entwined with environments generated by glacial retreat. Carbon dating (based on the 5700-year half-life of ^{14}C) has been applied with considerable precision to innumerable sites and landscapes of late Pleistocene and Holocene age since the method was discovered four decades ago.

Paradoxically, this plethora of Quaternary data causes most textbooks to give an oversimplified view of that period. The opposite product that many of us specialists help produce is a kaleidoscopic compendium, largely refractory to any but other specialists. In view of these circumstances, the present volume, clearly and coherently written by a single author, comes as a refreshing summer breeze from the north. E. C. Pielou, a resident of British Columbia, is best known for her outstanding books on quantitative methods in ecology and on northern evergreens and has received major awards in botany and ecology. Although this book is partly a new departure from her prior publications, the author clearly enjoys crafting together the details of such diverse subjects as glacial geology, geomorphology, paleontology, and the sytematics and biogeography of living organisms. She does not spare the details, yet they are succinctly summarized and enlivened by some 200 sketches ranging from Ice Age vistas to diatoms, larvae, plants, fishes, dung beetles, beaver dams, and mammoth teeth.

This book is a historical quest to recreate the peregrinations of organisms that now occupy the formerly glaciated land. No great underlying principles are revealed, unless it be the extraordinary complexity and contingency of life. Interpretations are inductive, and the author threads her way cautiously through many weak inferences and multiple hypotheses. Nevertheless, as she observes (p. 62), "When all is said and done, . . . the post-glacial history of the biosphere in Canada and northern United States is now fairly well known because it is based on an enormous amount of evidence."

Northward distribution of trees over glacial terrain has been particularly well studied. Origin from different refugia, unique modes of spreading, and varied soil and moisture requirements cause each species to follow its own destiny, thus producing a shifting set of "non-analogue" communities. The pattern of movement in the west is quite different from the pattern in the east. For example, the eastern white pine moved northward early, whereas the western lodgepole pine made a surprisingly late northward move, until its trek was assisted by evolution of lighter wing loading for its wind-borne seeds. Once a particular species is established, it is not easily displaced until fire or some other catastrophe breaks the logjam. Such "ecological inertia" implies that even today many communities may not exist in equilibrium with the climate and the cohabitants of their environment. For this reason the author advocates (p. 101) the view that "disequilibrium in ecological communities is much commoner than equilibrium."

Naturally there is a chapter on "The great wave of extinctions" among large mammals, which the author sees (p. 251) as "one of the most noteworthy, and most puzzling, events in ecological history." This chapter encapsulates the dilemma that characterizes the extinction debate: *neither side is right*. "The numerous 'environmental' theories put forward . . . all fail in being too farfetched or too 'particular.' . . . . Moreover, they all seem to overlook the fact that tremendous environmental changes occurred during the Wisconsin glaciation as well as at the end of it. The overkill theory has fatal objections, too." Pielou concludes (p. 266), with some frustration, that "the great wave of extinctions at the end of the Pleistocene has yet to be convincingly explained."

This splendid history of American lifeways in the recent past is published just when our society has reached a peak of anxiety over the future of our environment. And so the obvious question is whether this book provides a recipe or two that can help us plan more wisely. Certainly there are no grand pronouncements about global change. The processes and perspectives deciphered here are so intricate, and in many instances so heartily debated, that even simple applications must remain open to discussion. One can assert, however, that knowledge is better than ignorance, and that this book presents a valuable new synthesis of facts and ideas about climate, geography, and life during the past 20,000 years. More important, the book conveys an intimate appreciation of the rich variety of nature through time. As we, and other survivors of the late Pleistocene, struggle onward, this knowledge of life past may encourage us to protect life future.

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Tropical Sites

Four Neotropical Rainforests. ALWYN H. GENTRY, Ed. Yale University Press, New Haven, CT, 1991. xvi, 627 pp., illus. $57.50. From a symposium, Columbus, OH, Aug. 1987.

