boundary conditions, the book summarizes the essentials of polarography with an emphasis on its analytical applications to organic chemistry.

In the first three chapters Zuman deals with the basic principles of polarography, polarographic instrumentation, and experimental techniques. A convenient tabular summary of reducible organic groups is included. Considerable stress is laid upon indirect methods. Thus, the author has distilled out of the extensive literature numerous methods in which a polarographically inactive organic compound is subjected to an appropriate chemical perturbation so that the analysis may be completed polarographically.

The final chapters, "Polarographic analysis in the study of reaction rates and equilibria" and "Effects of structure: Polarography as a tool in the analysis of structures of organic substances," will be of particular interest to physical organic chemists.

This book can be recommended as a mature, well-written introduction to organic polarography. The author's goal of stimulating further understanding of the subject should be achieved. Book reviewers seem to be licensed to saddle their own particular hobby horse, at least for a short trot. In this context, I was somewhat disappointed to find that polarography in aprotic organic solvents is accorded only minimal mention in this book.

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Arizona Faunistics

The Vertebrates of Arizona. Annotated check lists of the vertebrates of the state: the species and where they live. Charles H. Lowe, Ed. University of Arizona Press, Tucson, 1964. x + 259 pp. Illus. $5.

This book is the outgrowth of a symposium by the same title held at Tucson in 1960, and chaired by editor Lowe. Already in press at the time was a lengthy treatise on Arizona mammals, by E. Lendell Cockrum, and nearing completion was a similar treatment of Arizona birds, by Gale Monson and Allan R. Phillips. Lowe himself contrived to produce a chapter on amphibians and reptiles, to promote one on fishes by Robert Rush Miller, and to assemble ecological information for a long introductory chapter, profusely illustrated, on Arizona landscapes and habitats. Altogether, this combined material makes an impressive volume on the vertebrate fauna of the state.

Arizona is sometimes regarded as an arid desert region, but it is much else. Between the Kaibab Plateau and Grand Canyon at the north, and the Chihuahuan Desert and Huachuca Mountains at the south, there stretches a nearly continuous belt of elevated woodland, as on the Mogollon Plateau. The cover of this issue of *Science* portrays the eastern end of Lake Mead, set amidst nearly barren volcanic mountains. Elsewhere in the state are vast sandy deserts and alpine tundra, expanses of cactus and chaparral as well as forests of aspen and pine, ranging from the subtropical Lower Sonoran to the near-arctic Boreal Life Zone. In this variegated environment lives a diverse assemblage of vertebrates. Tabulated in the book are 64 species of fishes, 22 amphibians, 94 reptiles, 434 birds, and 139 mammals, plus other hypothetical or introduced alien inhabitants. Common and scientific names are given for each, together with notes on seasonal status, relative abundance, introductions of exotics, fluctuations in populations, and habitat utilization. Distribution is often given by habitat (*Plecotus phyllotis* "from the oak zone"), by life zone (*Contopus sordidulus* "resident almost throughout the Transition Zone, and . . . locally in cottonwoods of upper part of Lower Sonora Zone"), by elevations (*Sceloporus jarrovi* "as low as 4,800 feet and as high as 10,700"), or by precise localities of record.

Provision of an index and of a single terminal bibliography would have been helpful. Specialists will regret the omission of any consideration of subspecies; and amateurs will wish for pictures of the animals and keys for their identification. Within its limits, however, the book was intended merely as an annotated inventory of the Recent species known to occur in the state. As such, it succeeds very well and should prove a valuable reference for professional biologists, students, and others interested in the native fauna of Arizona and its distribution there.

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Ecological Genetics. E. B. Ford. Methuen, London; Wiley, New York, 1964. xv + 335 pp. Illus. $7.75.

The biological, or "synthetic," theory of evolution, developed in the last 30 or so years, is the outcome of a confluence of several streams of thought originating in different biological disciplines. Ford's book, the most recent and a very important contribution, is based on findings of ecological genetics, which is defined as the field of study that "deals with the adjustments and adaptations of wild populations to their environments. It is thus . . . essentially evolutionary in outlook. Indeed it supplies the means, and the only direct means, of investigating the actual process of evolution taking place at the present time." The book is based primarily on the work of the very active group of investigators, sometimes referred to as "The Oxford School," of which the author is the leader. It is certainly a rare satisfaction for an author to be able to write a general book utilizing for evidence and illustration chiefly materials with which he is personally familiar. This does not mean that Ford ignores the findings of other ecologists and geneticists. The book is dedicated to the memory of Sir Ronald Fisher, whose inspiration is acknowledged. One of the 15 chapters composing the book is devoted entirely, and there are references elsewhere, to studies made with species of *Drosophila* flies (engagingly dubbed "Drosophilosophy") with which the Oxford School has until now done relatively little work. Six chapters are concerned mostly with work on butterflies and moths (*Maniola, Papilio, Panaxia,* and others), one with snails (Cepaea), one with plants (heterostylic and homostylic primroses), and the rest are general.

Ford is consistently and rigorously a Darwinist and selectionist. Much of the evidence available on the action of natural selection in wild populations of higher organisms, including some of the most direct and conclusive evidence, has been brought to light by the Oxford School. Perhaps the most spectacular is industrial melanism, the appearance and spread of darkly colored varieties recorded in over 80 species of British moths. The study of this phenomenon, pioneered by Ford and splendidly developed by Kettlewell, is succinctly summarized in chapter 14. Most inter-

esting is Ford's work on the butterfly *Maniola jurtina*. The populations of this insect show no local differentiation throughout southern England, but there is a distinct race in Cornwall and a series of distinguishable populations on the Isles of Scilly to the West. The boundary between the "Southern English" and the "Cornish" races has been localized very precisely. Not only has this boundary proved to be quite sharp, but it has been observed to shift from year to year. Ford concludes that there are "powerful selective forces acting at the boundary between the races." Observations on this phenomenon throw light on some fundamental problems of race and species formation. Other highlights are the chapters that deal with the evolution of mimicry (based mainly on the work of Clarke and Sheppard), and on the isolated colony of the moth *Panaxia dominula* near Oxford (the latter is perhaps the most intensely studied natural population of an insect in the world).

