proach, and a more complete treatment of this subject will require filling in of the latter. Also lacking in the book is discussion of other phenomena that may affect long-term orbital evolution, such as the effect of the nonlinear interplay of the secular resonances discovered by Williams with close planetary encounters. In some cases, further work on such phenomena calls into question the validity of some of Öpik's conclusions.

These omissions need not be a problem, provided the reader regards the book as an introduction to the important field that Öpik pioneered. It may be hoped that its availability will result in more scientists' becoming his followers.

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Island Biota

Biogeography and Ecology in the Canary Islands. G. G. KUNKEL, Ed. Junk, The Hague, 1976. xvi, 512 pp., illus. + plates. Dfl. 160. Monographiae Biologicae, vol. 30.

Papers giving information about the natural history of the Canary Islands are countless and are scattered through periodicals that are often difficult to obtain. A summary of the subject has long been desired. Considering the difficulties of getting various specialists to write articles that together represent a substantial part of the disciplines included in "biogeography and ecology," the book Kunkel has produced is reasonably well balanced. Beyond the scope of the title, however, are contributions on place names and biochemistry. An analysis of the economic history of the islands from clearing time to tourism time would certainly have been more appreciated. The volume is attractively got up, with good illustrations. Extensive reference lists enhance its value.

The individual islands are introduced at the beginning. Together they form a chain that geographically can be considered a prolongation of the Atlas range. Hypotheses about the origin of the archipelago are numerous. According to one the islands were once part of Africa, later breaking away and drifting westward. According to another they arose as independent volcanoes from the sea bottom. Finds of fossil ostrich eggs and land turtles seem to imply that land bridges to the Continent once existed. Strictly geological facts, on the other hand, irrefutably favor a purely oceanic origin. Relevant data are still insufficient, and in this volume a comprehensive report, mainly stratigraphical and petrographical, on recent progress in the geology of the islands takes a cautious attitude.

Solution of the origin problem would offer the biogeographers a firm base for discussion of the controversial question of how the archipelago received its biota. The uncertainties notwithstanding, it is generally agreed that the islands became refuges for a once widely distributed Tertiary biota which was largely exterminated in the Tethyan area as a result of catastrophes such as the desiccation of the Sahara and the extension of polar ice caps. In a paper on endemic vascular plants paleobotanical and biogeographical arguments are given for this view. For example, certain genera and families common to the Canary Islands and America but now absent from the Mediterranean area are also represented in southeastern Asia. Furthermore, primitive floral features such as higher proportions of diploids and woody forms are typical of the archipelago as compared with the Continent, where survivors had to evolve in response to more drastic climatic changes. The island isolation led to a biota very rich in endemic species and also with many endemic genera.

Indigenous mammals are absent, but a fossil rodent is known. Probably the entire fauna was once richer than it is today. A paper on recent ground beetles of laurel forests, a faunal group extremely rich in endemics, indicates that volcanic activity may have been important for the development of the fauna. The westernmost islands, Hierro and La Palma, with surface rock from relatively recent geological times, are unexpectedly poor in species compared with their next neighbor island, Gomera, which was undisturbed for a long period. On Tenerife, the middlemost island, recent patterns of distribution indicate that the fauna of an intermediate zone was not too long ago exterminated by deposition of volcanic material. Through resulting isolation vicariants evolved in the remaining zones, contributing to an especially great wealth of forms.

Other papers in the volume deal with climate, the laurisilva flora of Hierro, lichen flora and vegetation, fungus flora, bird fauna (rich in species, poor in endemics), amphibian and reptile fauna (poor in species, rich in endemics), and limnetic Crustacea.

The rapidly accelerated influence of man on vegetation and soil is accentuated in an account of introduced floral elements and exemplified by a report on recent developments on Hierro. In these and several of the other papers mentioned it is stressed that certain species of plants and animals are on the point of being exterminated. Nature conservation is young in this part of the world, and the work before ICONA (Instituto Nacional para la Conservación de la Naturaleza) is enormous if the islands are to keep the character of a unique refuge. In the last page of text the pious hope is expressed that leaders of tourist groups could by increasing public interest contribute to the conservation of the biota. Perhaps it would be a good opening to put the present book in their hands.

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Nonlinear Optics

Quantum Electronics. A Treatise. Vol. 1, Nonlinear Optics. HERBERT RABIN and C. L. TANG, Eds. Academic Press, New York, 1975. In two parts. Part A. xii pp. + pp. 1–472, illus. + index. $35. Part B. x pp. + pp. 473–754, illus. $22.50.

The origins of nonlinear optics are linked to the advent of powerful laser light sources some 15 years ago. This very active and still vigorously growing field is concerned with the interaction of light with matter at high intensities where the material properties, notably the dielectric susceptibilities or optical refractive indices, are themselves functions of the light-field strength. Nonlinear optics has not only led to the discovery of interesting new effects and phenomena, it is providing powerful new spectroscopic tools to study the structure of matter, and it has become the basis for an increasing number of technical applications and practical devices.

Although some of the basic concepts of nonlinear optics have become standard material in textbooks, there remains a need for up-to-date and in-depth reviews of the many research results and important details scattered throughout the primary literature. Volume 1 of *Quantum Electronics*, a well-organized and well-edited collection of reviews of selected topics, meets this need admirably. The emphasis in most of the papers is on the nonlinear optical properties of crystalline solids. Other important developments of much current interest, such as nonlinear high-resolution laser spec-

troscopy of gases, have been deliberately excluded. The contributions are authoritatively written, and most include clear introductions and extensive bibliographies, with some references as recent as 1975. A general introduction by N. Bloembergen helps to unify the volume and to place the subsequent contributions in their proper topical and historical context.