In his foreword to the 1985 reprinting of Thomas Belt's *The Naturalist in Nicaragua*, first published in 1874, Daniel Janzen wrote, "Just as Belt exposed some of the outlines of tropical biology, today we have by comparison an army of workers observing and recording natural history of the tropics. But Belt was working amidst an ocean of nature, while all that remains to us are small and rapidly shrinking ponds." Four of those "ponds" are the subject of this book, which presents the results of a symposium held at the Association of Tropical Biology's annual meeting in 1987. The four neotropical rainforest sites represented are La Selva, Costa Rica; Barro Colorado Island (BCI), Panama; Cocha Cashu field station in Manu National Park, Peru; and the Minimum Critical Size of Ecosystems (MCSE) study site near Manaus, Brazil.

The book is divided into six parts dealing with site histories, floristics, birds, mammals, amphibians and reptiles, and forest dynamics. Each of the latter five sections contains a chapter on each site and a chapter presenting an overview and summary of the topic. Thirty-six authors, including 26 housed in non-tropical institutions, have contributed to the work.

The four rainforest sites differ strikingly in their size, accessibility, degree of human disturbance, soil conditions, and history of study. La Selva is small (1500 hectares), disturbed, and easily accessible, whereas Cocha Cashu lies in a vast region of undisturbed forest and is least accessible. The soil at three of the sites is relatively rich, whereas that at MCSE is poor. BCI is the longest-established site (dating from the early 1920s) and MCSE the most recent (1979). To date, BCI and La Selva have been the most intensively studied sites and MCSE the least. The former two sites have large infrastructures, substantial annual budgets (over $1 million at BCI), and laboratories for technically sophisticated research. In contrast, Cocha Cashu with its magnificent forest and intact fauna consists of three simple buildings and has an annual operating budget of less than $5000, slightly more than the cost of one polymerase chain reaction machine. Hundreds to thousands of published studies have been done at La Selva

and BCI; relatively few have been done at Cocha Cashu and MCSE.

Reflecting the relatively rudimentary knowledge about the life histories and ecology of most species of plants and vertebrates at each site, most chapters focus on estimates of species richness, relative abundances, trophic structure, and biogeographic affinities of particular taxa. Much of this information is summarized in a large number of tables, figures, and appendixes representing about one-third of the book. It tells us that the three rich-soil sites are much more similar to each other floristically and in the structure of their vertebrate faunas than they are to the MCSE site; that biogeography and phylogeny have strongly influenced diversity patterns; and that high amphibian diversity is not necessarily correlated with high annual rainfall. Studies of bird populations indicate that densities are higher and home ranges or territories smaller in forest near BCI than at Cocha Cashu. Bird communities at La Selva receive substantial annual influxes of migrant frugivores and nectarivores. The high diversity and abundance of mammals at Cocha Cashu, compared with La Selva and MCSE, appear to be related to high plant productivity (fruits and seeds), high habitat diversity, and the absence of hunting. Janson and Emmons support Terborgh, who has argued that the intact predator fauna at Cocha Cashu has profoundly influenced populations of medium-sized seed-eating mammals and the plants whose seeds they eat.

Studies of the forest dynamics at these sites are in their infancy. Such studies are being conducted on plots ranging in size from 0.9 hectare (Cocha Cashu) to 50 hectares (BCI) covering time spans of less than 20 years. Trees with a DBH (diameter at breast height) of 10 centimeters or more have mortality rates of 1 to 2 percent per year, and annual gap formation averages about 1 percent of the forest area. Stand turnover times, defined by Hartshorn as the time needed for gaps to cover a unit area of forest (1 hectare, for example), at La Selva and BCI range from 62 to 137 years, depending on study plot. Foster estimates that much of the forest around Cocha Cashu is less than 200 years old owing to the profound influence of the meandering Rio Manu.

