



Creating the Nation's first BioPark

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Letter From the Desk of David Challinor
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In my March letter I discussed the extraordinary rapidity with which early man (Homo erectus and Homo sapiens) invaded Europe and Asia beginning about a million years ago. When these pioneer hominids first entered and occupied a territory, we assume that they found a habitat already filled with adequate plants and animals to sustain themselves. This month's letter will consider how organisms or, more precisely, life begins in what was previously an inorganic environment; that is, one without life as we define it (an organismic state characterized by capacity for metabolism, growth, reaction to stimuli, and reproduction).

When Earth began, scientists believe it was lifeless. To become habitable it had to cool and develop an atmosphere adequate to shield its surface from dangerous solar radiation. After a billion years, liquid water formed from hydrogen and oxygen molecules, which in turn led to the concoction of "primordial soup" from which the first bacteria (or life) are believed to have appeared. The birth of life on Earth was an extremely slow process and scientists can only speculate on bacteria's origin and its later evolution into a multicellular organism.

Today, natural events can create inorganic or lifeless conditions. The generation of Surtsey Island is an example. When camping with my family on Iceland's south coast in 1964, the southern view was dominated by smoke from a submarine volcanic eruption. About 20 miles off the coast a fissure had opened 300' below the surface along the mid-Atlantic ridge. When ocean water met the molten lava at that shallow depth, the water pressure was insufficient to contain the resulting explosion, which ejected hunks of the seabed through the water column as high as 1,000' into the air. The explosions were pulsed: after each one sea water repeatedly contacted the molten lava in the fissure. This action results in such rapid cooling of the molten rock that it produces fine grained sand particles called tephra.

In early June 1967, after 3-1/2 years of continuous explosions, the eruption ceased and the volume of tephra that rained from the sky, resulting from the cycle described, had produced a new island, called Surtsey, roughly 2km (1-1/4 mi) in diameter and about 100m (330') high. The total volume of lava and tephra ejected was estimated at 1km³ (one cubic kilometer). A few weeks later, on 26 June 1967, the surface lava had cooled and hardened enough so that it was safe to walk on the crust, even though one could see molten lava still flowing deep below the occasional surface cracks. A particularly memorable scene occurred when I and 7 or 8 other scientists, all on



hands and knees, stared intensely at a flowering Sea rocket (Cakile edentula) less than 2" high. This was the first plant discovered blossoming on the island. Other botanists discovered mosses and grasses which continued the biological invasion of Surtsey. The formation shortly thereafter of the Surtsey Research Society in Reykjavik stimulated long-term monitoring of the vegetating process. The Sea rocket was growing just above the high tide line, probably from a waterborne seed. Many of the light seeded grasses and mosses were introduced by passing birds. In an effort to control the inadvertent introduction of plant seeds, we were required to wade through the surf on landing to wash off any seeds that may have stuck to our boots. At best, this action merely slowed the invasion process, which must have begun as soon as the shore cooled enough for a bird to land and drop seeds from its feet, feathers or feces.

In Iceland, as in other glaciated places, glaciers are retreating. As they do so rock and mineral soil is exposed. Scientists assume that no life could have existed on or in this soil, which was under the weight of glacial ice. These newly exposed surfaces are instantly invaded, generally first by lichens which colonize bare rock faces. Lichens grow slowly, especially in the extreme temperatures of the Antarctic where they are the only known terrestrial plant. Growing in a circular pattern at a rate of 3 to 15mm (9/16") per century, the large polar area lichens may be the oldest living organism on earth. Crustose lichens in Lapland and Alaska are thought to be almost 10,000 years old.

In addition to retreating glaciers and new volcanic islands, earthquakes and fires can create conditions for biological invasions. Near the Panama/Colombia border, for example, steep forested hills line the Pacific shore. In this tectonically unstable area, occasional quakes trigger massive landslides into the ocean. The bare mineral soil on the exposed slope is thereby open to colonization by pioneer plants and animals. From controlled studies in the Caribbean, Puerto Rico, Jamaica and Panama scientists have learned that it takes up to 30 years to re-vegetate a big landslide scar to its former state with windblown and animal-transported seed from adjacent forests.

Fires vary in their long-term effects on vegetation; raging forest fires can blacken whole landscapes. But in temperate North America, within a few years, usually no more than a decade, new forests can grow without human intervention. The floral invasion of a burned area originates from the unburned peripheries and follows a predicted sequence of pioneering plants and trees. A similar but less predictive sequence occurs in the tropics where the greater number of species available makes the

regeneration pattern more complex. There exist, however, certain sites that, once burned, take at least centuries to recover. For example, Mt. Monadnock in New Hampshire's White Mountains used to be tree-covered to its 3,165' summit. Stunted spruce grew in the shallow soil overlaying the mountain's granite base. After a succession of forest fires swept the summit, all the trees and the shallow, highly organic soil were incinerated. Although today's view from the treeless top is panoramic, it will take many centuries for enough organic matter to creep up the bare rock from beneath a slowly advancing tree line before spruce and fir can again grow on the summit. Many people consider Monadnock's summit secure from plant and tree invasion, but that is only because humans are too short-lived to think in terms of centuries. We are too impatient to monitor such a slow process, and there is little incentive for a young scientist to establish and maintain such an experiment.

A final example of a new territory made available for slow, biological invasion occurs when an earthquake triggers a landslide in the mountains large enough to block the snow melt flowing through a valley. I visited an impressive example of a lake high (4200m/13,000') in the Ecuadorian Andes just east of Mount Antisana, which had been created in this manner. The natural dike was about a decade old, but at that elevation I could detect little aquatic life when walking along the shoreline. My inspection was cursory, I admit, because I was so debilitated by the altitude, having had inadequate time to adjust to the paucity of oxygen. Nonetheless, what is important is that newly created lakes are just as susceptible to invasion as any terrestrial community. The colonization of high mountain lakes through the transport of aquatic organisms is especially difficult and slow but still possible by wind- and bird-borne organisms.

Compared to the creation of new territories by natural causes, human-altered ecosystems now dominate our planet. In some extreme cases human alteration of a landscape can be almost permanent, at least on a human time scale. For example, Plato wrote that "the hills of Attica are a skeleton of their former selves" for the forests were being cut, the streams polluted, and the wild animals disappearing. This ancient destruction was even then attributed to people pressure. Today, around the eastern Mediterranean, it has reached a climax in the xeric (dry) vegetation common to and maintained by the long, dry summers throughout the whole eastern and southern Mediterranean basin. For the countryside to return to the forested paradise of Arcadia, the human population and its goats, donkeys and other grazers and browsers would have to be reduced by several hundredfold. Even were that possible, it is questionable whether enough new soil could even be generated for the barren hills to re-vegetate naturally.