ings presented, and the editors' reviews and generalizations, provide a wealth of useful material and raise significant questions that will undoubtedly stimulate future inquiry and cross-national comparisons on the "fundamental, although elusive, reality" (p. 1) of the informal economy.

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Paleoichnology

Dinosaur Tracks and Traces. DAVID D. GILLETTE and MARTIN G. LOCKLEY, Eds. Cambridge University Press, New York, 1989. xviii, 454 pp., illus. $54.50. Based on a symposium, Albuquerque, NM, May 1986.

The field of vertebrate paleoichnology is attempting to come of age, and the maturation process has been expressed largely in the form of meetings devoted to new discoveries. This volume, the result of the First International Symposium on Dinosaur Tracks and Traces, is a collection of 50 papers of variable quality, devoted to establishing vertebrate paleoichnology as a field in its own right.

The obvious strength of this volume is in providing a single reference source for vertebrate paleoichnology. A number of papers provide useful overviews of the occurrences of footprints in various parts of the world. Stimulating papers relating functional morphology to gait are presented (for example, by Padian and Olsen). Several other papers provide good descriptive accounts of new track localities or describe old trackways for the first time (for example, Farlow *et al.*). The editors emphasize that the study of footprints is now ready to move from these more traditional topics and make new contributions to our understanding of paleoecology, biostratigraphy, and the behavior of extinct organisms. Reality, however, may argue otherwise.

The consensus is that footprints cannot be assigned to a taxonomic level finer than family. Despite this repeated admission, the editors in the introduction to the section on biostratigraphy (p. 199) insist that vertebrate tracks hold much promise in this field. Since most dinosaur families are long-lived, recognition of tracks at a family level can, at best, provide only a large-scale resolution to stratigraphic questions. For some questions, resolution no more precise than, for example, assignment to the Upper Cretaceous may be sufficient. However, the prospect that a tool limited to such large-scale resolution can make a significant contribution to biostratigraphic problems seems unlikely.

A few papers include paleoecological conclusions. For example, in explaining the stratigraphic distribution of track types in the Triassic, Demathieu remarks that "the competition between the two groups of reptiles must have been relatively great." Competition is a phenomenon that most ecologists find difficult to detect at any taxonomic level. It seems highly unlikely that footprints, identifiable at best to the family level, can be useful in addressing the complex issue of competition, and such a discussion should be dismissed.

Another questionable point is raised by the discussion of prints attributed to swimming sauropods (for example, by Ishigaki). There exist three distinctly different types of trackways of sauropods that are considered to indicate swimming (see Lockley and Conrad's paper for references). Rather than consider these tracks as representing three different styles of swimming, Lockley and Conrad interpret them as underprints, a feature created in the subsurface beneath the original tracks. This interpretation may be correct, but the authors continue by stating that attribution of the prints to swimming sauropods will contribute to reviving the hypothesis that sauropods were aquatic (p. 124). Humans are certainly not aquatic, yet they can leave marks on lake or stream bottoms when they are in the water. The fact that sauropods may have likewise spent time in the water, swimming or otherwise, does not imply a preferred aquatic mode of life. A useful paleoecological point in the same chapter concerns the distribution of tracks through various depositional environments, drawing attention particularly to the numerous occurrences of tracks within dune facies. The potential of arid dune environments as a source of paleontological information is beginning to be recognized.

Several papers deal descriptively with eggshells. I am not clear why eggs are considered to be only "traces" of dinosaurs. Eggs with embryos certainly cannot be treated as such. If eggs are considered to be traces because they are composed of calcium carbonate rather than apatite as are bones, why should we not consider all of invertebrate paleontology the study of trace fossils? The reader is left with the impression that this book is intended as a bandwagon and the section dealing with eggshells is included to insure the field's popularity.

Overall the layout of the book is good, and there are an acceptably low number of typographical errors, unlisted citations, and poorly reproduced graphics. It may come as a surprise that so many people were able to contribute to a volume on this subject. The editors, however, should have exercised a heavier hand in selecting papers or at least worked to raise all of them to professional standards. For example, the following blatant sarcasm (Agnew *et al.*) is included: "Field preservation, with the requirements of at least fencing the site and possibly roofing it as well may just be too expensive for busy research scientists to go seeking funds. Who can blame them when it is such a time-consuming activity to protect a site?" Such a tirade is entirely irrelevant.

I consider this a useful book, although I do not share the optimism of the editors that vertebrate paleoichnology is ready to stand on its own. Recognition of the abundance of vertebrate tracks is a different issue from their practical utility for detailed studies. I encourage those dealing with trace fossils and dinosaurs to become familiar with this volume, for it represents the state of the science of fossil footprint studies. I think the field has a long road ahead in determining its potentials and limitations. Perhaps the most appropriate remark within the book concerning this field is, "The journey of a thousand miles begins with a single step" (Lao Tse, p. 3). That is precisely how this volume should be viewed.

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Quantum Electrodynamics

Photons and Atoms. Introduction to Quantum Electrodynamics. CLAUDE COHEN-TANNOUDJI, JACQUES DUPONT-ROC, and GILBERT GRYNBERG. Wiley-Interscience, New York, 1989. xx, 468 pp. $59.95. Translated from the French edition (Paris, 1987).

