

'Green Sickness' Prevention And Control In Oregon Caves

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If you were to go to Lascaux Cave in France, a world-famous site of prehistoric cave paintings, you would find the cave closed to visitation. It is closed because of the "Maladie Verte" (the green sickness), which affects, to varying degrees, almost all electrically lighted caves visited by the public. The green sickness is the exotic growth of algae and moss on cave surfaces. In Lascaux Cave, the growth (which largely consisted of a green alga) was covering and destroying the prehistoric cave paintings, so to protect the resources, Lascaux Cave is no longer lighted and is closed to the public.

Oregon Caves National Monument is located in the Klamath Mountains of southwestern Oregon. The site became a National Monument in 1909, and the caves, which have been electrically lighted and toured for many years, have been dramatically affected by the green sickness. Post cards available at the Monument commonly show greenish speleothems (cave formations); their natural colors are whites, greys, and earth tones.

Plant growth in caves is not simply a visual impact. Algae and moss can seriously damage speleothems. If the growth is allowed to persist, speleothem surfaces are etched and dissolved by plant growth, and in places, the surfaces of speleothems are turned to a jello-like substrate by algal attack.

Research on natural resource problems in National Parks often seems to be independent of construction and other activities which may be related to the problems. This was not the case at Oregon Caves. In late 1984 we began studies on exotic plant growth and methods of preventing and controlling it in Oregon Caves. Our investigations were prompted by three factors. First, we had conducted a major study in 1983-84 of exotic plant growth in Carlsbad Caverns, New Mexico where we were able to determine quantitatively the light intensity thresholds below which plant growth was greatly reduced and commonly prevented. These findings suggested that exotic plant growth studies should be a part of planning for new cave lighting systems. The second factor was that new electrical systems were being planned for Oregon Caves Monument and its caves and the contract to do this work had been let. The third factor was good communications, both within the Pacific Northwest Region and between that region and the Southwest Region, which led to recognition of the potential applicability of the Carlsbad Caverns study to Oregon Caves.

The flora of the naturally dark portions of Oregon Caves is large and diverse. To date, we have found two species of ferns, 11 species of moss, and, (including species reported by St. Clair et al, 1981), 51 different algae. It seems likely that, with more collecting, we would find that the Oregon Caves flora consists of more than 100 different species.

In Oregon Caves, about 15 percent of the areas covered by visible plant growth supports mature moss; another 10 percent supports moss protonema.

About 40 percent of the visible plant growth areas supports blue-green algae, and about 35 percent supports green algae. Diatoms, which are very small and generally do not cover large areas, are present in about half the samples of algae and moss protonema.

Substrates exert major influence on the extent of plant growth in Oregon Caves; the following generalizations apply:

A. Plant growth is greater on wet or very moist surfaces than on damp or nearly dry surfaces. Most surfaces in Oregon Caves are at least damp for part of the year.

B. Plant growth is greater on weathered speleothem surfaces and on surfaces coated with moonmilk than on firm speleothem surfaces.

C. Plant growth is greater on muddy speleothems and muddy marble than on clean and solid speleothems and marble.

D. Plant growth is greater on lint "globbs" and clay worms than on adjacent lint and clay worm-free surfaces. This difference is most noticeable on firm spelethems or marble surfaces.

E. Plant growth is greater on relatively flat surfaces than on steeply inclined surfaces, and greater on steeply inclined surfaces than on cave ceilings.

F. Plant growth is greater on broken margins of trail materials than on firm trail surfaces.

Clay worms are curving, tubular clay deposits which are scattered about on many surfaces in Oregon Caves. They are typically less than an inch long, and, based on limited samples, they consist of about 70 to 75 percent muscovite, with the balance being quartz. The worms typically have lint and algae associated with them.

Clay worms appear to be an unnatural feature of the caves, related to human actions, and tied to three unnatural conditions in the caves:

A. Airflow caused by the construction of new entrances, tunnels, and passage excavations which moves tremendous volumes of air, dust, pollen, and other air-contaminants from the surface into the cave.

B. Visitation of the cave, which introduces lint, hair, and other similar materials into the cave, providing substrates and nutrients favorable for plant growth.

C. Electric lights needed for cave touring, that cause plant growth on the clay worms. Plant growth may be associated with the development and/or enlargement of clay worms.

Many of our investigations in Oregon Caves focused on light intensity. We found at least some visible plant growth associated with all fixed lights in Oregon Caves. There does not appear to be a particular light intensity that maximizes plant growth in Oregon Caves, since abundant growth occurs over as wide a range of light intensities as 28 to 164 foot-candles. At least some "spotty" plant growth occurs at favorable sites where light intensities are as low as 2.5 foot-candles. (A foot-candle is the light

intensity of one standard candle at one foot's distance.)

Mature mosses are particularly destructive to speleothems. Based upon our data, it appears that mature mosses will be rare in areas receiving less than about 6 foot-candles of light. Our data also show that, if light intensities are controlled to minimize mature moss growth, then fern growth also will be controlled.

Approximately 85 percent of plant growth now found in Oregon Caves could be prevented if light intensities reaching moist surfaces did not exceed 4 foot-candles. For ideal plant growth prevention on sensitive cave features, light intensities at these features should not exceed 2.5 foot-candles.

It appears to be neither possible nor feasible to prevent all exotic plant growth in Oregon Caves. Some plant growth will become established and must be controlled. We found that a 5.25 percent sodium hypochlorite solution (bleach) is the best plant control agent in Oregon Caves. The use of bleach is far superior to the use of germicidal lights, herbicides, or other potential control agents. Bleach solutions of less than 5.25 percent sodium hypochlorite did not produce acceptable kills of exotic plants in Oregon Caves; solutions with greater concentrations do not appear necessary. We found that sodium hypochlorite solutions of the recommended concentration seldom if ever alter the color of speleothems. However, careful examination of areas to be treated and areas that have been treated is prudent and is recommended, since some generally rare cave features might suffer color changes.

Two principal ways in which plant growth in Oregon Caves can be minimized and prevented are:

A. By careful control of the intensity, duration, and location of the cave lighting.

B. By frequent and routine control of any plant growth that does become established.

We have worked closely with Dick Fay of Engineering and Design Associates of Tigard, Oregon (the lighting contractor) to establish criteria for the intensity, duration, and location of cave lighting. This work included several days spent together in Oregon Caves, data from our studies, and visits to three other caves with widely varying lighting systems. (Wind Cave and Jewel Cave [both NPS units in South Dakota] and Blanchard Springs Caverns in Arkansas [a U.S. Forest Service show cave].)

Lighting systems for show caves are routinely designed to provide for good interpretation and adequate visitor safety. The new lighting system for Oregon Caves will extend beyond these aims in that it also will be designed to protect cave resources from exotic plant growth and its associated damage. Such an approach could set a precedent for new lighting systems in other NPS caves. To paraphrase the "A-Team," I love it when a plan comes together, and when the research is done at the right time and is integrated into the plan.