so, thereby generating much unnecessary verbiage and confusion.

The two authors do not entirely agree with each other on the proper approach to reconstructing phylogeny. Szalay's chapters on prosimians are full of ancestor-descendant pairs, whereas Delson's section on catarrhines is full of hypothetical ancestral constructs—morphotypes—that are never quite identifiable with any known fossils. Some of these morphotypes are not very convincing, especially the hypothesized common ancestor of cercopithecoids and hominoids, which the authors persist in giving a skull like a gibbon's or colobine's despite their inclusion of the far more primitive *Aegyptopithecus* in the Hominoidea.

Perhaps the two most important evolutionary events in primate history were the origins of euprimates ("primates of modern aspect") and of anthropoids. Szalay and Delson recognize both groups as clades, but not as taxa; and so they have practically nothing to say about the functional or adaptive significance of either group's distinctive traits. As a history of primate evolution, the book therefore is apt to leave many readers unsatisfied. Of the first euprimates, we are told only that they differed from plesiadapiforms in having "superior grasp-leaping arboreal adaptations, necessitated by a particular feeding regime" (p. 99)—the nature of that feeding regime not being specified. "Grasp-leaping," one of a whole flotilla of new locomotor categories launched by the authors, is in turn defined simply as "the behavior responsible for the development of the superior grasping adaptations of the first euprimates." In other words, the first euprimates developed grasping feet as an adaptation for whatever behavior was responsible for their developing grasping feet—probably in connection with specializations for eating whatever they ate.

Other, less vacuous adaptive stories offered by the authors are often equally unconvincing. Although Szalay and Delson make a systematic effort to infer what they can about the behavior and ecology of extinct primates from the available remains, the principles governing their inferences are nowhere clearly stated, and many of their conclusions seem capricious. For example, they argue that enlargement of the incisors implies frugivory in *Tetonius* (p. 219) but insectivory in *Nannopithex* (p. 262) and gummivory in yet other omomyids (p. 226). (By the way, a "gumivore," as the authors consistently spell it, would be an animal that eats gourmands.) We are told that the skull of *Tetonius* is too badly crushed to allow us to infer nocturnal habits from its large orbits (p. 215), but the still more fragmentary cranial remains of *Nannopithex*, which evince large orbits "like those of *Tetonius* and *Necrolemur*" (p. 262), are offered as evidence that *Nannopithex* was nocturnal. No inferences are drawn concerning *Necrolemur*, which is known from several complete and undistorted skulls. Why does the poorest evidence warrant the most confident inference? The point is not trivial, since the relative size of the orbits of *Tetonius* and *Necrolemur* is a crucial bit of evidence bearing on the problem of anthropoid origins. Some of the authors' conclusions left me completely mystified—for example, the suggestion (p. 385) that the reduced thumbs of colobines "permit more efficient climbing and leaping," or that *Alouatta*'s flat cranial base "is an effect of the adaptation to increased development of the masseter complex" (p. 291), or that the diet of *Ekgmowechashala* "did not require large daily portions" (p. 258).

A few isolated errors large enough to deserve notice have crept in. The femur attributed to *Palaeopropithecus* in figure 84 is that of *Archaeolemur*. The shoulder joint of *Homo* is not more mobile than an orangutan's (p. 497). *Tarsius* does not have an "ossified annulus membrane" (p. 190). At least some modern hominids do not "lack the vermiform appendix" (p. 461). A more pervasive defect of the book's anatomical descriptions is that reasonable guesses about extinct species are often presented as if they were established facts; for example, the authors give dental formulas for taxa whose dentitions are not fully known. This is sure to mislead novices, and it renders the book less valuable as a reference. The authors' prose is generally lucid and to the point, but it is studded with typographical and grammatical errors, including a persistent confusion of *like* and *as*; the copy editors at Academic Press should hang their heads. The publishers deserve praise, however, for their remarkable feat of compressing 600 pages of small type into a slim, easily handled volume that is easy to read and pleasing to the eye.

