More compelling, I believe, is Marsden's charge that since the 1960s, first with the New Left and more recently with postmodernism, the ideal of rational, unbiased scholarship has come under heavy assault and even, in the strongest charges against it, become associated with the oppressive forces of modern, technological society. If the standards of an impartial, scientific methodology no longer compel, Marsden asks, why may religion not claim an equal legitimacy with other partisan explanations? A fair question, but it does not put Marsden in good company, at least not in the company I think he would like to keep. For certainly much of Marxist scholarship, feminist scholarship, and now the argumentation of Afrocentrism has not met the standards of empirical research and demonstration important to any scientific community. If universities have succumbed to the politics of subjectivity and political warfare by groups, one has to wonder, rather, whether we have not too readily abandoned at least the ideal of an objective scholarship.

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Reptilian Offspring

Dinosaur Eggs and Babies. KENNETH CARPENTER, KARL F. HIRSCH, and JOHN R. HORNER, Eds. Cambridge University Press, New York, 1994. xiv, 372 pp., illus. $79.95 or £55.

Paleontologist Walter Granger, a member of the American Museum of Natural History's 1923 Central Asiatic Expedition to Mongolia, is widely thought to have been the first person to recognize dinosaur eggs for what they were—a legend that the museum and perhaps generations of American paleontologists have been happy to publicize. But dinosaur experts have long known that eggs large enough to dwarf even the elephant-bird's were recovered from southern France and described 50 years earlier. More than a decade before that, the first eggshell fragments were identified from there by J.-J. Pouech but were not recognized as such: other scientists assured Pouech they could not be eggshells. His successor, Matheron, knew they were eggshells but thought their bearer was a giant crocodile. It seems to have taken Granger's discovery to confirm the suspicions about the French eggs, but even today it is not absolutely certain that the egg-layer is the widely suspected contemporaneous sauropod *Hypselosaurus*.

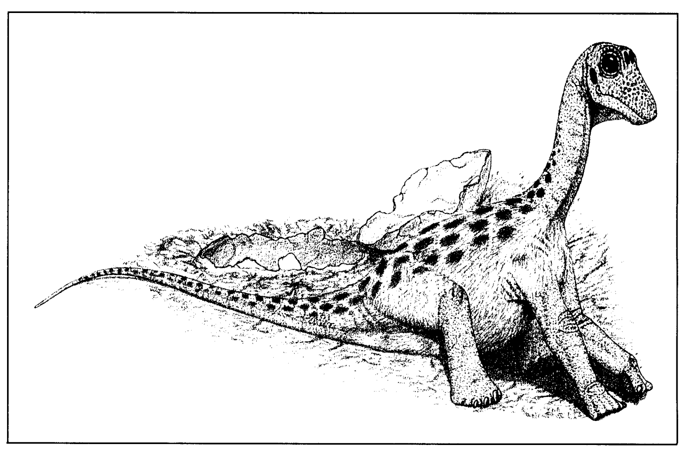
So science proceeds in fits and starts, and these historical vignettes form only a part of the interest of this remarkable new volume. This is the first book to review comprehensively the knowledge to date of the eggs, nests, and young of dinosaurs, and it is an impressive effort with some 50 authors and a strong international flavor. Although one of its major messages, as might be expected, is that there is still much to learn, a good indicator of the lurching pace of this field and its recent acceleration is the plain fact that this book could not have been written ten years ago—or at least, it would have been much slimmer. This is evident, for example, from perusing Carpenter and Alf's opening chapter, which surveys the global distributions of dinosaur eggs, nests, and babies. It is a superb compilation along the lines of D. B. Weishampel's compilation of standard dinosaur remains in *The Dinosauria* (University of California Press, 1990) and just as useful, complete with maps and ornamented by skeletal reconstructions of the better-known neonates.

