. (Order from Superintendent of Documents, Washington, D.C.) x + 194 pp., illus. Paper, $1.25.

Theodore von Kármán's autobiography should appeal to readers beyond those primarily interested in aeronautical research and even beyond the ranks of the scientific community. Admittedly, one approaches the work with skepticism. Books written "with" or "as told to" a journalist are usually thin gruel at best. But here the collaboration has been a happy one; in the scientist's own words, "It's me in good English." Certainly the portion of the volume completed before the subject's death is authentic Kármán; it successfully captures the man whom many of us remember, brilliant, lucid, witty, gregarious. It is the triumph of this book that it manages to combine a chatty, anecdotal, and highly readable tale of a distinguished scientist's everyday life with a substantial number of penetrating insights into the creative process, its ingredients, nurture, and exploitation.

If for no other reason than the fact that he is of that spectacular generation of Hungarian scientists to which Teller, Szilard, Polya, von Neumann, and others also belong, an account of von Kármán's origins and early education is of general interest. Son of a closely knit, multilingual, upperclass Jewish family with scholars on both sides of the family tree, the young Theodore enjoyed a rearing that would have pleased John Dewey: devoted parents, frequent praise, stimulating travel, and attendance at an experimental primary school stressing discovery rather than memory. At high school emphasis was on competition; public recognition for the teachers of prize-winning students added an extra dimension to the game. At school and at home the importance of theory was accentuated: "a practical engineer is one who perpetuates the mistakes of his predecessors." This orientation was carried further by an early encounter with Henri Poincaré's *Science and Hypothesis,* which helped the budding scholar develop a sound heuristic sense.

The critical turning point came in 1906, when von Kármán decided to study applied physics at Göttingen under Ludwig Prandtl, "the father of aerodynamics." In 1911 the obscure young Hungarian published a brilliant paper on a hitherto elusive source of drag, "the Kármán Vortex Street," thereby establishing his reputation. One always hopes to find in the biography of a scientist not only an account of the sequence of steps leading up to his great discoveries but also some new light on the intuitive leaps involved. If this volume falls short of this ideal, at least it compensates with a wealth of lesser insights. There are shrewd and amusing accounts of the German university community and something of its inner dynamics. Even better are the glimpses the author affords us of those qualities which made him a notable teacher: his delight in people, his insistence upon the importance of informal exchanges, and of the free comradery of the drinking hall. In the classroom he was a master of clear exposition, a gift repeatedly illustrated in his autobiography. His secret was the principle of least effort, cutting away nonessentials until all that remained was a core of elegant simplicity. Whenever possible he reduced this core conception to a graphic representation, which he then sought to express in a mathematical formula.

During World War I von Kármán took time out for a venture in applied science, developing a tethered helicopter as a substitute for barrage balloons in the Austro-Hungarian imperial army. One of the powerful drives of his life, fully evident after he accepted a chair of aeronautics at Aachen, was the desire to bridge the gap between science and engineering. While advocating massive doses of theory and mathematics for students of engineering, as a scientist he repeatedly concerned himself with practical applications. By doing so he attracted large research subsidies from industrialists such as the aviation pioneer Hugo Junkers.

The second critical turning point in von Kármán's career came in 1929, when Robert A. Millikan, of Cal tech, offered him the directorship of the institute's aeronautical laboratory, newly established through the vision and largess of Daniel Guggenheim. The rise of the Nazi party made it expedient for him to accept, even though the German Air Ministry wished to retain his services. Goering had said, "Who is or is not a Jew is up to me to decide." Von Kármán's great personal charm and thoroughly international outlook made the transition relatively easy. Now, instead of working for Hugo Eckener and the Zeppelin interests, he was serving Akron and the aircraft industry of southern California, where his efforts contributed to the development of that great design landmark, the Douglas DC-3 transport. His influence grew rapidly. As a consultant he helped found the Japanese aircraft industry, building the first industrial wind tunnel in that country; he studied wind phenomena in an effort to break the dust storms of the 1930's and was called in to investigate the spectacular collapse of the Tacoma Narrows suspension bridge. And all the while as a teacher he was turning out a generation of students, including many Air Corps officers who were to produce the air power which helped bring victory to his adopted nation in World War II.

The impact of von Kármán's sparkling genius on the national military effort has been profound. In contrast to the mistrustful and secretive Goddard, his gregarious nature and network of friendships quickly drew him into positions where his imagination and initiative enjoyed effective leverage. He brought his work in supersonic aerodynamics to the Ballistic Research Laboratory of Army Ordnance, secured air arm funds as early as 1939 to design a rocket-propelled aircraft, trained the group that developed JATO, the rocket device for assisting conventional take-offs, and helped found Aerojet Engineering Corporation, which sub-

sequently grew into a $700-million-a-year corporation, the GM of the rocket industry. But most significant of all was his role in forming the Scientific Advisory Board, a cluster of civilian scientists recruited to help determine the direction of research to be pursued by the Air Force. It was he more than any other individual who upset the prewar division of federal effort by which the National Advisory Committee for Aeronautics largely monopolized fundamental research in aerodynamics, leaving applied research to the military services. Under von Kármán's prodding, the Air Force adopted fundamental research as a major military responsibility. The successive steps by which this was accomplished are spelled out in Thomas A. Sturm's official history of the SAB. If Sturm's prose is bureaucratic, his study is nonetheless welcome as a factual and official supplement to the somewhat freewheeling autobiography.

