think we know that prevents us from learning." Until recently biologists thought they knew exactly how Darwin came by his theory of natural selection, but they misunderstood his *Autobiography* (not entirely their fault), and his *Notebooks* had to wait a hundred years after the publication of the *Origin of Species* before they were subjected to close scrutiny and the correct answer was found. Another basic consequence of Darwin's achievement had to wait the same time—the purposiveness of adaptation. As a fact, it is undeniable, and it was interpreted by Paley (and by other last-ditchers since then) to mean that teleological final causes, preordained programs, and providential (not to say divine) guidance were at work, an interpretation that led to a head-on collision between theologians and scientists as in the battles of Oxford and Dayton. Asa Gray praised Darwin for bringing teleology back into science because adaptation is purposive. But what Darwin really did was to show that organs which serve a purpose can and do arise, without any preceding agent of purposefulness at all but opportunistically, by the rigorously nonrandom directives of natural selection. This conclusion is inescapable now that it is known that the vast majority of species which have lived on earth have become extinct (was this providential guidance?) and that the vast majority of new heritable variations are acted upon adversely by selection (thereby wrecking any preordained program).

The term *teleology* was the trouble because of its metaphysical, not to say theological, connotation with which men of science were, of course, unable to compromise. Here it is fitting to recall the words of a forgotten mathematician from Cambridge (England), William Kingdon Clifford, who in 1875 pointed out the confusion that arises from the two meanings ascribed to the concept of purpose. In the first, the idea of the end precedes the use of the means as in theological teleology. In the second, an adaptation may serve a purpose even if it originated by accident, "by processes of natural selection." Clifford went on to say that "since the process of natural selection has been understood, *purpose* has ceased to suggest design to instructed people, except in cases where the agency of man is independently probable." This luminous analysis was, however, neglected, and the *Origin of Species* had to wait a hundred years for Colin Pittendrigh to clarify what Darwin meant by introducing the valuable term *teleonomic*, a term that does not antagonize scientists as teleology does.

It is difficult for a reviewer to criticize a book with which he is in fundamental agreement. This may mean that he is the wrong reviewer, but in order for this one to show that he does not swallow everything, he will end with two comments. Is Simpson right in drawing a distinction between the concept of differential mortality and survival, to which he restricts Darwin's view of selection, and reproductive selection, which means the consistent production of more offspring? It is true that in the later editions of the *Origin* Darwin made the mistake of adopting Spencer's unfortunate expression "survival of the fittest" when (rightly) dissatisfied with the adequacy of his own term "natural selection." He would have been better advised to turn to his *Notebook* of 1838 and use the words with which he committed to paper the flash of light that struck him on 28 September of that year: "One may say there is a force like a hundred thousand wedges trying to force every structure into the gaps in the oeconomy of nature, or rather forming gaps by thrusting out weaker ones." It is also true that Darwin frequently speaks of survival as the prize won by adequate adaptations, but this is always shorthand to mean survival in order to leave offspring, for he never lost sight of the fact that differential reproduction is the effective element in selection. As he wrote in the *Origin*, "I use the term struggle for existence in a large and metaphorical sense . . . including (which is more important) not only the life of the individual, but success in leaving progeny" (Peckham's *Variorum* edition, p. 146). I may also add that as David Lack has shown, it is deleterious for a species to produce too many offspring, because their ecological conditions may lead to the consequences that are now seen in many underdeveloped nations. I therefore prefer Darwin's guarded expression "success in leaving offspring."

Finally, I must question the impression which Simpson gives, that he deserted literature and poetry to devote himself to science. On the contrary he has enrolled these arts under the banner of science in a Simpson style that can be recognized in all his works because of its clarity and complete avoidance of ambiguity. He has a technique in writing which only accomplished artists can use with impunity (Charles Ferdinand Ramuz is one such). When the progress of his exposition or the thread of his argument requires the repetition in the same sentence of the same word or groups of words, Simpson repeats them, and the effect is incomparable.

Photochemistry

Advances in Photochemistry. vol. 1. W. Albert Noyes, Jr., George S. Hammond, and J. N. Pitts, Jr., Eds. Interscience (Wiley), New York, 1963. x + 443 pp. Illus. $16.50.

This volume is devoted to tracing the changes which befall a molecule that has absorbed radiation. Although photochemistry is more than 100 years old the field has advanced rapidly in recent times as a result of developments in related disciplines. A better understanding of spectroscopy and quantum mechanics has helped with the fundamental theory of photochemistry. The possibility of bringing about rapid changes with flash photolysis is noteworthy, while ascertaining what kinds of excited molecules and molecular fragments are present has been greatly helped by nuclear magnetic resonance and electron spin resonance.

The volume consists of 9 chapters written by 13 authors. The first chapter (Pitts, Wilkinson, and Hammond) is called the "Vocabulary of photochemistry," and it gives a quick rundown of nomenclature and of the concepts used. This will be especially useful to the nonspecialist.

A chapter by E. J. Bowen, "The photochemistry of aromatic hydrocarbon solutions," deals effectively with fluorescence, phosphorescence, energy degradation to the triplet or the ground states, dimer formation, photooxidation, and energy transfer. In another chapter D. H. Volman discusses the photochemical gas phase reactions in the hydrogen-oxygen systems.

