used and in types of data considered. Phylogenies are apparently intuitive and not based on strict cladistic principles. There is virtually no attempt at quantification, the few numerical analyses being crude in the extreme. The characters considered are essentially restricted to the external morphology of adults; immatures are almost ignored although a fair amount is known about a variety of larvae. As a result, a few disagreements between the present classification and an earlier one based on larvae by Evans are glossed over. The authors' conservatism is further evident from the reasons given for rejecting a division of the group into a number of families which would be more nearly equivalent to the families of bees and other stinging Hymenoptera: "Even subfamilies are difficult to delimit except on a local basis, and it is only when we reach the level of the tribe that the subdivisions become readily definable" (p. 33). This surely begs the question, since ease of delimitation is by no means the most important consideration for family status; bees, for example, are often easier to key to genus than to family. The authors have thus missed the opportunity of creating an innovative and exciting work of modern systematics and have instead produced a book which is merely essential. Perhaps that is enough.

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Respiratory Adaptations

Respiration of Amphibious Vertebrates. Papers from a symposium, Bhagalpur, Bihar, India, Oct. 1974. G. M. HUGHES, Ed. Academic Press, New York, 1976. xx, 402 pp., illus. $29.75.

In the 17 papers collected in this book amphibious respiration, a mode of respiration in animals that partially or entirely emerge from the water to exchange gas with the atmosphere, is described from many points of view, morphological, physiological, behavioral, ecological, and evolutionary. The last approach is particularly interesting, since the ancestral vertebrates that made the transition from an aquatic to a terrestrial environment presumably possessed some of the many adaptations to air breathing here described.

The differences between air and water as respiratory media are considerable, as is pointed out by Dejours and by Rahn and Howell. Apart from factors such as viscosity, density, caloric capacity, and heat conductivity, oxygen and carbon dioxide behave differently in the two media. Oxygen capacitance in particular is much lower in water than in air, requiring relatively heavy energy expenditure for ventilation in aquatic breathing; carbon dioxide capacitance is approximately equal in air and water, but concentration in air is low, which makes small, air-filled respiratory spaces less suitable for carbon dioxide elimination in the absence of high rates of ventilation. Thus the functional requirements for aquatic and aerial respiration are opposed, and evaporative water loss in air breathing creates additional complications. Solutions to these problems have arisen independently in many groups, and the book deals with a wide spectrum of respiratory adaptations, from purely aquatic branchial respiration in dogfish (Scheid and Piiper), through truly amphibious respiration in fishes, amphibians, and sea snakes, to aerial respiration in amphibious reptiles (caiman, snapping turtle), whose ventilatory mechanisms are described by Gans. The overall picture emerging is a complicated one; almost any epithelial surface has been utilized by some vertebrate group for gas exchange, and parallel developments and convergences abound.

Most of the papers treat some aspect of bimodal respiration, in which oxygen is obtained through one respiratory organ (usually lungs, swim bladder, or accessory oral or pharyngeal structures) and carbon dioxide is released through another (most often gills or skin). A good review of the structure of teleost respiratory organs is given by Munshi; Hughes and Weibel use modern stereological techniques to describe the lung of the South American lungfish *Lepidosiren*. Satchell, describing the circulatory system of air-breathing fishes, clearly shows the intricate relationships between respiratory and other organ systems, implicitly providing an eloquent plea for an organismic approach to functional morphology. Graham explores a neglected field in a review of respiratory adaptations in marine fishes, contrasting these with freshwater teleost air breathers, which generally show higher degrees of specialization; he advances the hypothesis that amphibious behavior in freshwater forms is mainly a means of locating new aquatic habitats, and that the evolution of a highly amphibious freshwater fish fauna was prevented by the presence of terrestrial predators in and around bodies of fresh water.

In several papers the distinction between comparative treatment of recent groups and construction of phyletic lineages is obscured. This does not, however, detract from the value of the book as a complement to several recent texts on the comparative physiology of vertebrate respiration.

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Meteoritics

Handbook of Iron Meteorites. Their History, Distribution, Composition and Structure. VAGN F. BUCHWALD. Published for the Center for Meteorite Studies, Arizona State University, by University of California Press, Berkeley, 1976. Three volumes, in slipcase. Vol. 1, Iron Meteorites in General; Tables, Appendices, References. Vol. 2, Iron Meteorites: Abakan–Mejillones. Vol. 3, Iron Meteorites: Merceditas–Zerhamra; Supplement. xxiv, 1418 pp., illus. + indexes. $140.

Let it be said at the outset that this book is a formidable work and must be the product of extreme dedication. Any criticism made below should be considered with this fact in mind.

