Anthropogenic and Foreign Chemicals in Caves
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What’s the difference between your kitchen floor and a cave? On the kitchen floor, you want to get rid of visible dirt and lower the populations of microorganisms and unwanted invertebrates. In a cave, after careful evaluation, you want to get rid of visible negative impacts while keeping the environment safe for the native microbes and larger cave organisms.

Types of Chemical Agents
When planning to address contemporary graffiti, get rid of unwelcome microbes like algae, or repair physical damage to speleothems, many potential chemical products come to mind. These chemicals fit into several categories:

- Anthropogenic (human-manufactured) chemicals not found in nature
- Products derived from a “natural” source but not native to the cave environment
- Chemicals that are native to the cave environment

Of the bewildering array of products available, which are safe and effective for use in caves?
Throughout this book, we recommend using no commercial chemical agents for restoration and repair unless the product is demonstrably harmless to the biota of a specific cave.

Any agent should be quickly and thoroughly removed from the cave. Over time, degradation of materials left behind in caves and outgassing from residual deposits of cleaning chemicals or glues can cause tremendous harm to cave biota, habitat, delicate speleothems, and minerals.

Damage from Chemical Compounds
What factors influence the potential damage that a particular compound can do?

- First. Various caves differ in their sensitivity to materials. Caves with many or large openings to the surface or a high volume of flowing water may be able to purge themselves of harmful traces of products in solution or outgassing of deleterious compounds.

- Second. Caves with no flowing water and caves with small openings are effectively closed systems and do not have the capacity to flush out harmful chemicals or their breakdown products. Obviously, a small amount of material getting into a vigorously flowing cave stream is less harmful than the same amount of material flowing into a tiny, closed pool with no outlet. The biological uniqueness is likely to be higher in that tiny pool because of long isolation from other influences. Thus, the potential damage to native microbial populations is much greater and more significant in isolated cave passages.
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- **Third.** A compound that may be suitable for use on the surface may not be the best choice for cave use. For example, a product labeled “biodegradable” may be a great choice for aboveground household tasks. But biodegradable simply means the product is “edible” to some microorganisms. Introduction of such a compound into a cave means that you are upsetting the natural nutrient balance of the cave and feeding some organisms at the likely expense of others.

- **Fourth.** Some compounds (for example, certain glues, epoxies, paints, and plastics) continue to emit gasses over long periods of time. Some of these gasses are toxic and some could be inappropriate nutrient sources for organisms. Additionally, non-water-based cleaners use organic solvents (for example, toluene, trichloroethane, or kerosene) that are toxic to many cells and a potential food source for others.

- **Fifth.** Consider the introduction of surface microorganisms into caves. Human cavers carry invading microbial populations into isolated cave passages on soiled boots, clothing, and gear. Introduced microbes are much more likely to use inadvertently introduced chemical compounds as nutrients. Surface organisms are adapted to highly fluctuating environments and may easily supplant the native species. Cave natives are typically adapted to ultra-low nutrient and relatively unchanging environments.

**Soaps, Detergents, and Cleaning Agents**

Soaps and detergents can be disastrous in caves. They make surfaces more wettable, help dissolve oils, and make other organic molecules more soluble. All of these properties adversely affect the protecting biofilms that organisms make to trap and store nutrients, protect themselves against desiccation, and make local microenvironments most compatible with their needs (Costerton and others 1994; Ben-Ari 1999). Soaps and detergents also have organic components, and may provide nutrients for some nonresident microbes.

Organisms have preferred levels of acidity or alkalinity (expressed as pH values) in which they like to live. A pH of 7.0 is considered neutral. Numbers less than 7 indicate acidity, those larger than 7 indicate alkalinity. Most cleaning chemicals are highly alkaline:

- Household ammonia (typically pH 11.5)
- Common chlorine bleach (typically pH 12.5)
- Common oven cleaners (typically pH 13.5)

Others are at the opposite or acidic end of the pH spectrum:

- Muramic acid (typically pH 3.5)
- Muriatic acid (trade name for product often used in spas and swimming pools, typically 31.5% hydrochloric acid in water with pH less than 1.0; acidity varies with concentration; chemical name is hydrochloric acid, pH 0.0)

Compounds with pH values far from the natural pH value of a particular microbial habitat can impair growth or even kill the organisms. Luckily, most caves formed in carbonates have a good buffering capacity that minimizes the effects of acidic pH extremes.

Nevertheless, application of acidic compounds can have deleterious effects on small spatial scales. Alkaline compounds are typically very aggressive oxidants that destroy organic matter, both living and dead.
Cave Restoration Chemicals

For speleothem repair, always use museum-grade epoxies and adhesives. The recommended products are formulated to achieve minimal degradation and outgassing. Used in caves since the early 1980s, these compounds have proven to be relatively safe for use in subterranean environments. (See cave-safe materials, page 172 and page 445.)

Unfortunately, there are few chemicals native to caves that are appropriate for cave restoration. Cave water is a potentially safe cleaning agent if there is enough water for restoration purposes. (See sources for cave restoration water, page 393.)

Ideally, cleaning water is removed from the cave. If removal is impractical, then an acceptable alternative may be to dispose of restoration water in the trail only if the dirty water cannot find its way into pools or onto speleothems or other features. Water contaminated with any anthropogenic agent must be removed from the cave.

Cited References

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