the U.S. cancer data as they supposedly reflect the occupational cancer burden are disparate.

The conference provided an interesting and worthwhile collection of papers on occupational cancer epidemiology. Some of the most enlightening reading is the discussion material included after most of the papers. As one might expect, the question of what estimated percentage is best is not resolved. One positive suggestion by Peto merits consideration. He proposes a very large case-control study of lung cancer, which might aid in sorting out quantitatively the individual and synergistic impact of each of the suspected risk factors. The papers and discussions contained in the Banbury report will no doubt convince the reader of the difficulty of quantitatively estimating an occupational cancer burden with present data and methodologies.

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## Music and Psychology

**The Psychology of Music.** DIANA DEUTSCH, Ed. Academic Press, New York, 1982. xviii, 542 pp., illus. $49.50. Academic Press Series in Cognition and Perception.

Helmholtz's 1863 treatise *On the Sensations of Tone as a Physiological Basis for the Theory of Music* identified response characteristics of the auditory system as the basis for the evolution of certain musical structures and compositional conventions. This early work, coupled with later increased precision in sound production and measurement of behavioral responses, generated an extensive literature on the relations between acoustic and sensory representations of sound. Both musical and psychological considerations, however, suggest that explanations based on peripheral mechanisms are limited. Such accounts are at odds with the diversity found in music cross-culturally, as well as with the explorations of novel pitch structures and timbres in 20th-century Western composition. Moreover, music-theoretic treatments of traditional Western music extend well beyond and sometimes contradict the constraints implicit in the view established by Helmholtz. Physiological acoustics, in addition, provides an inadequate framework for psychology's broadening conception of musical behaviors, which includes the skills exhibited in performance, the rich perceptual and cognitive aspects of the response to music, and the influence of cultural and social factors.

From these concerns has emerged what might be called a new psychology of music. The volume edited by Deutsch is the first comprehensive collection of papers on a wide range of musical topics treated from the perspective of empirical psychology. Each contribution considers a different topic, and, though different experimental methodologies are employed, interesting connections among the approaches represented become apparent. The application of concepts from physical acoustics to the subject of the listener in the acoustic environment is balanced with a concern for the measurement of subjective variables. Psychoacoustic treatments of pitch and of the physical and sensory basis for intervals, scales, and tuning systems consider the experience of the listener as well as general perceptual and cognitive factors. Detailed analyses of the physical correlates of instrumental and vocal timbres are provided with reference to expressive and other musical functions of performance. Measures of the perception and production of temporally structured musical patterns reveal complex associations between motor movements in performance and perceptual organization of meter, stress, and rhythm. Thorough reviews of the literature on memory for music cover absolute pitch and variables that affect the ability to organize, recognize, and remember tone sequences. Abstract conceptual systems are described that represent pitch in terms of hierarchically organized temporal and tonal-harmonic relations. The diversity of musical functions is apparent in the treatment of individual differences in ability, developmental changes in perception and memory, and the dissociations observed in clinical cases of musical dysfunction. Music is considered in its emotional and social context, and the relation between recent developments in the psychology of music and contemporary music composition and theory is evaluated.

This collection is an invaluable source for the reader interested in music from any perspective. The papers are of uniformly high quality, and the selection of contributors properly reflects the diverse activity in the field. Extensive lists of references provide excellent guides to the widely scattered literature.

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## A Barrier Reef

**The Atlantic Barrier Reef Ecosystem at Carrie Bow Cay, Belize, I.** Structure and Communities. KLAUS RÜTZLER and IAN G. MACINTYRE, Eds. Smithsonian Institution Press, Washington, D.C., 1982 (distributor, Superintendent of Documents, Washington, D.C.). xiv, 540 pp., illus. $18. Smithsonian Contributions to the Marine Sciences, no. 2.

The barrier reef off the shore of Belize is the second largest in the world. Yet, aside from early expedition studies and infrequent visits by shipboard scientists, the region is largely unknown. The reef complex includes not only the extensive barrier but also the only atolls in the Caribbean. As a reservoir for increasingly endangered coral reef organisms and as a site for research on pristine reefs, the Belizian barrier reef is unequaled. This volume presents the first extensive series of investigations on the barrier reef, carried out at the newly established research station at Carrie Bow Cay.

