

by their activities, needs, and reactions both in life histories and in morphological adjustments. The book is written for the nonspecialist, but is not written down to him, with the result that the technical ornithologist will also find it interesting and rewarding to read. The author interjects his own reactions to discussions about many uncertain topics, and as his personal experience has been worldwide and prolonged these are of interest to his professional colleagues as well-reasoned and balanced statements.

Thus, in his preface, the author writes that the basic problems that birds have had to face, those of reproducing themselves and of occupying and utilizing as fully as possible the space and the diverse habitats of the world, have been met in many ways and it is the diversity of these solutions that makes the study of birds as living organisms so endlessly fascinating. The book is arranged by topics into some two dozen chapters. To take but a few of these headings, we may mention the senses of birds;

patterns of diversity; activity and rest; migration and hibernation; behavior, instinctive and learned; and the nature of species. This type of "breakdown" constitutes a new and welcome departure from the usual, prosaic type of textbook presentation.

The illustrations, by E. J. Pfiffner, are all black-and-white drawings with no attempt at a high degree of finish, but they are effective as visualizations of points made in the text. The book closes with five useful appendices containing information on such topics as classification and field-study techniques, a list of suggested reading, and the scientific names of all birds mentioned in the text. The book is adequately indexed, and should be a most useful as well as a reliable volume for the layman interested in knowing about birds, not just the birds in his immediate locality but birds in general.

HERBERT FRIEDMANN

*Los Angeles County Museum of
Natural History, Los Angeles,
California*

The Technological Awakening and Its Sources

Engineers of the Renaissance. BERTRAND GILLE. M.I.T. Press, Cambridge, Mass., 1966. 256 pp., illus. \$12.

For all they may teach and inform, relatively few in the scholarly world produce books that carry their message with grace and style. But Bertrand Gille bears the burden of his extensive knowledge with deceptive lightness, conveying to the reader a history so well told that we unconsciously assume it to be already familiar. Considering that he provides us with an essential historical narrative, missing from the normal annals of civilization, this is a fine accomplishment indeed.

Engineers of the Renaissance deals to a large extent with the makers of the material environment—or rather the leaders of technological development—at a time when the Western world was undergoing enormous change. By an act of formidable original scholarship, Gille has transformed the primary material of this development—its artifacts (fortifications, bridges, houses, dikes, canals, and the like), its aspirations and its dreams (the drawings and diagrams of industrial machines, automata, and the mechanisms of war), and its rationale (the rare treatises, texts, and apologetics, most of them in manuscript, of the

nascent engineering professions)—into a historical narrative that gives us a balanced view of technological history. That assessment demonstrates the roots of the technological movement in the past, above all in the booming, expansionist atmosphere of the Hellenistic world. Its continuity through the succeeding medieval period is stressed, and though the new "awakening of technological thought" is revealed to be a 14th-century German phenomenon with considerable emphasis upon military technology (as revealed by such frequently imitated treatises as Konrad Kyeser's *Bellifortis*), the narrowness of the German school is also made clear. Limited by their concern mainly for military hardware, satisfied too soon with single solutions to engineering problems, their curiosity fixed by early success, the Germans were soon left behind by the Italians, whose daring and grace and boundless disposition to inquire brought them simultaneously to the pinnacle and the center of Renaissance technology, even as it did in the science of the period.

If the technicians of northern Europe emerged from a military matrix, those of Italy rose from a softer clime, with different ambitions and larger hopes.

"They were true humanists," Gille tells us, "artists or scholars, who, beyond their particular problems . . . looked for general solutions . . . and the means for completely dominating the new world which was opening out. It was almost by accident that, as they proceeded, they encountered the military problems which were simultaneously engaging the attentions—but in this case almost to the exclusion of everything else—of their contemporaries north of the Alps" (p. 79).

The case for the Italians, and it is essentially one made for their imaginative fertility, is measurable in this general study of Renaissance engineering by a crude quantification. Of the ten chapters in the book, five are devoted to their accomplishments. In the course of his Italian tale, Gille also finally lays to rest the panegyric mythology of Leonardo da Vinci's alleged accomplishments in science and technology. If Leonardo's achievements are less than the obvious merit of the great drawings we have come to know, if originality is only an occasional ingredient in a welter of derivative ideas, there are a methodology and a conceptual aspiration that are truly his, and these Gille rescues and explains. In the problems of designing gears and of determining the elasticity of beams, in the studies of eddy currents, and in an occasional capacity to generalize (as is exhibited, for example, in his theory of water pumps) he showed remarkable powers, but even though he experimented from time to time he was not systematic or logical in his research. He "tried to define technical truths by the setbacks, mistakes, and catastrophes he experienced, just as doctors have acquired their knowledge of men through the expedients of their illnesses. . . . A scientist . . . would have been aware of the enormous gaps that existed and would have tried to build up a scientific whole. Leonardo was an engineer who was concerned only with efficiency and whose efforts brought him no more than a means of acquiring power over the material world" (p. 190).

In the last analysis, Gille shows us how the Renaissance engineers, for all the novelty of the world in which they lived, were bound by their own traditions. But though these may have led them into places which closed down upon them because the real stuff of the world would not respond to their theories, their aims nevertheless embraced the continuing technological

ideals of systematic mechanization and progress. An enormous debt was owed to the Renaissance engineers by those, for example, who were to find fundamental physical law in the free fall of a stone. Gille demonstrates this forcefully toward the end of this extremely well-wrought volume by bringing the circle of our understanding to a close with the reminder that Galileo was one of them.