"Philippe Matheron (1807–1899) who discovered the first dinosaur eggs in the Upper Cretaceous of Provence." [From E. Buffetaut and J. Le Loeuff's paper in *Dinosaur Eggs and Babies*; photograph courtesy of Robert Fournier, Musée d'Histoire Naturelle de Marseille]

Generally the first question about a fossil egg that springs to mind is who laid it. This is difficult to determine unless it contains an embryo, and even then there are problems because newborns of related species differ from each other less than adults do. Most fossil eggs and shell fragments lack embryonic material, and associated bones of larger animals could represent parents, predators, or neighbors of different species. Even without embryonic verification, though, there turn out to be a lot of data in eggshell, which can be stored and compared when better finds emerge.

The contributors to this book include the foremost specialists who have taken the study of fossil eggs to the microstructural level, analyzing eggshell architecture, protein, organics, and isotopic ratios. These latter factors are also important in understanding the environment of the nest (and indirectly something about the biology of the egg-layer), the physical conditions of the locality, and diagenetic factors of preservation. Again and again, authors return to features of gas exchange, calcite balance, crystalline structure, and development in the eggs of living animals and their evidence in fossil eggs, making this volume of substantial paleobiological interest. The studies of dinosaur embryos and nestlings, pioneered by J. R. Horner, R. R. Makela, and D. B. Weishampel among others, have used comparative bone histological features to determine differences in life-history syndromes among contemporaneous species. Studies of the dynamics of dinosaur growth and metabolism are necessarily rooted in this kind of data.

It is worth citing a few examples from this uniformly excellent collection. One that stands out for sheer comprehensiveness is the review by Vianey-Liaud and her colleagues of French eggshells, which includes stratigraphy, microstructural anatomy, and taxonomy (also well detailed by Zhao and Hirsch in their respective chapters) with chemical analysis of the calcites and amino acids in what should be a standard for further work. Curiously, despite



A three-kilogram titanosaur sauropod hatchling. The "small size of dinosaur hatchlings made possible large clutch sizes and high reproductive rates that rendered even the largest dinosaurs r-strategists with exceptional population recovery and dispersal potential." [From G. S. Paul's paper in *Dinosaur Eggs and Babies*] the rage for cladistics in all fields of comparative biology, no one seems to have applied this approach to the features of eggshells by trying to identify nested sets (no pun intended) of characters shared by different types of eggshell. Weishampel and Horner, however, in a fine contribution, use what sparse evidence there is of embryonic and neonatal dinosaurs (only 3.5 percent of known dinosaur species are so represented) to chart phylogenetically the evolution of life-history strategies in dinosaurs, establishing minimal hypotheses of evolutionary change in nesting, parental behavior, and growth regimes. And, as Gregory Paul shows, the difference between dinosaurs and living warm-blooded animals—or for that matter, any animals—is enormous not only in terms of size: an elephant may produce about a dozen young in 40 fertile years, but a sauropod might have laid 500 to 4000 eggs. Consider that a baby elephant may weigh 400 pounds and grow to 10,000 (a 25-fold increase), but a sauropod laid a volleyball-sized egg of maybe 8 pounds that grew to 80,000. It is clear that, once again, we simply cannot assess dinosaurian biology solely by the yardsticks and limits of the arbitrary slice of life that exists on our planet today. This thoughtful, stimulating, and informative volume is required reading for a perspective on these and many other paleobiological issues; the field of dinosaurian development is hotter than ever.

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Vignettes: Non-Skepticism

At least two circularities are involved in the search for knowledge. One is the hermeneutic circle: we have to believe in order to understand and we have to understand in order to believe. That is why scepticism is so unfruitful a strategy. Why do I believe in quarks when no fractionally charged particle has ever unequivocally been observed in an experiment? Set your doubts aside for a while and see how belief in confined quarks enables us to understand a variety of phenomena . . . which otherwise would have no underlying intelligibility.

