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SHORT COMMUNICATION

The Sodium Hypochlorite Solution for the Removal of Lichen from Vertebrate Track Surfaces

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The removal of extraneous biological materials from vertebrate ichnological specimens may be necessary if they have been exposed to subaerial processes in the field for long periods of time. It is not uncommon for fossil track specimens to be found nearly completely covered with lichen colonies, especially those recovered from alpine areas. This paper describes a technique using a sodium hypochlorite solution (bleach) to remove lichen from a track surface containing numerous avian prints and small theropod prints with skin impressions.

Keywords Bleach preparation, NaClO, lichen removal, vertebrate tracks

INTRODUCTION

Lichen are a symbiotic association of cyanobacterial and fungal hyphal cells which commonly colonize rock surfaces (Hale and Margham, 1991). The most common form of lichen found on rocks in the alpine of the Rocky Mountains in British Columbia is crustose lichen (Gadd, 1995, pp. 405–411), which, when present, can obscure sedimentological and ichnological structures. Crustose lichen may be removed via mechanical methods (i.e., scraping) that have the potential to alter or damage surface details or by chemical means described herein.

The objective of this paper is to describe a method of removing lichen from the surfaces of ichnological and sedimentological specimens using a solution of sodium hypochlorite (bleach). The specimen used in this study is an organic-rich sandstone track-slab recovered from the Boulder Creek Formation (Early Cretaceous: Albian) in the alpine of northeastern British Columbia (Fig. 1).

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The track-slab contains natural casts of multiple small avian prints (currently under description) and a few small theropod prints (cf. *Irenichnites* ichnosp.) with skin impressions. A large portion of the track surface was completely obscured by the lichen growth (Fig. 2), whereas the rest had no lichen growth due to its partial burial in talus. Removal of the lichen solely by mechanical means was not feasible due to the potential to damage the tracks and lichen-obscured skin impressions.

BRIEF REVIEW OF SOME METHODS FOR REMOVING UNWANTED SURFACE MATERIALS

The "solvent-soak" method is a nondestructive technique for removing hardened surface adhesives from fossils. It ensures prolonged contact of the solvent to the adhesive by preventing evaporation of the solvent (Herbel, personal communication, 2003). Anderson et al. (1994) report on a similar adhesive removal technique used on specimens consolidated with Glyptal-acetone at the Mammoth Site in Hot Springs, South Dakota. Acetone was applied to the surface of the bone and the softened Glyptal was lifted off with a soft cloth or removed gently via mechanical means. Triplehorn (2002) suggested using plastic wrap to cover specimens treated with a DMSO solution for disaggregating sandstone matrices to prevent the evaporation of that chemical during the dissaggregation process.

Sodium hypochlorite (NaClO), hereafter referred to as bleach, breaks down organic material by oxidation (Bairbakhish et al., 1999; Casson and Bess, 2003). Bleach is commonly used for the removal of extraneous organics and has a multitude of applications. In testing for optimum germination conditions, Clevering (1995) used bleach to chemically remove the waxy coating on seeds of the wetland plant *Scipus* sp. Vetter et al. (1996) used Clorox® bleach to dissolve spider silk, allowing more prey to be identified to species. Housing vials were soaked in bleach to remove spider silk and caused no deleterious effects

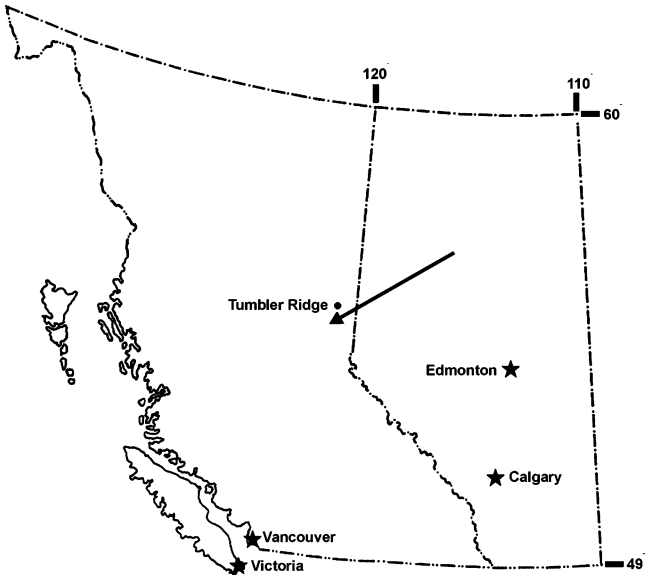

FIG. 1. Geographic position of the Boulder Creek Formation track-slab locality.

