a detailed knowledge of the life cycles and biology of a large number of species [can one] chart the future of ecosystems"), and progressive evolution ("Let us not pretend to deny in our philosophy what we know in our hearts to be true. . . . An undeniable trend in progressive evolution has been the growth of biodiversity by increasing command of the earth's environment").

As Wilson points out, extinction has many causes. Cataclysmic events may be important historically but do not illuminate the current crisis. Chronic disappearance of species is made more likely by ecological specialization, habitat fragmentation, and small population size with its attendant problems of inbreeding and loss of genetic variability. Wilson focuses on tropical rainforest, which is disappearing at an accelerating rate, currently about two percent per year. Extrapolating from known relationships between number of species and size of area sampled, and from estimates of the total diversity of tropical rainforests, Wilson estimates that 27,000 species, mostly insects, disappear each year. Seventy-four per day. Three per hour. One may quibble with these calculations, but Wilson makes his point. Species, many of them unknown to science, are disappearing.

Why should this matter? Clearly it does to Wilson. His concern is for the dwindling of the aesthetic richness of nature that is treasured by many naturalists and field biologists. Although Wilson has argued that all humans share the potential for this intimate emotional relationship with nature—what he has called "biophilia"—he clearly recognizes that aesthetic value does not feed the hungry or fuel the economies of poor nations. To justify conservation, one must appraise natural systems in the recognized currencies of economics, politics, and social and cultural institutions.

The conservation movement has had two basic points of view. One emphasizes the preservation of individual species for aesthetic or spiritual reasons, and perhaps as a metaphor of our own precariousness, individually and as a species. The other focuses on the preservation of habitats and ecosystems, partly for their inhabitants' sake, but mostly for the ability of intact systems to support economically important species, maintain watersheds, prevent soil erosion, ameliorate local climate stresses, and reduce the consequences of natural catastrophes. Increasingly, scientists are recognizing the importance of intact ecosystems in countering anthropogenic global climate change.

Wilson clearly adopts the first point of view, preferring the individual species and the multitude of species over the ecological systems they make up. He endorses the New Environmentalism movement, based on the proposition that "new ways of drawing income from land already cleared, or from intact wildlands themselves, will save biodiversity from the mill of human poverty." Wilson explains that biodiversity generates economic value in two ways. One arises from the fact that populations of different species are interconnected: predators and disease organisms control populations of their victims, pollinators and seed dispersers promote reproductive success and population growth of plant species, and so on. Biodiversity also generates economic value from extractable products obtained from individual species. Wilson portrays natural systems as sources of unmined riches and lists pharmaceuticals and foods from little-known plants and animals. A closer look at these reveals that few come from the rainforest treasurehouse of biodiversity; instead many are weedy plants from disturbed habitats or species used by traditional cultures. One wonders whether the value of natural systems as extractive reserves can often exceed their value as sources of wood products or as land converted to conventional agriculture. Wilson cites one well-studied case in Peru, where it was determined that a hectare of intact forest could yield sustainably harvested products with a net annual value of over $400. Ecotourism and pharmaceutical prospecting also have produced income in such countries as Costa Rica.

Wilson does not consider whether such optimistic bottom lines for natural systems as extractable reserves might suffer as they are scaled up from the small study area or pilot project to the enormous areas needed for effective conservation of biodiversity. High values of many products depend on limited supplies and cannot be extrapolated to vast extraction enterprises; ecotourist dollars are finite, and their per-hectare value diminishes when they are spread over the entire area of intact systems. Whether richer nations will support local initiatives in conservation and biological inventory in poorer nations, as in the case of the national park system and INBIO in Costa Rica, remains to be seen on a global scale.

Many pragmatists believe that conservation and rationale development will find greater support from the economic, political, and social worth of intact ecosystem processes than from the value of biodiversity itself. In truth, most humans are concerned more about the fate of their own species than about that of any of their cohabitants on earth. Considerations of quality (and, unfortunately, quantity) of human life would seem to weigh heavily against the economic worth of species, even in their vast numbers. Most of the earth's land and oceans will be managed; perhaps, at best, a sample of the earth's biodiversity will remain in preserves, gene banks, zoos, botanic gardens, and, to some extent, as elements of the landscape created by our endeavors.

Wilson treasures nature for reasons other than its economic worth but is compelled to argue for its preservation in the disadvantageous arena of economics and politics. In the end, however, the value of intact nature is determined by those who claim it. To the extent that biodiversity is preserved, and by whatever rationale, it will be due largely to efforts of committed and persuasive individuals like Wilson, for whom the loss of biodiversity brings an impoverishment of the human spirit. "Wilderness settles peace on the soul because it needs no help; it is beyond human contrivance."

