ered that ASL itself is a rich expressive language that could be used as a medium of instruction, and there are no standard ways of assessing a deaf child's proficiency in ASL, as there are in English. Some of the complexity of this visual language is described in the final section of the book in papers on discourse features. A study by Zimmer of stylistic differences between ASL in a formal lecture and in informal situations reveals, among other differences, that in the lecture signs are made more slowly, cover a larger space, and are held onto longer. A chapter by Roy describes the special features used in an ASL lecture that observers found exciting and fascinating; the topic was mating rituals of the stickleback fish. Observations such as these leave little doubt about the potential of ASL as a language of instruction in an unprejudiced world.

Some of the studies that are reported in this collection are somewhat preliminary and suggestive rather than definitive in nature, but each of the chapters is clear, and a strong editorial hand is evident in the summaries and conclusions that are included.

Linguistic theory will ultimately have to incorporate data from ASL if it is to derive universal rules about the nature of human cognition and human communication. Studies of grammar are necessary but not sufficient; we also need to know how language is used in society. The scholars who have written *The Sociolinguistics of the Deaf Community* have provided an excellent starting point.

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Winter Absences

Where Have All the Birds Gone? Essays on the Biology and Conservation of Birds That Migrate to the American Tropics. JOHN TERBORGH. Princeton University Press, Princeton, NJ, 1989, xvi, 207 pp., illus. $45; paper, $14.95.

The title of this collection of 14 essays suggests an ornithological mystery. Many species of migratory birds, especially some of the 250 species that breed in the temperate zone of North America and winter in the Neotropics, are declining in numbers, but avian ecologists and conservationists have had difficulties pinpointing the causes of this troubling trend. Some investigators suspect that problems on the breeding range are responsible, whereas others blame problems on the wintering range. John Terborgh's far-flung field investigations have given him extensive personal experience with birds and their habitats in both the temperate zone and the tropics. His clear thinking about the threats to migratory birds combines the insights of a keen naturalist with the analytical skills of an ecologist. The resulting book makes for intriguing reading, much like Rachel Carson's *Silent Spring*, which also attracted general readers with the specter of a mysterious threat to songbirds.

Populations of forest-dwelling songbirds—such as warblers, vireos, thrushes, and flycatchers—are featured characters in Terborgh's essays. The breeding habitats of these birds have been subjected to complex changes over the past 350 years. Eastern North American forests were steadily reduced until reaching their nadir in about 1900. Throughout this period populations of most forest songbirds were, as Terborgh suggests, limited by the carrying capacity of their breeding habitat. Recently, forest cover in eastern North America has rebounded, but the regenerated forest is a fragmented one dominated by ecological edges, unlike the extensive unbroken forest in which these birds evolved. In this patchwork forest surrounded by developed lands, forest songbirds are experiencing severe reproductive problems. Their nests are preyed upon by a variety of increasingly abundant predators and parasitized by a burgeoning population of brown-headed cowbirds that lay their eggs in songbird nests, causing the hosts' eggs and young to perish. Today, populations of forest songbirds are declining while the area of their habitat is expanding. Is their inability to reoccupy the expanded forest due to inadequate reproduction or to new problems on wintering areas? Terborgh relies on his own experiences and a review of the literature through 1988 to provide answers.

Whereas forest cover in North America is expanding, in the Neotropics, where migrant forest songbirds spend half the year, forests are rapidly dwindling. Tropical deforestation receives much attention in Terborgh's book; he addresses the social and economic forces that drive deforestation and the ecological consequences, focusing on the impacts for migrants. Terborgh reviews our nascent knowledge of the ecology of migrants on their wintering range and draws several key conclusions. Most migrants are concentrated in geographically small areas just south of the temperate zone: Mexico, Central America, and the Caribbean. Some populations are compressed into winter ranges only 10 to 20 percent of the area of their breeding ranges. Most migrants are species-specific in their selection of forest habitats, and not all require primary forests; some do well in disturbed second-growth or even certain agricultural lands, such as coffee plantations. Terborgh's inescapable conclusion, however, is that, if present land-use trends in the Neotropics continue, more and more migrants will eventually become limited by the carrying capacity of their winter range. Some have already reached this point, and at least one, Bachman's warbler, may have become extinct because of loss of winter habitat.

Despite Terborgh's logical examination of the mysteries of declining migrants, the subject remains controversial. A 1989 symposium on the ecology and conservation of neotropical migrant landbirds failed to reach a clear consensus on either how or where populations are being limited. Much of the uncertainty is due to the paucity of crucial information on the ecology of most wintering migrants. Unfortunately, the most revealing data—on overwinter survival in various habitats—are also the most difficult to obtain. Nonetheless, Terborgh concludes his book with recommendations on what must be done to conserve migrants in both the temperate zone and the tropics. His solutions would preserve not only migratory songbirds but other important elements of biotic diversity as well.

Anyone who loves the vernal chorus of migratory songbirds and is concerned about these evocative creatures and the habitats on which they depend should read this book. The environmental problems Terborgh addresses will be as important in the 1990s as those that Rachel Carson alerted us to in the 1960s. The consequences of not heeding Terborgh's message may be spring forests as silent as those Carson once warned us about.

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Computational Physics

Frontiers in Numerical Relativity. CHARLES R. EVANS, LEE S. FINN, and DAVID W. HOBILL, Eds. Cambridge University Press, New York, 1989. xiv, 435 pp., illus. $54.50. From a workshop, Urbana-Champaign, IL, May 1988.

Numerical relativity—that is, computer simulation of relativistic gravitational fields and their sources—has become one of the most active areas of "classical" (non-quantum) relativity, and a remarkable number of contributors to this volume representing its development are people who have moved into this area after doing important analytic work in general relativity.