In spite of its defects, *Evolutionary History of the Primates* sets a new standard of thoroughness for future books in its field. It bristles with challenging arguments and interpretations that will be debated by professionals for many years to come. If its authors had been less complaisant in reviewing and reworking each other's contributions, it might have been a landmark in the history of primate biology. As it is, the book is one that serious students of primate and human evolution can afford neither to do without nor to take entirely at face value.

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Taxonomic Exploration

Catalog of Hymenoptera in America North of Mexico. Prepared under the direction of KARL V. KROMBEIN, PAUL D. HURD, JR., DAVID R. SMITH, and B. D. BURKS. Smithsonian Institution Press, Washington, D.C., 1979 (available from the Superintendent of Documents, Washington). In three volumes. Vol. 1, Symphyta and Apocrita (Parasitica). xvi pp. + pp. 1-1198. $30. Vol. 2, Apocrita (Aculeata). xvi pp. + pp. 1199-2210. $28. Vol. 3, Indexes. xxx pp. + pp. 2211-2736. $20. New edition of *Hymenoptera of North America: Synoptic Catalog* (1951).

The great Linnaean task of biology is less than half finished. Approximately 1.5 million species of organisms have been described and formally named since *Species plantarum* (1753) and the tenth edition of *Systema naturae* (1758), but the true number is estimated by various authors to lie between three and ten million. The continuation of this survey is necessary to the progress of much of ecology and applied biology. More important, the ultimate benefit for the human spirit of a full knowledge of life on earth cannot even be imagined at this time.

The difficulty of this important residual task is not excessive. The following arithmetical exercise will show what I mean. If one specialist characterized an average of ten species per year, including the collecting, curatorial work, revision, and publication, about one million person-years of work would be required. Given 40 years of productive life per scientist, the effort would cover 25,000 lifetimes. That is a relatively modest investment. The number of systematists would represent less than 10 percent of the current population of scientists in the United States alone. Nor is information storage an overwhelming problem, even by less efficient contemporary methods. If each species were given a single double-columned page for the standard taxonomic description, a figure, and a brief biological characterization and the pages were bound into ordinary 1000-page, 6-centimeter-wide hardcover volumes, the 10,000 or so final volumes of this ultimate *Systema naturae* would fill 600 meters of library shelving. That bulk is far below the capacity of some existing libraries of evolutionary biology. The library of Harvard University's Museum of Comparative Zoology, for example, occupies 4850 meters of shelving.

The *Catalog of Hymenoptera in America North of Mexico* represents a landmark in the ongoing taxonomic exploration of the North American fauna, the third of its kind during the past century. From 1892 to 1902 K. W. Dalla Torre listed the hymenopteran fauna of the world. In 1951 C. F. W. Muesebeck and a group of associates provided a complete taxonomic record of the species of North America north of Mexico, with summaries of natural history data. Important syntheses always work toward their own obsolescence, and so it was that the Muesebeck catalog stimulated a rush of new systematic and biological studies. In 1971 a group of hymenopterists from the Smithsonian Institution and the U.S. Department of Agriculture laid plans to summarize the information once again. The present three-volume work is the long-awaited result.

The *Catalog of Hymenoptera in America North of Mexico* represents an innovation in methodology. The entire body of information is stored in a computer in a form that permits continuous data retrieval and updating. The revised edition was produced by a computer-driven Linotron in the Government Printing Office. Yet despite this amount of automation, the result is a well-arranged and readable set of conventional books. As should be expected from the reputation for competence and expertise of the authors, the material appears to be accurate. I pored over the entries for every one of the 580 species of ants without noticing an error. A similar favorable impression has been registered by several other hymenopterists with whom I discussed the catalog.