—*John Polkinghorne*, in *The Faith of a Physicist: Reflections of a Bottom-Up Thinker* (Princeton University Press)

The skepticism of science is famous, but not so widely known is its optimism. One might even suggest that creative work spans a wider spectrum than most activities between the hopeful and the critical, between proliferation and selection.

John Archibald Wheeler, in *At Home in the Universe* (AIP Press)

The Idea of Chemistry

From Chemical Philosophy to Theoretical Chemistry. Dynamics of Matter and Dynamics of Disciplines, 1800–1950. MARY JO NYE. University of California Press, Berkeley, 1994. xviii, 328 pp., illus. $48 or £37.50.

Is there a uniquely "chemical" way of seeing and describing the natural world? And if so, how does it compare with the "physical" way? When can we speak of the emergence of "theoretical" chemistry, and who were its practitioners? These and other important questions are the focus of Mary Jo Nye's highly original historical analysis of the *idea* of chemistry—the notion of a theoretical chemistry distinct both as a discipline and as a method of investigating nature. From the outset, Nye employs a novel approach: she centers on the problem of the dynamics of matter, rather than the traditional topic of the structure of matter. Chemical affinity and reactivity are thus ideal topics for understanding the interface between chemistry and physics, the crystallization of a specific discipline of modern theoretical chemistry in the 1920s and '30s. For, though it is generally considered that chemistry became an established profession, with its own identity, methods, and goals, well before physics, this empirical, laboratory culture did not attain the philosophical high status of physics because it was seen as lacking axiomatic and mathematical foundations. Kant had declared categorically that chemistry could never become "true knowledge."

Despite the attempts by the generation of Lavoisier's *chimistes* and *physiciens* to pursue problems of common interest, the 19th century saw an increasing demarcation of chemistry and physics as distinct disciplines. Nye argues that the chemists' urge to provide useful knowledge hampered the development of a theoretical chemistry and often produced incomprehension of closely related domains. But toward the end of the 19th century, chemical thermodynamics and electrochemistry led to the formation of a theoretical chemistry that sought to bridge, or even reduce, chemistry to physics. A group of Continental physical chemists that included W. Ostwald, S. Arrhenius, J. H. van't Hoff, W. Nernst, P. Duhem, and J. Perrin provided a mathematical mechanics of matter, centered on the relations between energy and the properties of macroscopic systems. Planck's quantum radiation hypothesis of 1900, the theories of the electron, and structural chemistry provided the impetus for the growth of specific research schools, molded by different national traditions, and laid the foundation for the new subdiscipline of physical organic chemistry in the early decades of the 20th century. Here Nye provides a fine-grained exploration of the Paris school of theoretical chemistry led by Robert Lespieau at the Ecole Normale; of the London-Manchester schools of A. Lapworth and T. Lowry; and of Christopher Ingold's 30-year effort at University College, London, to produce a general theory for a new physical organic chemistry.

Nye's is not a traditional narrative of ideas, experiments, and confirmatory achievements. Rather, it traces the varying ways in which chemists defined their identity, both conceptually and methodologically, within research schools. Nye makes a powerful argument for the thesis that by 1873 chemists had essentially recognized, before most physicists, "the conventional character of the basic definitions and premises of scientific explanation systems" and that "multiple explanations are superior to a simple but wrong explanation" (p. 72). Considerably later, Ingold's synthesis of physical chemistry and organic chemistry explored both molecular forces and structure, evolving into a genuine chemical theory of electrical, polar, and stereochemical effects compatible yet distinct from the then-emerging quantum chemistry.

In the last part of the book, Nye moves to the United States, where quantum chemistry was vigorously pursued by L. Pauling, J. Slater, and R. Mulliken among others. European physicists, including N. Bohr, M. Born, F. Hund, W. Heitler, and A. F. London, who initially made significant contributions to the emergence of quantum chemistry, relinquished the field primarily to American chemists. It was in the United States, too, that the elusive split between quantum chemists and chem-