This book represents a milestone in our knowledge about the structure and function of New World tropical forests. Though it contains an impressive amount of information about what we do know about certain aspects of these forests, it is perhaps more valuable for highlighting what we do not know about them. We know little about the long-term population dynamics of most species of tropical plants and animals. Studies summarized in this book pay little attention to plant-animal interactions, perhaps the topic of greatest interest in tropical biology today, as it was for the 19th-century tropical explorers such as Belt. Insects have been totally neglected, as the editor acknowledges. When written, books on these and other tropical topics will fill libraries. Clearly there is enough ecological and evolutionary work to be done in tropical forests to keep Janzen's "armies" busy for the foreseeable future. Given the uncertainty of funding for tropical research, however, much of this work will be done in piecemeal fashion instead of being coordinated and directed toward answering large questions requiring long-term studies. Owing to the shrinking nature of the tropical "ocean," much of this research will be conducted at the four "ponds" described in this book.

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The Sunshine State

Ecosystems of Florida. RONALD L. MYERS and JOHN J. EWEL, Eds. University of Central Florida Press, Orlando, FL, 1990. xviii, 765 pp., illus. $75; paper, $29.95.

The Rivers of Florida. ROBERT J. LIVINGSTON, Ed. Springer-Verlag, New York, 1990. xii, 289 pp., illus. $59. Ecological Studies, vol. 83. From a conference, Tallahassee, FL, June 1987.

When I was a child, I looked forward to our annual spring family vacation in Florida. As a budding naturalist, I was fascinated by the swamps near Windermere—cypress trees festooned with Spanish moss, wintering parula warblers, anhingas, and the occasional alligator. Now the swamps are gone, the lakeshores dotted with boathouses, and the wildlife scarce. What was a natural wonderland has been replaced by suburbia, Disney World, and an interstate highway.

A peninsula extending into the tropics, with a rich geological history of wetland, Florida is one of the most diverse landscapes of the United States. Within a few kilometers, one may pass from xeric sand pine (*Pinus clausa*) woodland with frequent fire to dense cypress forest in permanent floodwater. Unfortunately, most of that landscape has been abused, environmental planning forgotten as the state has tried to accommodate one of the fastest rates of population growth in the United States. In *Ecosystems of Florida*, Ronald Myers and Jack Ewel capture what is known of the extent, composition, and function of the diversity of Florida's natural ecosystems. First gathered at a conference at the Archbold Biological Station in 1986, 31 authors have contributed 18 chapters covering the major habitats of the state. The result is a masterful blend of science and natural history that will capture the interest of the academic ecologist, the land planner, and the educated weekend naturalist. The book could also serve admirably in undergraduate classes in plant ecology and regional biogeography.

"Subsidence of an organic soil (in this case a Saprist) has lowered the ground surface around the pilings and around the septic tank of this house at the Everglades Research and Education Center, Belle Glade (Gold Coast-Florida Bay physiographic district). The ground surface originally was just below the floor of the house." [From Brown *et al.*'s chapter in *Ecosystems of Florida*; photo by R. B. Brown]

Introductory chapters on climate, soils, and geologic history are followed by three major sections that contain chapters on upland forests, wetlands, and coastal ecosystems. Pine "flatwoods," cypress domes, and other specialized features of regional plant ecology are given special attention. Movements of water and soil nutrients and occurrence of fire are shown to control the juxtaposition of plant communities on the landscape and to maintain the functional linkage of ecosystems. Most chapters describe the extent and history of human perturbation—first for citrus and later for urbanization. In Florida, human mastery of the land is paramount. In Palm Beach County, 81 percent of the shoreline is now developed.

The Rivers of Florida (whose editor is also a contributor to *Ecosystems*) focuses on the conduits that form the hydrologic network of the state and link its ecosystems. Several introductory chapters provide background on the origin and function of stream ecosystems in Florida and their accompanying floodplain forests and fishes. Seven chapters then cover the major drainage basins of the state. In one of these, James Kushlan provides an especially concise overview of the