The volume is primarily descriptive: the reefs are mapped, the tides and currents monitored, the flora and fauna surveyed. Systematic accounts include works on the Belizian hydroids, diatoms, algae, sea grasses, scleractinians, octocorals, sipunculids, isopods, pycnogonids, crinoids, and ophiuroids. The primary reef habitats are described, zonations are established, and reef structure is compared with that in other well-known Caribbean localities. The strength of the volume lies in this rich empirical foundation.

The volume suffers from some obvious omissions. Most glaring is the lack of any description of the vertebrate fauna. There is insufficient discussion of the distribution and abundance of sponges, echinoids, and gastropods. Many of the ecological studies are of very specialized interest and add little either to the overall description of the reef or to a more general analysis of processes regulating reef structure and function. Excepted from this criticism are the studies of Norris and Fenical on chemical defense in algae and of Graus and Macintyre on

ecophenotypic variation in scleractinians; both deserve a wide audience.

Despite its omissions, the volume will have enduring value. Advances in tropical field biology are ultimately dependent upon the vision and energies of the rare scientist who establishes a research station and guides it through the early years of descriptive science. This is particularly true for coral reef research. Reefs are phenomenally diverse, and synthetic studies must rest upon a rich knowledge of taxonomy, distribution, and abundance. Reef scientists must applaud Klaus Rützler, the station's founder, for his efforts and the Smithsonian Institution for its farsighted policy of support for long-term tropical field studies. The establishment of the research station at Carrie Bow Cay and the detailed description provided in this volume cannot fail to stimulate research on coral reef biology and geology.

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## Metal-Metal Bonds

**Multiple Bonds Between Metal Atoms**. F. ALBERT COTTON and RICHARD A. WALTON. Wiley-Interscience, New York, 1982. xiv, 466 pp., illus. $47.50.

The developing chemistry of metal-metal bonds is one of the major factors contributing to the rise of present-day inorganic chemistry. Within the broad spectrum of inorganic compounds and materials that contain metal-metal bonds, those with multiple bonds hold central positions. Cotton's discovery in 1964 of the quadruple bond in $Re_2Cl_8^{2-}$ caused the awakening of a new era in chemistry. If quadruple bonds can exist between metal atoms, what are the possibilities that pentuple and sextuple bonds may be formed, and what, too, for bonds of fractional order, such as 1.5 and 2.5? How short can metal-metal distances become, and how strong are metal-metal multiple bonds? Could a metal-metal quadruple bond be stronger than the triple bond in carbon monoxide? Can metal-metal multiple bonds provide reactive functional groups for inorganic reactions in a manner parallel to that that is well established for C≡C, C≡N and C≡C functions in organic chemistry? Aided by the powerful tools of automated x-ray diffractometers and a multitude of spectroscopic and calculational techniques, Cotton and his co-workers set about studying metal-metal multiple bonds. This is the first comprehensive treatise written on the subject, sometimes referred to as "Cotton chemistry," though the appelation should not denigrate the many significant contributions of others such as Walton.

The first chapter of the book provides a general overview of the subject and traces its development. The second, third, and fourth chapters deal with quadruple bonds, and the fifth chapter deals with triple bonds. The chapters on quadruple bonds are divided into sections by element (Mo, Cr, Re, Tc, W), and the chapter on triple bonds is divided according to electronic configuration ($\sigma^2\pi^4$, $\sigma^2\pi^4\delta^2\delta^{*2}$). Then follow chapters on double bonds and compounds, such as Rh(II) and Pt(III) dimers, with close formal relationships to those with multiple bonds. In each of these chapters, the preparations, derivatizations, and reaction chemistry of the compounds are described. A chapter entitled "Physical, spectroscopic, and theoretical results" discusses structural and thermodynamic data, numerical electronic structure calculations, electronic spectra, vibrational spectra, and photoelectron spectra for the various types of compounds, as well as the diatomic molecule $Mo_2$.

The book is well structured and written. Each chapter is referenced separately. There is an extensive index, and the table of contents is broken down in considerable detail. Consequently, the book is easy to use as a reference source. It will undoubtedly find its way onto the library shelves of most chemical institutions and inorganic and organometallic chemists. It will be used extensively in graduate-level chemistry courses. Most of all, it will provide a concise historical account of the childhood years of the chemistry of metal-metal multiple bonds.

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