I am sure that others will share the feeling I have experienced of wanting to pursue studies of the little-known but potentially interesting and significant species now made more visible. Widely scattered notes in the literature have been turned into coherent but preliminary and tantalizing characterizations. The authors are to be congratulated for a large and difficult job well done, the benefits of which can only grow with time.

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A Segment of Biochemical Research

A History of Biochemistry. Part 5, The Unravelling of Biosynthetic Pathways. MARCEL FLORKIN. Elsevier, New York, 1979. In two volumes. Part A, xx, 434 pp., illus. $68.25. Part B, xx, 320 pp., illus. $52.75. Comprehensive Biochemistry, vols. 33A and 33B.

The twin volumes constituting Part 5 (chapters 53 through 74) of Marcel Florkin's history of biochemistry trace the complicated development of an important segment of recent biochemical research, namely the unraveling of biosynthetic pathways. This history, starting with early isotope studies at the Columbia laboratory during the late 1930's, documents in detail the progress of studies on biosynthesis primarily of the smaller molecules—the sugars, nucleotides, pyrroles, vitamins, and amino acids—during the succeeding two or three decades. The story builds on the contents of volume 32 of this series, in which the early history of research on biosynthesis is explored. In this early period biochemists attempted with great difficulty and often frustration to define even the simple outlines of metabolic pathways without the use of the modern armamentarium of enzyme technology, bacterial mutants, and isotopes, the latter two being major contributions of genetics and physics, respectively, to biochemical research. The strong influence of organic chemists, whose early efforts led to hypotheses concerning possible precursors of simple molecules, in shaping the infant discipline of biochemistry is evident. Although it was H. A. Krebs, a biologist, who in 1932 first developed in his ornithine cycle the concept of a biosynthetic pathway as a discrete succession of enzyme-catalyzed reactions, the unraveling of biosynthetic pathways by a new cadre of biochemists was undoubtedly closely allied to chemistry and to a chemist's understanding of experimental design.

Florkin has organized his treatment to show how the great revolution in biochemical research during the '30's depended not only on the development of specific methology but also on the clarification of the structures of important biological constituents, for example, that of adenosine triphosphate (ATP), which is the currency of all energy exchanges in living systems. The role of phosphorylation in the activation of metabolites that enables them to participate in biosynthetic reactions is illustrated in chapter 53 by the discovery of coenzyme A (CoA) and its participation with ATP in the activation of acetate and higher fatty acids as the CoA derivatives. Thereafter, in chapter 54, Florkin explores the issue of whether biosynthetic reactions are the simple reverse of catabolic reactions as a function of the mass law. This prevailing idea was challenged by the realization that the ordered sequence of amino acids in proteins could not be achieved through the action of proteases or by transpeptidation reactions. The synthesis of the simple tripeptide glutathione was recognized as an exception to this generalization and also as not typical of the reactions of protein biosynthesis. As is illustrated even more lucidly by examples in carbohydrate and lipid synthesis, biosynthetic pathways, although sometimes using enzymatic systems common to catabolism, always require their own specific energy-yielding reactions to overcome the thermodynamic differential between precursors and products.

Chapters 55 and 56 explore the discovery of the pentose pathway as a major channel of carbohydrate metabolism, which provides not only the five carbon sugars for nucleotide synthesis but also the complement of reduced triphosphopyridine nucleotide needed for reductive biosynthetic reactions, as in the case of lipid synthesis. The interplay of research in this area and research on photosynthesis led ultimately to an understanding of how carbohydrates may be formed from CO_2 and how the reducing potential is developed.

Chapter 57 logically moves on to the topic of CO_2 assimilation by heterotrophic bacteria and by animal tissues. The isolation of ^{14}C and its availability after World War II provided a quantum jump in the study of the metabolism of carbon compounds. As one of the first and easiest candidates for studies of this kind, CO_2 was shown to participate in glyconeogenesis and indirectly in lipid synthesis. The discovery of the nucleotide sugars, in particular uridine diphosphoglucose and its role in the synthesis