the source of light—no farther from the hole than about half the diameter of the hole. The reason is that once the light passes through the hole it rapidly spreads out—like water leaving a garden hose, as Isaacson puts it—and no longer illuminates just one small part of the sample. But very close to the hole the spot of light will remain much less than a wavelength across.

The microscope built by Isaacson and Lewis works in a slightly different way. Instead of restricting the illumination to a subwavelength spot, it relies on a detector that can see only a subwavelength bit of the sample at a time.

The detector is a hollow, needle-shaped tube with a tiny opening at its tip. This probe is made by drawing down a glass pipette until its tip is as small as 150 nanometers across and the inner hole has a diameter of just 50 nanometers. The outside of the pipette is then covered with a thin coat of aluminum so that light can enter only through the hole. Finally, the pipette is hooked up to a sensitive light detector that measures the amount of light coming through the tube.

By illuminating the sample and moving the tip of the pipette over the sample's surface in 15-nanometer steps, the microscope builds an image bit by bit. The microscope, which Isaacson now operates with graduate student Eric Betzig, has achieved resolution as good as 50 nanometers, or about one-tenth the wavelength of visible light.

The theoretical limit of the resolution should be around 10 nanometers, Isaacson says. Past that point, the small amount of light that leaks through the aluminum coating on the pipette becomes a problem.

So far, Isaacson has looked mostly at test samples to study the microscope's abilities, but he foresees a number of applications. Because visible light does little or no damage to samples and because it can be used in air or water, the near-field optical microscope should be useful in examining biological structures, such as viruses or chromosomes, in vivo. Since the microscope is sensitive to visible light, it might be used in conjunction with testing techniques that induce fluorescence in biological samples.

The microscope could also be used to examine the surfaces of integrated circuits without damaging the circuits as scanning electron microscopes do. And its sensitivity to visible light might be useful in measuring directly the output of laser diodes.

Since the near-field scanning optical microscope detects visible light with much greater resolution than possible before, it opens up a new world to human sight.

■ **Robert Pool**

Pattern and Process in Extinctions

The subject of extinction has in recent years become the focus of a great deal of interest and research activity, not least because the occasional mass die-offs that punctuate Earth history demand explanation. More generally, however, the pattern of extinction is likely to reflect something about the processes underlying the evolutionary histories of the myriad groups of organisms that constitute the biota. With this in mind, University of Chicago paleontologists David Raup and George Boyajian posed the following question: "Does the fossil record of extinction in the Phanerozoic show a consistent, repeatable pattern, or is it a confused amalgam of signals produced by many independent evolutionary histories?" The answer is that the extinction pattern is surprisingly uniform, at least among the nine groups of marine organisms they studied (see diagram below).

The result is a surprise, because there is considerable evidence that extinction can be a selective process, depending upon a variety of ecological, geographical, and physiological variables. Such selectivity would be expected to affect different groups in different ways, yielding a random, not uniform, response to extinctions. And, as Raup and Boyajian note, this expectation is apparently supported by the oft-repeated assertion that "My group was not affected by [this or that] extinction."

The Chicago researchers are not suggesting that their results imply a complete absence of selectivity, merely that the strongest component of the pattern is uniformity of response across different groups. "We have extinction events that cut across functional, physiological, and ecological lines," say Raup and Boyajian, "and this suggests common external causes. In other words, the results suggest that extinction is physically rather than biologically driven." The key issue is that, whatever the mechanism, "major pulses of extinction result from geographically pervasive environmental disturbances."

Norman Newell, of the American Museum of Natural History, New York, was promulgating this very same message more than 30 years ago, note Raup and Boyajian, but it became lost amid a suspicion of inferring large-scale patterns from necessarily incomplete data, and a collective concentration on particular cases. Now, with a growing interest in pattern and process, the Chicago researchers were able to reexamine the issue by using the data set of some 20,000 marine genera heroically compiled by John Sepkowski.

■ **Roger Lewin**

ADDITIONAL READING

D. M. Raup and G. E. Boyajian, "Patterns of generic extinction," *Paleobiology* **14**, 109 (1988).