pology. Now they are fields in their own right.

During the late 19th and early 20th centuries, anthropologists mainly studied "primitive" cultures. But now, notes Geertz, not only are such cultures—untainted by modern life—rapidly disappearing, but the anthropologists are virtually stepping on each other's toes to study those that remain. Whether in the highlands of New Guinea or Amazonia, researchers find "not just 'natives' and mud huts, but economists calculating Gini coefficients, political scientists scaling attitudes . . . sociologists counting houses."

Such changes have outmoded the old dirt-under-the-toenails approach to the study of foreign cultures that initially attracted the field's stalwarts. However, there is a good side to all this diversification. The field, Geertz says, is at the height of its "prestige." Leading 20th-century anthropologists (Claude Lévi-Strauss, Franz Boas) are now read by biologists as well as literary critics.

Geertz believes that the new anthropology of test tubes and computer printouts will lead to a more sophisticated understanding of many societies. But he still longs for the days when anthropologists could "walk barefoot" through primitive cultures.

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Nature's Geometry

"Fractal Symmetry" by Mort La Brecque, in *Mosaic* (Feb. 1985), National Science Foundation, Washington, D.C. 20550.

Does randomness have a pattern?

The question is strange, almost oxymoronic. And yet a question like this led Benoit Mandelbrot, a Harvard mathematician, to the remarkable discovery that many seemingly random shapes in nature (coastlines, mountains, flowers, etc.) have underlying patterns and structures that can be described mathematically. For his discovery, the National Academy of Science recently awarded him the Bernard Medal for Meritorious Service to Science.

Mandelbrot's fractal geometry (derived from the Latin word *fractus*, meaning fragmented or irregular) is a mathematics of irregularity, instead of regularity, says La Brecque, a former editor of *The Sciences*. Mandelbrot looks for simple, infinitely repeating patterns in highly convoluted objects. A beautiful cloud formation might be reduced to mushroom-like shapes growing out of similar mushroom-like shapes. Or a few jagged lines that spawn similarly shaped lines might evolve into a pattern that looks like last year's Dow Jones average. By programming fractals into computers with graphic capabilities, Mandelbrot has been able to generate startling reproductions of landscapes, vegetables, planets, and solar systems.

The key to fractals is "self-similarity," a concept exemplified in Mandelbrot's text, *The Fractal Geometry of Nature* (1982). Take, for example,

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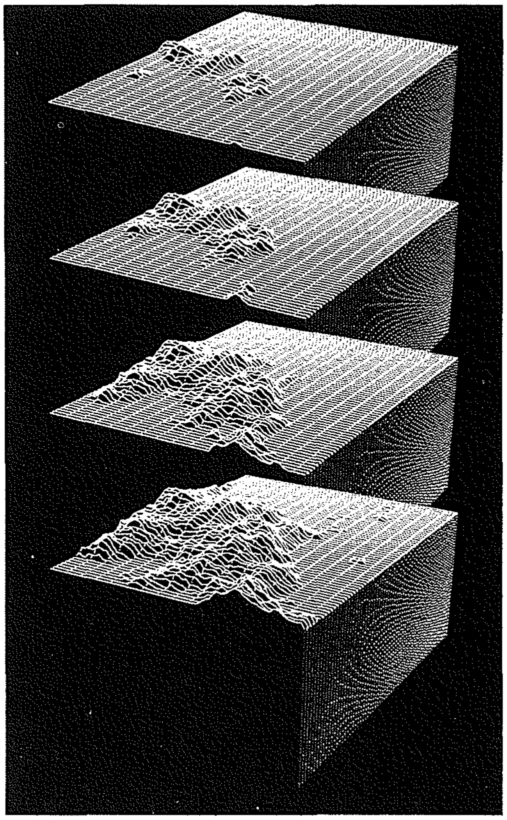

During the 19th century, scientists noted that rocks and land masses tended to fracture in predictable patterns. In 1975, Mandelbrot reversed the process. Using computer graphics to expand three-dimensional fractals, he was able to simulate volcanoes growing, continents evolving, and islands emerging from the sea.

an equilateral triangle. Place on each side of that triangle a little triangle (half the size of the original one, for instance) with the same proportions. Place on each side of those smaller triangles an even smaller triangle of the same proportion. If this procedure continues infinitely, a snowflake image is formed.

Mandelbrot has found widespread applications for fractals. He can analyze turbulent airflows under an airplane, recreate branching blood vessels, and simulate water flowing down a fall. Previously, engineers and scientists were forced to approximate these irregular shapes with techniques based on Euclidean geometry. Developed by the Greeks circa 300 B.C., this system uses "ideal" shapes (cones, spheres, cubes) to analyze non-ideal problems. But the Euclidean model breaks down when faced with great irregularity.

Mandelbrot says that Euclidean geometry is often called "cold and dry," even limited, because its analytical methods are formal and rigid. "Then there is real chaos," he says, "which is messy and incomprehensible. In between the two classical poles there is now fractal geometry. It is neither overly smooth nor fully chaotic."