to future vial occupants (Vetter et al., 1996). Bleach has also been used to dissolve silk produced from other arthropods such as lepidopterans (Strong et al., 1968). Household bleach is used to remove organic contaminants prior to isotopic analysis of coral skeletons (Grottoli et al., 2005, and references within). Grottoli et al. (2005) tested whether pretreating coral skeletons with bleach to remove organic contaminants significantly altered their $\delta^{13}C$ and $\delta^{18}C$ levels. For a comprehensive list of references dealing with bleach and the removal of organic carbon in coral skeletal isotopic studies, please refer to Grottoli et al. (2005). Bairbakhish et al. (1999) used a combination of household bleach and hydrogen peroxide to disaggregate coccoliths in sediment trap samples.

Removing organic material with bleach is well documented, but we have found no references for the removal of organics, particularly lichen, from the surface of rocks. The bleach technique described herein is a novel approach for removing lichen from the surface of rock. Previous attempts to remove the lichen from the surface of the track-slab by spraying on a bleach solution were unsuccessful. The application killed the lichen but did not have a chance to break down the organic material before the solution evaporated. By combining the bleach solution with the "solvent-soak" technique, an effective process for the removal of lichen from track surfaces was developed.

METHODS

Pretreatment Specimen Assessment

The lichen removal technique may not be suitable for all track specimens. Track specimens to which this treatment may be applied are those composed of highly consolidated sediments (such as sandstone) and are free of fractures or other damage that could compromise the surface stability of the specimen. Lichen encrusted specimens that have been previously consolidated with adhesive need to have the adhesive removed from the lichen for the treatment to be effective.

***Step One*:** Gently brush the track surface of loose sedimentary debris. Remove finer sedimentary debris by rinsing with water and allow the specimen to dry.

***Step Two*:** Spray a prepared 1:1 solution (by volume) of bleach (Javex®, 4.5% sodium hypochlorite undiluted was used) and distilled water onto the lichen encrusted surface (treatment

FIG. 2. Boulder Creek Formation track-slab pre-treatment. Note the lichen obscuring the natural casts of avian prints on the left-hand portion of the track slab. (See Color Plate V)