The first of the three volumes of the work is partly a general textbook on meteoritics and partly an introduction to the descriptions of almost 600 individual iron meteorites that constitute volumes 2 and 3.

Chapters 1 through 5 and chapter 12 in volume 1 cover relevant astronomical phenomena, physical phenomena related to meteorite falls and showers, meteorite craters and ages, and statistical and historical topics. These parts, apparently adopted from a university course, are simply, almost naively, written and are hardly intended for the specialist. Chapter 6, "Shapes and surface characteristics," is rather mixed. Some descriptions are almost artistic, and others, such as the discussion of features due to atmospheric heating, are highly technical classic metallography. It is worth noting that the author uses hardness data extensively and to great advantage.

In chapter 7, "Classification," stony and stony-iron meteorites are treated in about five pages. Irons appropriately are discussed in more detail, especially the correlation between the older structural classification and the current "chemical" system based on the content of nickel and some trace elements. The author wholeheartedly endorses the latter system, perhaps with too little critical

discussion in view of the fact that 92 of 480 irons are listed as "anomalous," that is, as not belonging to any of the 12 groups, and that, even within chemical group I, 19 of a total of 88 are also listed as "anomalous."

Chapters 8 through 11 deal with chemical composition, mineral and structural components, and primary and secondary structures of iron meteorites. The concentrations of 32 selected elements, all minor except nickel, are discussed in some detail, and the concentrations of 12 of these—nickel, cobalt, phosphorus, carbon, sulfur, chromium, copper, zinc, gallium, germanium, iridium, and platinum—are reported for the individual meteorites in volumes 2 and 3 when the information is available. The author, a classic metallographer, is at his best when discussing structural features and phenomena. The structures and their interpretations are discussed clearly and critically, with due caution about such concepts as "cooling rates." Most of the photomicrographs in volume 1 are good, as are the diagrams, except for three that have been too much reduced. In the other two volumes the illustrations are of more variable quality. Some light or low-contrast photographs have suffered in the reproduction, and some diagrams and tables are barely legible. In any case chapters 8 through 11 constitute an excellent introduction to the descriptions in volumes 2 and 3.

Volume 1 also contains eight appendixes. One of these lists the 480 well-studied meteorites by chemical group, another lists 129 insufficiently known irons, and yet another lists 99 meteorites that have been artificially reheated (a most useful warning to other researchers). Some spallogenic gas data and exposure ages are also given. Finally, volume 1 lists the 2000-plus references cited throughout the work. Spot checks of the references and the data in tables and appendixes did not reveal any errors, and all cross-references seem to be correct—a remarkable feat in a work of this magnitude.

A major flaw in volume 1 is that only a few of the more than 230 illustrations are referred to in the text, which makes correlating text and illustrations laborious. The figure captions seem to have been written independently of and on a different level from the main text and almost constitute a parallel text. It could also be said that some parts of volume 1 are rather "primitive" and barely related to the main purpose of the *Handbook*. However, with the addition of a chapter or two on stony meteorites—and perhaps some condensation of chapters 6 through 11—the volume could become an excellent textbook in meteoritics for senior- to graduate-level students. Even in its present form, it would be valuable to have volume 1 available separately at some modest price.

The major part of the work, volumes 2 and 3, consists of alphabetically ordered descriptions of practically all known iron meteorites. The descriptions range from a few lines, essentially for the "insufficiently known" meteorites, to about 25 pages and 47 illustrations for Canyon Diablo, and average about one page with one or two illustrations. Little criticism can be leveled at the general layout. Some photomicrographs are of rather poor quality, but the features described are usually discernible. Few of the illustrations are referred to in the text, but this is not as disturbing here as in volume 1. Cross-references to features discussed in volume 1 would have been valuable.

The author has himself seen the major masses or substantial parts of most of the meteorites he describes. This has resulted in a consistent comparative study of iron meteorites of all types. The work is also quite international, as are the (Danish) author's several erudite quotations; the reviewer (Swedish) feels the following (Norwegian) quotation appropriate:

> For fortune such as I've enjoyed I have to thank America. My amply furnished library I owe to Germany's later schools. From France, again, I get my waistcoats, my manners and my spice of wit—from England an industrious, and keen sense for my advantage. The Jew has taught me how to wait. Some taste for *dolce far niente* [sic] I have received from Italy—and one time, in a perilous pass, I had recourse to Swedish steel.—H. IBSEN, 1867.

Certainly this work will be of long-lasting value and a standard reference for anyone studying iron meteorites. And, because no real solution to the problem of their origin can be offered in spite of this monumental work, it should inspire further, more sophisticated research with modern tools.

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