HARRY WOOLF

*Department of the History of Science,
Johns Hopkins University,
Baltimore, Maryland*

Physical Adsorption

The Solid-Gas Interface. E. ALISON FLOOD, Ed. Dekker, New York, 1967. Vol. 1, xviii + 514 pp., illus. \$21.75; vol. 2, xvi + 661 pp., illus. \$27.50.

This two-volume treatise brings together knowledge of essentially all aspects of physical adsorption of gases on solids, and at the same time treats the subjects in depth. The work consists of 37 chapters written by various authors, and each volume is concluded with a commentary on its contents. There is some overlap of subject matter among the chapters, but for the most part this duplication is useful in that a different point is emphasized in each chapter. Chemisorption is not comprehensively covered, but it is mentioned in many parts of this work; likewise, liquids are treated in relation to certain topics such as sorption.

After a historical survey of the study of adsorption, volume 1 goes on to cover most of the basic phenomena and the theory of adsorption. Subjects dealt with include thermodynamic analyses of adsorption, treatments which lead to the BET (Brunauer-Emmett-Teller) and other classical isotherms, adsorbent-adsorbate interaction forces, surface energy and structure, adsorbate equations of state, and lattice theories. The papers range from complete derivations and lucid discussions (for example, of Gibbs's isotherm) to more abbreviated developments, but each is complete in itself. Also covered in volume 1 are heats of adsorption and immersion, surface cleanliness, and very-low-pressure adsorption.

Volume 2 covers the various methods and techniques used to study surfaces and adsorbed layers and also covers sorption and transport prop-

erties of gases on or through solids. Among the methods discussed are dielectric, magnetic, optical, infrared, nuclear magnetic and electron paramagnetic resonance, Mössbauer, and low-angle x-ray scattering studies. A discussion of semiconductor surfaces complements the electronic studies. Adsorption accompanied by dimensional and other physical and mechanical changes is reported on, as are theories of pore structure. Ways in which pore structure and adsorption influence the interaction of gases and solids are discussed in chapters on chromatography, accommodation coefficients, and adsorption hysteresis. Active carbon, perhaps the most frequently used adsorbent, is given a chapter by itself, but otherwise the work is arranged according to the method or theory employed.

These volumes adequately present the principles of the various methods used to study adsorption in addition to comparing the various applications of these techniques. They also provide generous quantities of experimental results which are used to evaluate and test experimental studies and theoretical descriptions of adsorption, as well as to characterize adsorption phenomena. The treatise admirably fulfills its aim of combining theoretical and experimental results from a wide range of disciplines relevant to adsorption. It is readable and should be immediately useful to all workers in this field. The specialized researcher and the graduate student alike can gain a nearly complete background in physical adsorption from this treatise.

TERRELL N. ANDERSEN

*Department of Chemistry,
University of Utah, Salt Lake City*

Technique in Protein Chemistry

Cross Electrophoresis. Its Principle and Applications. SHOJIRO NAKAMURA. Shoin, Tokyo, 1966; Elsevier, New York, 1967. x + 194 pp., illus. \$17.

This little book, describing a modification of the usual paper electrophoresis procedure, demonstrates what can be done with imagination combined with a thorough knowledge of the technique. A recent issue of an authoritative journal devoted to biochemical research contained 20 papers (out of a total of 37) which could have been significantly improved by the use of paper or gel electrophoretic methods. More

certainty of results, economy of experimenter's time, and reduction of material consumed are all desirable objectives in any experimental technique. This book provides evidence, which can easily be extended, that these objectives can be achieved by use of paper and gel electrophoresis techniques.

Why are these techniques used so ineffectively, if at all? Why, for example, do we continue to see the homogeneity of a protein preparation "demonstrated" by ultracentrifugation—or even by free-solution electrophoresis—when the example of the serum albumin polymers proves the superior resolving power of gel electrophoresis? Why is there not more use made of discontinuous buffer systems, two-dimensional gels, or ion-exchanger gels, all of which can contribute significant information, including some that cannot be obtained from any other experimental procedure?

One reason may be the absence of electrophoresis experiments in the usual undergraduate biochemistry courses. Another may be the tendency of the modern molecular biologist, accustomed to using digital computers and nuclear magnetic resonance, to look with disdain upon electrophoretic procedures: the apparatus is inexpensive (often homemade), the mathematical theory does not go beyond high school algebra, the results are little more than qualitative. Worst of all, good results demand more artistic talent than scientific technique. Whether or not these strictures are valid, the consequence is a serious deficiency of interest in electrophoresis methods, and failure to apply them as useful laboratory procedures.

Perhaps these characteristics of electrophoretic methods are really advantages. I myself prefer paper and gel methods to free-solution electrophoresis just because of them. At any rate, such purported deficiencies do not diminish the usefulness of the technique Nakamura describes in the present work.

I must confess that, on first reading this book, I was appalled by the opportunities I have missed. For years I have tried to eliminate "artifacts" and irregularities from my electrophoresis patterns, the object being to produce paper or gel electrophoresis patterns as much like the standard free-solution electrophoresis pattern as technical control can make them. Nakamura has perceived that deviations from the expected pattern are not after all purely accidental: they are the predictable results