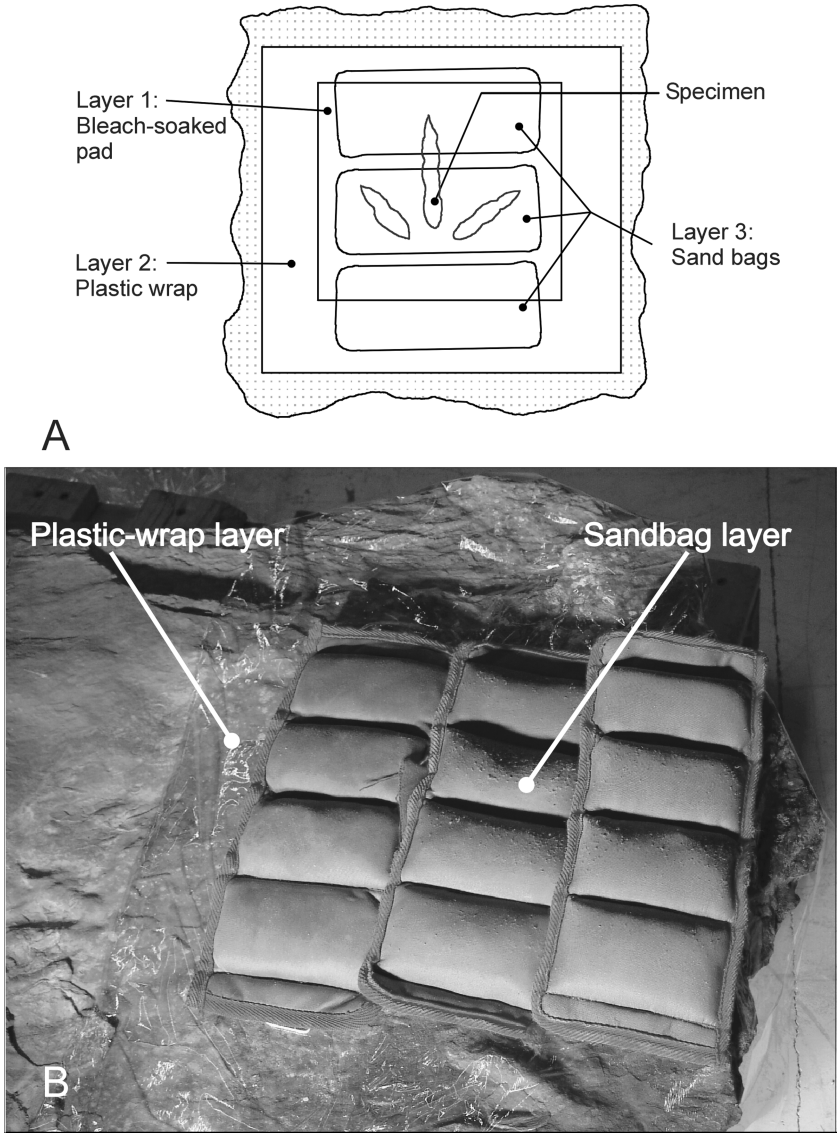

FIG. 3. **A**. Schematic view of the bleach disintegration technique, showing the order of application for each layer. **B**. Image of track-slab undergoing treatment with the paper towel, plastic, and sandbag layers in place. (See Color Plate VI)

area). Different concentrations of bleach solution should be tested to find the most effective mixture for each specimen. There are many varieties of household bleach products. We recommend that brands containing such additives described as "color safe" or "fabric protection" not be used for this process, as it is unknown what effect these additives may have on fossil specimens.

***Step Three*:** Assemble a pad of three or more layers of two-ply paper towel and spray on both sides with the bleach solution until the towel is damp. Apply the towel pad directly to the treatment area and gently press into place so that it conforms to the rock surface.

***Step Four*:** Completely cover the towel pad in a single layer of plastic-wrap (Saran-Wrap® or similar product), leaving at least a 15 cm border of plastic around the edges of the towel pad. If the towel pad is wider than the plastic-wrap, additional sheets of plastic-wrap may be laid side by side such that the edges of the plastic sheets overlap. Gently place the plastic wrap onto the towel pad and press down to ensure the applied solution does not evaporate. Place small sandbags onto the plastic/towel pad to provide prolonged contact of the solution to the surface (Fig. 3).

***Step Five*:** Allow the treatment to react for approximately four to six hours. This time may vary depending on the degree of lichen encrustation and strength of the bleach solution.

***Step Six*:** The plastic/towel pad may be removed. If the treatment was applied correctly, the paper towel should still be damp and the treated lichen will appear swollen or bloated. Wet