Biologists interested in evolutionary problems will find here a rich source of information and ideas. A crystal-like clarity of presentation and a style which is at the same time elegant and free from all pedantry make this book pleasant reading.

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Chemotaxonomy

Chemotaxonomie der Pflanzen, vol. 2, *Monocotyledoneae*. R. Hegnauer. Birkhauser, Basel, Switzerland, 1963. 540 pp. Illus. F. 98.

This volume, covering the chemotaxonomy of the Monocotyledoneae, is the second of a projected series on the comparative chemistry of plants. Volume 1 treated algae, fungi, bryophytes, ferns, and gymnosperms.

A number of comprehensive treatments of the chemistry of natural products have been published rather recently—*Konstitution und Vorkommen der organischen Pflanzenstoffe* (Birkhauser, Basel, 1958) by W. Karrer; *The Chemistry of Flavonoid Compounds* (Macmillan, New York, 1962) edited by T. A. Geissman; *Ergebnisse der Alkaloid Chemie bis 1960* (Akademie Verlag, Berlin, 1963) by H. Boit; and *Annual Index of the Reports on Plant Chemistry* (Hirokawa, Tokyo, 1961, 1962, and 1964) edited by T. Kariyone. But, with some justification, Hegnauer considers such books of limited value to the taxonomist because in most of them the taxonomy is incidental to the chemistry, and because only the years 1957 to 1961 are now covered by Kariyone's *Index*. As stated in the preface to volume 1, our knowledge of plant chemistry is still quite fragmentary; nothing is known about the chemistry of extinct plants; and only limited biosynthetic data are available. Newer analytical methods have nonetheless made a vast amount of chemical data available to the chemotaxonomist. *Chemotaxonomie der Pflanzen* is therefore organized to emphasize the taxonomic implications of the chemistry and to provide the chemical data in a form useful to the taxonomist.

In addition to the strictly chemical survey, the author has included "anatomical" data based on structures derived from specific chemical entities—myriophyllin cells, calcium oxalate crystals, carbohydrate reserves, and others. Despite the fact that traditionally such characters have been acknowledged to be within the domain of the chemotaxonomist, I consider these substances, collectively, of slight systematic value. Therefore the significance of the inclusion in the present work of an "anatomical" section for each family or other taxonomic category is debatable. The author, in an attempt to provide a comprehensive treatment of chemical data, also included references to pharmacological activity, insecticides, quantitative data on dried storage organs, minerals, oil characters, and the like when such data were available. Since the chemotaxonomic literature has accumulated in large part through commercial and pharmaceutical interest, and not systematically, this type of organization makes it difficult for the reader to separate the wheat from the chaff.

The taxonomist may be sorry to find this statement in the preface of volume 2—"Leider zeigte sich im Lauf der Arbeit, dass in den meisten Fällen unsere Kenntnisse über die Inhaltstoffe noch dermassen unvollständig sind, dass eingermassen begründete chemische Sippenvergleiche unmöglich sind." However, the numerous instances throughout the book where a specialized chemistry is correlated with delimited taxonomic groups should provide some compensation.

The degree to which chemotaxonomy must progress before it will be possible to employ chemical data extensively to supplement other taxonomic criteria is emphasized in the concluding observations at the end of a 68-page section on the Gramineae: "Die Gramineae, sind Kieselsäureakkumulatoren. Sie zeichnen sich ferner durch die Tendenzen zur Erzeugung von cyanogenen Verbindungen und zur Ersetzung der Stärke in den vegetativen Organen durch Fructane aus. Andere chemische Charakterzüge sind das Fehlen von Leucoanthocyanen in den Blättern und das vermutlich häufige Auftreten von nicht allegemein verbreiteten flavonoiden Verbindungen (Tricin, Glykoflavone)." The absence of leucoanthocyanins is likely to be of relatively limited importance. (Probably the presence of *p*-OH benzoic acid type monomers in grass lignin is more significant). A recent survey of a number of grass genera failed to disclose free tricin, a flavone analogous to the anthocyanidin, malvidin, although tricin glycosides were present as minor flavonoid components of most of the grasses, and glycoflavones were extremely common. It is doubtful that more than a small fraction of the approximately 6000 grass species has been investigated with respect to their secondary chemistry. It is possible that eventually a complex flavonoid chemistry will be exposed within this family, despite the absence of showy floral structures, but for the present only a few suggestive correlations, such as the frequent association, *together in a species*, of O-glycosides of tricin and C-glycosides of certain other flavones (glycoflavones), are available for the speculations of the chemotaxonomists.

If the present book falls short of providing an integrated chemical superstructure to classical taxonomy, it is testimony to our fragmentary knowledge of plant chemistry. Hegnauer's work represents a major achievement in collecting diversified and widely scattered chemical knowledge under a comprehensive taxonomic focus. He has been cautious in the application of these data to "solve" taxonomic problems, yet he has called attention to those instances in which chemical data are corroborative or contradictory with respect to a specific hypothesis. The chief point of difference, from my viewpoint, involves the more restricted conceptual basis of chemotaxonomy implicit in Hegnauer's work. I antici-