Other chapters treat the photochemistry of cyclic ketones, the addition of atoms to olefins, organic mechanisms, mercury photosensitization, photochromism, and rearrangements of organic molecules. R. Srinivasan, R. J. Dveta-

novic, H. E. Zimmerman, H. E. Gunning and O. P. Strauss, R. Dessauer and J. P. Paris, and O. L. Chapman, respectively, have effectively written the last six chapters.

A second volume is promised almost immediately with others to follow. For volume 1, the editors have succeeded in securing authors thoroughly familiar with their fields. Subsequent volumes will be awaited with great interest.

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Evolution

The Process of Evolution. Paul R. Ehrlich and Richard W. Holm. McGraw-Hill, New York, 1963. xvi + 347 pp. Illus. $8.95.

Evolution. Jay M. Savage. Holt, Rinehart, and Winston, New York, 1963. viii + 126 pp. Illus. Paper, $1.25.

It is surprising how similar two very different texts can be. In both of these books evolution is discussed as a process of gene frequency change. Both authors present a strong interest in herpetology, which has led to a relative abundance of examples from a usually neglected field. These authors are based in California, and maps of that state are common and references to its backwoods require a greater knowledge of local geography than one might expect of students in other parts of the country. Both books tend to refer the student to other texts rather than to original papers. There is a tendency to state opinions and theories as if they were facts, and this is coupled with inadequate references to source material. The inquisitive reader often has no place to turn for enlightenment.

Ehrlich and Holm have written a reasonably good text on the process of evolution. Their book will probably be used in advanced courses but it was intended for a more general audience. Therefore, it contains an extensive exposition of genetics and an introduction to cytology, which, together, occupy about one-third of the book with material that is not needed by the bulk of the readers. The other major subjects covered include theoretical population genetics; examples of natural and artificial selection; methods for requiring, permitting, or prohibiting the recombination of genes; and a discussion of variation within and between species. In addition to this traditional description of the genetic aspects of evolution, there is a final chapter in which the authors discuss the problem of variation within a species complex from the computer user's ultramodern point of view. This section should prove far more impressive than understandable, but the student will receive some idea of the large amount of simplification present in the usual definition of a species. Throughout the book, information is firmly packed into each paragraph so that it is difficult to read. Undoubtedly, Ehrlich and Holm will prove to be an interesting competitor with the standard texts in the genetic explanation of evolution.

Savage's *Evolution* can easily be dismissed. It is short and catastrophically bad. The discussion of evolution is acceptable, but almost everything related to genetics is disputable or wrong—mostly wrong. The worst fault is the confusion of an allele's name with its frequency, so that p is the frequency of p and it is an allele of q, which has a frequency q. Two such loci are discussed at the bottom of page 41, and the number of errors there may set a record for six lines of print in a modern science text. No instructor should lead a student into this morass.

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Electron Deficient Compounds

Boron Hydrides. William N. Lipscomb. Benjamin, New York, 1963. x + 275 pp. Illus. $14.

In 1933 Alfred Stock published the first book summarizing his brilliant pioneer work on the identification and chemical characterization of the enigmatic boron hydrides. In this early volume structural and theoretical information was either nonexistent or mostly incorrect. During the past 15 years work on these early problem areas has been cleverly advanced by Lipscomb and his co-workers. It is thus appropriate that such new material forms the heart of Lipscomb's book, which includes developments up to the summer of 1963.

The first chapter is an excellent summary of structural information on about 40 boron hydrides, halides, and their derivatives. Chapters 2 and 3 are devoted to theoretical models for the so-called "electron deficient molecules." In chapter 2 boron hydrides are described in terms of localized two- and three-center bonds and electron delocalization is then described in terms of resonance involving these bonds. In chapter 3 a very terse introduction to the molecular orbital method for B_5H_9 precedes the description of an application of molecular orbital theory to such topics as an estimation of energy levels, spectral lines, ionization potentials, heats of formation, and charge distribution in the boron hydrides. Lipscomb is enthusiastic in his presentation and has devoted a large amount of space to the semiquantitative applications of theory, but in my mind many of the problems considered are so difficult that, despite the amount of space used, the results are not reassuring. For example, in B_2H_6 the bridge protons are referred to as more negative than the terminal protons (pages 33, 106, and 172) by one method, as more positive than the terminal protons by another method (page 106), and as a subject for further study (pages 107 and 112). As Lipscomb notes, our problems are probably indicative of the "symmetry of our ignorance."

Chapter 4 gives a résumé of available information on nuclear magnetic resonance spectra of boron hydrides and their derivatives. It contains a proper recognition of both the problems and strong points of the method. Chapter 5 is a concise summary of the chemistry of the various hydrides. Much of this information is presented in tables, equations, and illustrative reactions. Although I would prefer to have a little more detail, the book does provide a neat summary and entrée into most of the pertinent literature on the subject.

The book is nicely presented and reasonably free from typographical errors. One of the features that will cause some annoyance to the average reader is the constant reference to numbered borons in the theoretical discussions of chapters 2 and 3 and the complete absence of numbers for borons on all of the accompanying figures.

It is inconceivable to me that anyone working with boron hydrides or related compounds would wish to do