The volume consists of two parts. Almost two-thirds of part A is devoted to a discussion of nonlinear susceptibilities, which can be used to describe and characterize any nonlinear optical phenomenon in a given material. The rather detailed and highly mathematical article by C. Flytzanis on the theory of these susceptibilities covers both the macroscopic phenomenological aspects and the microscopic theory, using quantum mechanical perturbation theory up to third order and progressing from rarified media to anisotropic solids. The subsequent article by S. K. Kurtz on the experimental determination of these parameters and their numerical values in a variety of materials is more limited in scope, restricting itself essentially to second-order susceptibilities in crystals, which are important for sum or difference frequency generation or parametric conversion of light waves.

The remainder of part A presents discussions of a number of nonlinear optical phenomena that are primarily of spectroscopic interest. All these contributions achieve a balance between theory and experimental material. They include a review of two-photon absorption spectroscopy by H. Mahr, which emphasizes electronic transitions in solids, a review of stimulated Brillouin scattering in gases, liquids, and solids by I. L. Fabelinskii, and a relatively short update on stimulated Raman scattering by C.-S. Wang, which emphasizes transient effects. Some less widely known and used spontaneous and stimulated parametric scattering processes are discussed in a paper by C. L. Tang.

Readers with more practical interests may find part B even more useful. It consists of three papers on the application of nonlinear optical phenomena to the generation of coherent light at new wavelengths. The first paper, by S. A. Akhmanov, A. I. Kovrygin, and A. P. Sukhorukov, gives a detailed account of the theoretical and practical aspects of optical harmonic and sum-frequency generation. The second, by R. L. Byer, is a comprehensive review of optical parametric oscillators. And the third, by J. Warner, is devoted to difference frequency generation and upconversion. The first two papers are notable for a valuable collection of equations, diagrams, tabulated data, and references, which are sometimes hard to find elsewhere.

By selecting topics that have reached a certain maturity, the authors and editors of this volume have minimized the danger of instant obsolescence. And by presenting a few topics in depth rather than attempting a general survey of nonlinear optics, the volume succeeds not only in conveying the spirit of the field to the novice or graduate student, but in offering valuable reference material to the specialist.

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Aerial Locomotion

Insect Flight. Proceedings of a symposium. R. C. RAINEY, Ed. Halsted (Wiley), New York, 1976. xii, 288 pp., illus. + plates. $47.50. Symposia of the Royal Entomological Society of London, No. 7.

The evolution of a successful flight mechanism by insects was one of the great events in the development of life on Earth. It enabled the group to undergo a radiation not equaled before or since and to dominate the biological scene without rival until the recent advent of man. Insects account for three-quarters of animal species, living and fossil, and are estimated currently to number 10^{18} individuals with a biomass of about 10^{13} grams.

Insect Flight is a collection of a dozen articles by as many authors. In these days of specialization, the book is unusual and appealing in its attempt to give a broad perspective on the phenomenon of flight and its biological implications without undue sacrifice of sophistication. The topics treated range from sensory and muscular adaptations (J. W. S. Pringle) and central nervous mechanisms (B. Mulloney) through navigation (M. Lindauer) to population movements and atmospheric conditions (R. C. Rainey).

Among the highlights is an account of night migrations given by G. W. Schaefer. Developments in radar technique have made possible the detection of individual insects at distances of 3.1 kilometers (swarms to 70 kilometers) in densities down to ten per cubic kilometer with some species identification from wingbeat frequencies. This capability reveals that "great masses of insect migrants become airborne after dark, regularly assume a common orientation related to wind-direction or compass bearing, climb actively for hundreds of meters to reach altitudes of apparently optimum temperatures and winds, continue to fly for periods of hours, and finally land after travelling tens or hundreds of kilometers, repeating this behavior night after night." The extent and general biological role of small aerial fauna are poorly understood, but such migrations are certainly critical in pair formation, dispersal, and location of suitable reproductive and foraging areas and, of course, for insect control.

A thought-provoking resuscitation of the gill theory of the evolution of flight is offered by V. B. Wigglesworth. The currently most widely held theory envisages the progressive extension of paranotal thoracic "flaps," first as a parachute in retarding descent, then as a gliding mechanism, then as movable steering vanes during gliding, and ultimately for actual flapping flight. After reviewing the structure of vibratile gill plates on the abdomen of Ephemeroptera (mayflies), Wigglesworth suggests that similar appendages on thoracic segments could have evolved into wings. The ecological basis is viewed as an attempt by aquatic insects, under seasonal or long-term drying conditions, to disperse to damper areas. The interesting parallel is indicated between this theory and Romer's theory of the evolution of terrestrial locomotion in fishes, also during the Devonian.

T. Weis-Fogh provides an analysis of wing aerodynamics and recent developments in our understanding of events during nonsteady airflow conditions of slow and hovering flight. Initiation of lift by flow across an airfoil normally involves establishment of a bound vortex and shedding of a "starting vortex." Disruption of smooth flow causes stalling, a severe problem with a wing that not only is moving but must frequently reverse direction. Two partial solutions, "flip" and "fling," are employed by insects. In the latter, the wings are pressed together at the top of the stroke and peeled apart at the leading edge to create two lift-generating bound vortices immediately without any starting vortex. The mechanism is independent of size and could also be used by birds, in which case it might create an audible clap. Such a clap is produced at the start of flight by some pigeons, as Virgil (*Aeneid*, book V) noted.

The volume suffers from some imbalance. About a third of it is concerned with population movements, and in-