Robert E. Ricklefs
Department of Biology,
University of Pennsylvania,
Philadelphia, PA 19104–6018

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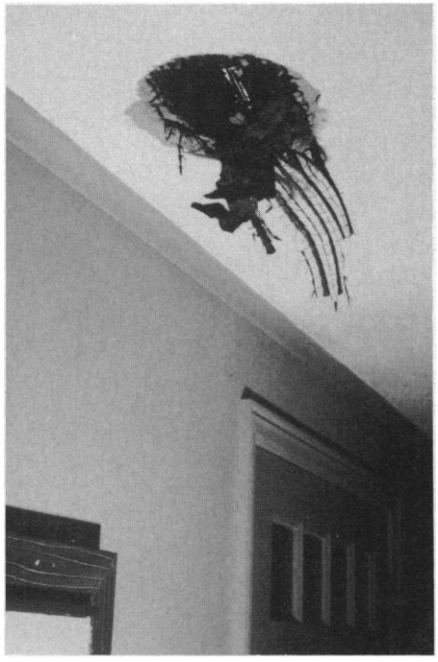
Being First

The Cambridge Guide to Astronomical Discovery. WILLIAM LILLER. Cambridge University Press, New York, 1992. xii, 257 pp., illus. $29.95.

Being the first to discover something is not as easy as it might seem. There are strategies that pay off and strategies that don't; there are places to explore and places to avoid; there are times that are ripe and times that are not. Above all, there is an intuition or outlook that guides toward the successful choices and persists during long periods of failure.

Such are the lessons brought home by *The Cambridge Guide to Astronomical Discovery* by William Liller. The book discusses and illustrates the process of the discovery of objects in the night-time sky by persons whose resources are limited. Intended as a guide for those who would join this pursuit, the book also serves a more general audience interested either in the tactics of searching for anything new in a scientific arena or in the nature of several types of astronomical objects most amenable to observation with binoculars or small telescopes. The author is a former professor of astronomy at Harvard, now engaged in the search himself.

This readable work conveys its message in a variety of ways. The first portion of the book provides the astronomical background for the types of objects most likely to be investigated by an amateur: comets, novas and supernovas, asteroids, and variable stars. Next, the discoverers speak for them-



"Only a few meteorites have caused damage to dwellings. This photograph taken by Phil Dombrowski shows a recent occurrence: Wethersfield, Connecticut, November 8, 1982." [From *The Cambridge Guide to Astronomical Discovery*]

selves. Contributions from nearly two dozen successful discoverers relate the history and salient features of the process. Following this, the most efficient techniques of searching and the mechanics of reporting discoveries for official, worldwide recognition are described. Factual material is relegated to ten appendixes, useful in their own right to anyone interested in astronomy, whether a sky-hunter or not.

The discussion of astronomical objects centers on how they behave, especially where in the sky each is found and at what time, and how this pattern is translated into a hunting strategy. This is an illuminating way of revealing the complex nature of each type without going into immense technical or mathematical detail. For example, comets are described as classifiable into two groups: long-period ones, which essentially have never been seen before, and short-period ones, which revisit the earth regularly at intervals less than 200 years. Almost all of the latter circle the sun in the same direction as the earth, and nearly in the same plane; finding them is best done looking in a narrow band of sky. However, since most have been discovered before, spotting one that will carry your name back into the heavens is rather unusual. In contrast, the long-period comets are harder to find, being rather uncommon and moving throughout all parts of the sky. A proper search must cover more area, but the chances are higher that a sighted object is an original find.

The appendixes provide an excellent complement to the more general discussion of the early chapters. One appendix is devoted to the mathematics of orbits, required for a full understanding the paths of comets. Other topics include methods of measuring time and position in the sky and of measuring brightness and what determines how faint a source can be seen. A wealth of tabular information on previous discoveries of each major type of object is included, for the better planning of search strategies. Four appendixes are devoted to sources of additional information, astronomical societies, and suppliers of astronomical products.

Increasing the chances of success in a particular type of search depends on the method used to detect the object, and this is the issue discussed in three final chapters. The techniques and tradeoffs of visual searches, the use of photographic plates, and the modern charge-coupled device (CCD) are all described.

The most enjoyable part of the book is the investigators' own tales. As each recounts his or her successes and failures, sacrifices and rewards, many rich and varied insights emerge. Throughout run the themes of perseverence in the face of difficulty and of maximizing the use of whatever time and materials are available.

Being first is indeed difficult, yet many people have tried to find an astronomical object to call their own. This book provides a readable and illuminating guide to making the most of the process.

Ruth C. Peterson
Lick Observatory,
University of California,
Santa Cruz, CA 95064

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