The workshop on which the book is based was conceived as a follow-up to a similar meeting at Drexel University two-and-a-half years earlier, which produced the excellent volume *Numerical Relativity and Dynamical*

Spacetimes, edited by Joan Centrella (Cambridge University Press, 1986). The present collection is a worthy successor, and indeed the two books make an interesting comparison.

Although there is a considerable overlap among the contributors to the two books (more than 70% of the papers in the Centrella volume have authors who have written for the present one), there is a noticeable change of emphasis. The Centrella volume caught the field at a turning point, when the simplest axisymmetric problems had been studied and new supercomputers were beginning to make three-dimensional problems look tractable. It was very much concerned with code tests and analytical guides to calculations, and it introduced a number of areas in which numerical work was only just beginning.

The present volume reflects a great increase in activity in many directions. There are more than twice as many papers as in Centrella's book. A third of them report numerical results for three-dimensional problems. Others continue new directions that emerged in the Centrella volume, such as numerical studies of cosmic censorship and null-cone relativity. Several use the increased computing power now available to put better physics into earlier calculations: radiation hydrodynamics, magnetohydrodynamics, cosmological nucleosynthesis. There are a number of valuable papers on techniques: multigrids, adaptive meshes, spectral methods, finite elements, smooth-particle hydrodynamics, even a "pde compiler" to automate the generation of complicated code.

There are many other interesting papers, on perturbation techniques, analytical methods, solving the initial-value constraints, black-hole interactions, and gravitational radiation. The variety of activity reflected in this volume is in part a tribute to the wisdom of the National Science Foundation in establishing its supercomputer centers, and it is no coincidence that the meeting was hosted by Larry Smarr's National Center for Supercomputing Applications: Smarr was one of the founders of numerical relativity and one of the prime movers behind the supercomputer centers. However, the meeting was genuinely international, and the strength of the Japanese work in this field is particularly evident in this volume. The computing power available to some of the Japanese groups will probably make them the pace-setters over the next couple of years.

This collection is the best review of the state of numerical relativity currently available. It is the place to start if you want to get into the field or if you want to see what is known about the main problems. If your library contains the Centrella volume, you should certainly get this one too. And if your library doesn't, maybe it is time it caught up with this rapidly developing subject.

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Biogenic Minerals

Biomineralization. Cell Biology and Mineral Deposition. KENNETH SIMKISS and KARL M. WILBUR. Academic Press, San Diego, CA, 1989. xiv, 337 pp., illus. $69.95.

On Biomineralization. HEINZ A. LOWENSTAM and STEPHEN WEINER. Oxford University Press, New York, 1989. x, 324 pp., illus. $57.

Biogenic minerals are amazingly varied and highly complex components of living organisms and of the earth's surface. In addition to their crucial biological functions, they play a major role, through enormous sedimentary deposits in the oceans, in biogeochemical cycling and the composition of both land and seas, with important environmental and economic consequences. More than 60 different biogenic minerals have been found, and the list is not yet complete. "Biomineralization" is the term now used for the processes by which organisms form or regulate the formation of minerals. The study of these processes has certainly come of age in the past decade, and they are now the subject of intense worldwide research activity embracing many disciplines and perspectives.

Mineralized plates, or coccoliths, from the alga *Emiliania huxleyi*. "Viewed from the side [these coccoliths appear] to be composed of two superimposed plates. In fact, the basic building blocks are not the plates but individual anvil-shaped segments that fit together side by side. . . . In a very elegant study, Watanabe (1967) showed by electron diffraction that one entire segment behaves as if it is a single crystal." Coccolithophorid species, of which *E. huxleyi* is the most abundant, "are undoubtedly *the* major contributors [of calcium carbonate] to the ocean sediments." [From *On Biomineralization*]

The two books reviewed here are quite similar in organization, opening with general comments on the nature of the processes involved in biogenic mineral formation, moving on to more detailed discussions of the processing in specific phyla, and ending with rather sweeping discussions of the global, environmental, and evolutionary aspects of biomineralization. However, reflecting the diversity of the field, they have very different emphases and perspectives. All four authors have made notable individual contributions to the field, and the melding of concepts and insights one finds throughout both books suggests that writing them must have been intellectually stimulating.

With both books in hand, which to read first? After skimming both, this reviewer chose to read Simkiss and Wilbur first, and in retrospect this was a good choice. *Biomineralization* places its emphasis on how organisms move ions from one intracellular compartment to the next and how the accumulation of ions is regulated. These topics are introduced in chapters 3 and 4, and the principles are referred to in each of the 11 chapters on specific cellular organizations. Each of these chapters describes in detail the biology of the system it is concerned with and attempts to present what is known concerning the intracellular ion movements. A major strength is the summaries at the ends of the chapters. Individual chapters get a bit bogged down in detail, but a consecutive reading of the summaries provides a coherent overview of the general features of cellular regulation of biomineralization and of the importance of the concept of compartmentalization of mineral deposition. The place of vertebrates in biomineralization studies, in the minds of the authors, is evidenced by the fact that all vertebrates are dealt with in a single chapter of only 20 pages, and bone is given a rather shallow discussion in less than 10 pages. The volume ends with a consideration of global processes governing biomineral deposition and generalizations on the cellular organization required. *Biomineralization* is profusely illustrated, but the figure legends, particularly for the drawings and diagrams, are not as informative as one would like.

In *On Biomineralization* Lowenstam and Weiner eschew much discussion of cellular processes and the biochemical problems of moving the mineral ions to the correct compartments. Instead they focus on the processes whereby matrix macromolecules initi-