Recent years have witnessed a renaissance of interest in atomic physics and its interplay with quantum optics. Laser, maser, and synchrotron sources have revolutionized the study of interactions between matter and radiation. More recently, the invention and perfection of traps for single atoms—honored by the Nobel prize a few months ago—have opened the door to stunning experiments on individual atoms interacting with light. Previously, only large ensembles of atoms could be dealt with, and a number of quantum mechanical effects were thus hidden. The new developments have stimulated a vast amount of research.

This book, which is a translation of a French work, presents the theoretical foundations for the description of atoms and radiation and their interplay. The underlying theory, quantum electrodynamics, is well covered by textbooks, but these text-

book treatments usually address the concerns of field theorists and emphasize such topics as relativistic invariance and covariance, Dirac spinors, and renormalization. Here different aspects are important, such as a non-relativistic treatment of atoms and their coupling to the quantized radiation field. Given that most books on quantum optics give short shrift to the fundamentals of electrodynamics and its quantization, I think there is a place for a book like this. It is addressed to both graduate students and researchers, and both can profit substantially from it.

The span of the book is considerable, and it contains a wealth of material not easily found elsewhere. It starts with a detailed review of classical electrodynamics, followed by its Lagrangian and Hamiltonian formulation in the Coulomb gauge and by a discussion of symmetries and functional derivatives. This makes up somewhat more than a third of the book. Then quantum electrodynamics in the Coulomb gauge is treated in depth, since this gauge—though not manifestly covariant—is mostly used in quantum optics because of its practicality. Also the coupling to non-relativistic charged particles is presented. Equivalent formulations, obtained either by a change of gauge or by general unitary transformations, are then discussed thoroughly. The presentation of the Power-Zienau-Woolley transformation, which eliminates the potentials from the Hamiltonian and expresses the interaction with the charged particles in terms of the electric and magnetic field, is clearer than I have seen in other books. The last part of the book deals with quantization in the covariant Lorentz gauge and the problems associated with an indefinite metric. The Dirac field is also introduced, but Feynman diagrams and renormalization theory are not discussed. The book then finishes with a special treat for the reader, a justification of the non-relativistic theory in the Coulomb gauge starting from relativistic manifestly covariant quantum electrodynamics.

The presentation is lucid. It is apparent that the authors have taught this subject repeatedly, and some of the more unconventional material—and there is a lot of it—may have been prompted by concern with students' questions. Intentionally there are practically no concrete applications to atomic physics and quantum optics. These are reserved for an accompanying volume entitled *Interaction Processes between Photons and Atoms*, soon also to appear in English translation. Therefore a course following this book probably would have to be selective, with applications drawn from the other volume. This is facilitated by its very structured form.

The book shows, in particular through enlightening comments, that the authors have gone beneath the surface of their subject and thoroughly understand what they write—which is more than one can say about many a book. I definitely enjoyed reading it.

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Neuronal Carbohydrates

Neurobiology of Glycoconjugates. RICHARD U. MARGOLIS and RENÉE K. MARGOLIS, Eds. Plenum, New York, 1989. xviii, 453 pp., illus. $79.50.

For over a century it has been postulated that the assembly of the nervous system is mediated by cell-surface or extracellular molecules. Ramon y Cajal proposed the existence of chemical cues in the extracellular environment to explain his observations of the directed growth of axons, and Sperry further suggested that specific cell-surface molecules guided axon navigation and synapse formation. Biochemical analyses of the constituents of membranes and extracellular matrix have suggested that the most likely candidates for these critical functions are glycoconjugates—a family of carbohydrate-bearing species including glycosaminoglycans, proteoglycans, glycoproteins, gangliosides, and glycolipids.

Neurobiology of Glycoconjugates is an updated version of an earlier volume assembled by the same editors. Glycoconjugate biology and biochemistry have advanced considerably over the last 10 years, and the contributors and topics in the present volume reflect these advances. For scientists in the field, as well as for neophytes, the editors have made an interesting and useful selection of topics. Included are chapters on the identification and characterization of nervous system glycoconjugates as well as on the basic biochemistry of these molecules. Full chapters are devoted to the biosynthesis of glycoproteins, gangliosides and proteoglycans, topics that are given only passing attention in many review articles.

Most of the book, which contains 15 chapters by 23 authors, is well organized and well written. Some of the better chapters include not only reviews of work up to the present but also interesting discussions of controversial topics and insightful indications of future directions. Some chapters largely reiterate material covered in recently published reviews but are useful in rounding out the volume as an overview of the subject. Unfortunately, there is no general introduction describing the criteria by which a molecular species is considered a glycoconjugate and explaining why these molecules are of such great interest in neurobiology.

The detailed roles that glycoconjugates play in neural development and structure are still little understood. At present it seems clear that both carbohydrate and protein structures contribute importantly to intercellular interactions. Carbohydrates may function to target proteins to specific cellular domains and may also, as in the case of sialic acid, regulate intermolecular interactions. The presence of intracellular glycoconjugates suggests additional roles, which in the nervous system are currently unknown.

A volume such as this documents that the list of molecules that may play a role in cell recognition and adhesion grows rapidly. Despite the increase in the number of such molecules identified during the last decade, understanding of the precise molecular mechanisms that mediate specific cell-cell recognition and axon navigation remains elusive. With a few good candidate molecules and the powerful techniques of modern molecular biology, work over the next decade is likely to produce a third volume in this series that will contain answers to some of the remaining questions concerning the functions of neural glycoconjugates. Until that time, the present volume will serve as a much-needed reference in the field.

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