ARTICLES (CONT'D)

Lichens: Indispensable members of ecosystems

SMALL AND OFTEN FORGOTTEN, lichens are indispensable members of forest, alpine, desert, and even aquatic ecosystems. Though individually inconspicuous, they are aesthetically pleasing on a grand scale. McCune et al. (2006) point out that lichen communities paint the tremendous rockscapes in Yosemite and Sequoia national parks. Visitors seldom appreciate this phenomenon for what it is but nevertheless enjoy the elegant vertical striping on the massive granite outcrops in these parks.

The diversity of lichens is astounding: foliose (leaflike) lichens such as yellow specklebelly (*Pseudocyphellaria crocata*), fruticose (shrublike) lichens such as clustered coral (*Sphaerophorus globosus*), and crustose (crustlike) lichens such as bullseye lichen (*Placopsis gelida*).

Lichens are also indicators of past environmental conditions and present ecosystem health. For example, *Rhizocarpon geographicum*—Granny Smith apple–colored disks that colonize fresh rock surfaces in alpine areas—document when glaciers receded from a valley, specifically when a particular landform became ice-free. Glacial geomorphologists use this species because of its longevity and great range for dating—up to several thousand years in some alpine areas and perhaps 9,000 years in parts of the Arctic (Lock et al. 1979). Lichens are also useful in dating past seismic rockfall events.

Because many lichen species are sensitive to air pollution, they are useful biological indicators of change in atmospheric conditions. Poor air quality, however, is one of the greatest risks to the vast biodiversity represented in lichen communities (Hutten and Woodward 2002). For example, investigators in the Great Lakes region have found chemical patterns in lichens related to human activities. Bennett (2007) notes, "the soil elements aluminum, iron, and sodium decrease from west to east [across the Great Lakes region], probably because of increasing distance from blowing dust of the Great Plains. However, elements associated with human activities—copper, lead, sulfur, and zinc—increase from west to east with increasing proximity to eastern population centers." Furthermore, lichens have the capacity to absorb high levels of metals, suspected to be responsible for above-normal incidences of childhood leukemia (Associated Press 2005). Lichen chemistry has shown significantly elevated levels of tungsten and cobalt in the small Nevada town of Fallon (Sheppard et al. 2007), which has the "most unique cluster [of incidences of childhood leukemia] ever reported" (Steinmaus et al. 2004).

The symbiotic nature of this dual organism, consisting of fungus and alga or cyanobacterium, is as intriguing as it is significant. All lichens that contain cyanobacteria as a symbiotic partner fix nitrogen, converting atmospheric nitrogen into forms usable by plants and animals. Some lichens (e.g., *Bryoria fremontii*) are an essential winter food source for such species as northern flying squirrel (*Glaucomys sabrinus*) and Douglas squirrel (*Tamiasciurus douglasii*). Indeed many organisms depend on lichens for food—just one way that nutrients, assimilated by lichens, cycle into an ecosystem. In addition to eating it, northern flying squirrels and Douglas squirrels use *Bryoria* for nest material (McCune et al. 2006), as do many other animals. At least 19 species of birds in Sierra Nevada parks use lichens for building or lining their nests (McCune et al. 2006).

Unfortunately the indispensable lichen is often ignored. Primarily for budgetary reasons, most biological inventories throughout the National Park System address only vascular plants and vertebrate taxa (see http://science.nature.nps.gov/im/inventory/biology/index.cfm, accessed 6 February 2008). Despite this systemwide focus, biologists for the Sierra Nevada Network have recognized lichens as a conspicuous part of ecosystems and as important vital signs for evaluating ecosystem conditions and trends at Yosemite and Sequoia national parks and Devils Postpile National Monument. Recently the Sierra Nevada Network released the report *Lichens in Relation to Management Issues in the Sierra Nevada National Parks*. The purpose of this study was to synthesize existing data about lichens in and near the Sierra Nevada parks, as a first step toward developing better baseline information and assessing lichen populations or communities as potential indicators of ecosystem change. This report identifies and categorizes lichens into functional groups and highlights the connection of lichens to management issues such as biodiversity, fire, air quality, water quality, and restoration of drained reservoirs (i.e., mitigating the "bathtub ring" effect). The authors make recommendations for surveying species that are in particularly marginal positions, monitoring communities that are already in transition, and improving floristic inventories. They also suggest "quick surveys" to obtain needed data about lesser-known aquatic and terrestrial lichens (e.g., in calcareous areas and grazed meadows).

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