This reviewer would take serious issue with von Kármán on only two points. He is unfair in charging military men with myopic resistance to recognizing the importance of basic research. He fails to support his sweeping assertions on this score, and it is he who is myopic in failing to appreciate such institutional factors as the built-in inertia of large organizations manned by short-term staff. And concerning his harsh condemnation of his old master Prandtl for serving Hitler, it is only fair to ask: would von Kármán himself have done differently had he not been a Jew?

In retrospect, one sees von Kármán as a remarkable human being. A great showman, he was an inspiring teacher. But he demanded as he gave; his friends soon learned the voracious requirements of his ego. His zest for intellectual creativity thrived on convivial drinking and the company of beautiful women. He was a thoroughgoing internationalist, and his science knew no national horizons; one of the great prides of his life was his role in creating AGARD, the Advisory Group for Aeronautical Research and Development in the NATO nations. As scientist and engineer, to the day of his death in 1963, he retained the faith of his childhood; he saw no conflict between science and religion: "science deals only with consistency, not with truth."

I. B. HOLLEY, JR.
Department of History, Duke University, Durham, North Carolina

Developmental Immunology

Ontogeny of Immunity. Proceedings of a workshop, Sanibel Island, Florida, Feb. 1966. RICHARD T. SMITH, ROBERT A. GOOD, and PETER A. MIESCHER, Eds. University of Florida Press, Gainesville, 1967. xiv + 208 pp., illus. $15.

One has only to skim through this volume to realize the magnitude of the revolution that has taken place in experimental biological science during the past decade. The subjects discussed constitute the moving edge of the area in which immunobiology, tissue transplantation, molecular biology, and developmental biology meet. Most fundamental is the problem of differentiation —one of the enigmas of biology, and probably the key to the eventual understanding and control of the problems of neoplastic growth, transplantation of genetically foreign tissues and organs, aging, and indeed of biological evolution itself. We have come a long way from descriptive embryology and from the classical biochemical "bag of enzymes" approach of Needham's *Chemical Embryology*. This workshop illustrates well the grist of modern biological science, as well as its exciting intellectual fare. It is clear from the list of professional and departmental affiliations of the participants that in this as in other areas of modern biology, the traditional academic departmental boundaries are being transcended. There is obviously a lesson for us here with respect to what constitutes the "best" academic background and training for our next generation of experimental biologists.

One of the participants, Schneiderman, discusses control systems in the differentiation of silkworms and recounts the fascinating story of the molting hormone, ecdysone, which Karlson and Butenandt isolated from 1000 kilograms of pupae, crystallized, and identified as a steroid. This insect hormone and its relatives appear to act on the cell nucleus, and perhaps on the genes directly, to set into motion the synthesis of specific RNA's involved in growth and molting. The discovery of biologically active steroids in insects certainly implies that steroid hormones are not a recent evolutionary acquisition of the vertebrates.

The formation of fiber cells from epithelial cells in the vertebrate lens provides another example of differentiation susceptible to the molecular biological approach. Here, Papaconstantinou demonstrates the synthesis of a new group of specific proteins, the γ-crystallins. Initially, the synthesis of these proteins is susceptible to inhibition by actinomycin D, but this susceptibility is lost in the fiber cell—a loss probably referable to the differential turnover of messenger RNA in the different cell populations.

The many questions and conceptual problems associated with differentiation of the lymphoreticular cells to specific antibody formation are discussed in a series of excellent papers. Following the now-classic observations of Fishman on the two-cell interaction (macrophages and lymphocytes) in antibody formation, Feldman and Gallily beautifully show the applicability of the Fishman concept to the production of anti-*Shigella* agglutinins by x-irradiated mice. Still not settled is the question of whether the macrophage-processed antigen acts as a "superantigen," or whether the RNA of the complex contains specific messenger-like information for the antibody synthesis.

Clearly, one is concerned here with *messages* between cells, or at least with functional interactions between cells in a given microenvironment, the significance of which is just beginning to be glimpsed. The technically relatively simple procedure for culturing human blood lymphocytes represents, as Hirschhorn so cogently explains, another model experimental system for the investigation of derepression, differentiation, mitosis, and the specific cellular and molecular events occurring during the immune response. The question of pre- and postnatal immunological function of the lymphoreticular system forms a separate "chapter" of this volume. What is the nature of immunological immaturity? The immunological responses of the fetal lamb and of fetal rhesus monkey (Silverstein), in contrast with those of the "fetal" opossum, in which plasma cells are not found until 40 days after birth (Block), give us pause in the use of the term "immunological immaturity"; certainly in the case of several mammalian species, including man, fetal spleen can be shown to synthesize γ-M immunoglobulins in vitro (Thorbecke and Van Furth). Hildemann contributes a thoughtful discourse on transplantation disease. "Purified" small lymphocytes derived from peripheral blood or thoracic duct lymph are apparently able to initiate graft-versus-host reactions. But here again, the question of the role of the macrophage, as well as of the identity of the lymphocyte type respon-