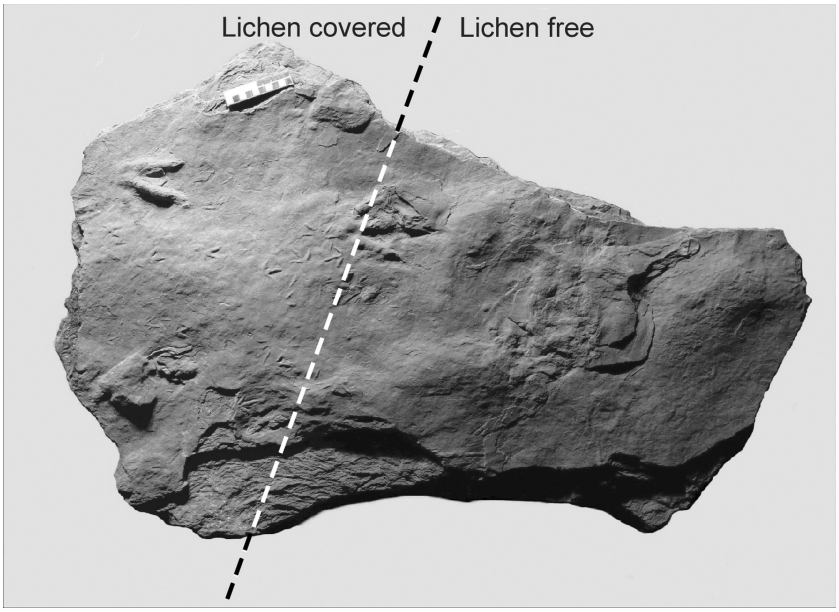

FIG. 4. Boulder Creek Formation track-slab post-treatment (10 cm scale in upper left corner). (See Color Plate VII)

the treated surface with water. Use a medium-bristled toothbrush to scrub away the lichen residue. Additional paper towel may be used to absorb the dirty water.

***Step Seven*:** Once all the treatments are complete, rinse the surface with copious amounts of water until no surface residue or 'bleach' odour remain.

RESULTS AND DISCUSSION

Test Number One

An initial test was conducted on a nontrack-bearing area of the Boulder Creek Formation track-slab, some of which was covered with lichen. The test treatment was applied for approximately four hours, after which the plastic and paper towels were removed. A small amount of water was used to rinse the treated surface, and the area was gently agitated with a toothbrush. The lichen, having been nearly completely disaggregated by the bleach solution, was easily removed. The treated area was rinsed thoroughly with water and allowed to dry. We found that the surface previously covered by lichen was lighter in color than the portions of the track surface that had no previous lichen cover.

Test Number Two: Bleached or Leached?

A second test area was treated to discover whether the bleach treatment caused the discoloration of the specimen. The second treatment site was on a nontrack-bearing part of the surface that lacked lichen cover. The procedure was repeated as described, with the exception that the treatment was left on for 20 hours. Upon removal of the treatment, the surface was thoroughly rinsed with water and allowed to dry. A faint area of discoloration was observed on the treated surface. It is likely that minor bleaching of the surface occurs if the treatment is left to react for long periods of time. The bleaching effect may not occur on specimens with less fossil organic content. The color change on the first test area (lichen covered) was more distinct than that of the second test area (lichen free). This suggests that the drastic color change seen in the first test area was largely the result of organic material being leached by lichen colonies over a period of decades.

Observing no deleterious reaction to the surface, a series of treatments were applied to four overlapping areas covering the entire track-bearing surface colonized by lichen. It was unnecessary to treat the areas of the track surface that were lichen-free.

Posttreatment, the lichen was easily removed from the rock surface by the wet toothbrush. In addition, no noticeable erosion to the track surface resulted from this technique. As expected, there was a noticeable color difference between the treated area of the slab and the untreated area (Fig. 4) that was primarily the result of lichen leaching.

In the pretreatment stage (Fig. 2) the lichen obscured a great deal of the track surface. Although approximately 12 avian and two theropod tracks were visible through the lichen, the total number of tracks on the slab was unknown. In the posttreatment stage (Fig. 4), an additional 35 tracks and five trackways were revealed. Thirty-three of the newly revealed prints were avian, and many were of very low relief. Two were of a small theropod (cf. *Irenichnites* ichnosp.), of which one showed very delicate and fine skin impressions that were made visible as a result of the lichen removal. Another theropod footprint (ichnogen. indet.) with skin impressions was also revealed.

Conservational Concerns

Before applying any treatment, the stability and the composition of the specimen should be assessed. The reaction between bleach and the more commonly used paleontological adhesives is currently unknown. It is also unknown whether this treatment is suitable for the removal of lichen that is encrusting fossil bone. It is not known what the long-term conservation and curatorial concerns may be. As with any new preparation technique involving fossils, the treated specimen should be periodically assessed for accelerated deterioration (Triplehorn, 2002).

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