formed sheets, and sizing and burnishing. Halftone photographs show an Indian papermaker at work and illustrate the visible effects of drying, sizing, and burnishing on paper.

In chapter 4, the "Qualitative Characteristics of Islamic Paper" are listed as quality, grade, color, sheet size, and watermarks. The quality of Middle Eastern paper is good because of its fiber content and processing and because the environment in Persia and the Middle East was favorable before industrialization brought pollution. There is some written documentation about grading, sizing, and coloring paper, although it can be vague and confusing. Watermarks in the Western sense did not exist, but chain lines grouped in distinct patterns appear in Syro-Egyptian papers and, rarely, in Persian papers.

The second part of the book is about analyzing paper. At the time she wrote her book, Loveday had examined and recorded the characteristics of 1,237 dated manuscripts produced in Egypt, Syria, and Persia from the 12th century to the beginning of the 19th century. In chapter 5 she gives a "Protocol for Paper Classification" using nine criteria: quality (including crispness), thickness (measured in millimeters), surface characteristics (including color, sizing, and burnishing), quality of pulp (including distribution of fibers, inclusions, and translucency), mold construction, chain-line characteristics (including grouping and separation, direction, thickness, clarity, and character), laid-line characteristics (including the number of laid lines per centimeter, direction, thickness, clarity, character, and type), rib shadows, and comments.

In the next chapter Loveday summarizes her data, using a version of the criteria in the previous chapter. The data are divided into quality and thickness, color, surface characteristics, quality of pulp, translucency, and mold construction. A comparison of Persian and Syro-Egyptian paper using these six categories shows that Persian papermaking had two datable phases—from A.D. 700 to 1400 and from 1400 to the early 1800s—with papermaking techniques changing a great deal in the latter period. In Syria and Egypt, papermaking developed gradually with no dramatic changes. Nine halftone photographs of papers illustrate differences in fiber distribution and mold construction.

The "Table of Results" is a list of the characteristics in the preceding two chapters. Loveday concludes that it is impossible to describe all Islamic papers precisely and consistently, but she believes that a study of the characteristics of dated samples can be used as corroborative evidence in the analysis of undated material. A systematic analysis of paper shows trends in papermaking over seven centuries and can give us a broader understanding of the history and craft of Islamic books.

The first part of this book will be useful for anyone interested in the history of Islamic papermaking. Loveday's summary of the documentary sources is compact, informative, and readable. It is not meant to be exhaustive, and for those who want more details, there is a bibliography of 41 historical and technical references. The photographs in the book are good, making one wish for more of them.

Paper conservators and paper historians will be especially interested in the second part, on analyzing paper. The criteria are explained in the "Protocol for Paper Classification" and the "Summary of Findings." The "Table of Results" is a comparison of Persian and Syro-Egyptian papers over the centuries using Loveday's analyses. An analysis of paper is partly subjective and depends on the experience of the examiner. Loveday has used her knowledge and experience to make her analysis as consistent and objective as possible. Her criteria could be applied to other collections of Islamic paper, especially to dated samples in the collection, but also to show similarities and anomalies in undated material. In that case, it would useful to see the design of her database.

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RAKESH KUMAR AND ANURADHA V. KUMAR, *BIODETERIORATION OF STONE IN TROPICAL ENVIRONMENTS: AN OVERVIEW.* Research in Conservation Series. Los Angeles: Getty Conservation Institute, 1999. 85 pages, softcover, $25.00. Available from Getty Trust Publications, 1200

Getty Center Drive, Suite 500, Los Angeles, Calif. 90049; (310) 440-6795; booknews@getty.edu. ISBN: 0-89236-550-1.

This overview limits itself to examining the literature on the impact of micro-organisms and plants on stone, without considering human effects. The title of the volume suggests an overview of biodeterioration of stone in tropical environments; however, only 20 percent of the references relate directly to the tropics. As a result, most of this review is really devoted to biodeterioration of stone in temperate regions. The volume is divided into five chapters, covering general aspects of biodeterioration in tropical regions (9 pages); biodeteriorgens: characteristics and biodeterioration mechanisms (18 pages); preventive and remedial methods (7 pages); selection of chemical treatments (12 pages); and current research status and areas for future investigation (6 pages). A short glossary, a 9-page index, and a 20-page, 270-entry bibliography are also included.

This is a frustrating booklet to review. Often the authors provide good information with reasonable statements, as in the preventive conservation chapter. Then they put in hasty, incorrect generalizations, as in the biodeteriorgens chapter. They miss many important references and concepts in the biodeterioration field. They attempt to synthesize the information available, but they should have included a biologist as a co-author to provide better insight into the literature and its interpretation, or at least had the draft version critiqued by a biologist to avoid the numerous mistakes included.

The chapter on preventive and remedial methods is generally good. There are, however, occasional lapses in understanding. For example (p. 30), the authors do not understand the rationale for accelerated, laboratory testing, as opposed to field testing. They feel that extrapolation from accelerated tests must not be made until full correlation with field trials is performed. But the whole point of accelerated testing is to provide a rapid screening test of the relative susceptibility to microbial deterioration of the various products in question. Those products that fail first in this type of laboratory test will also fail first in the field.

The authors provide a good, comprehensive table (4.1, pp. 41–45) on biocides. Details given on each chemical include trade name, LD_{50}, organisms targeted, surface applied to, method of application, effectiveness of treatment, and references. This table is a good idea, limited only by the quality of the information available in the references. In most instances, papers citing treatments do not specify the organisms or the substrate. Comments on the effectiveness of the treatment, especially over the long term, such as "kills biological growth in five months" or "residual effects that prevent growth for 3–5 years," provide useful guidelines. As good as this section is, though, it would have been even better if more space had been devoted to further elaboration.

Mixed in with the helpful parts, unfortunately, are many incompletely developed sections containing much misinformation.

While the authors correctly state the basic definition of biodeterioration in the introduction (any undesirable change in the properties of a material caused by the vital activities of living organisms), they fail to include the term "biodegradation" and its definition (any *desirable* change in the properties of a material caused by the vital activities of living organisms, e.g., biodegradation of PCBs). The two terms, and processes, are closely linked.

The section on general aspects of biodeterioration in tropical regions is good as far as it goes, but it misses important concepts and references, especially in the paragraphs dealing with identification of microbes and their activities. Reference to DNA molecular tools to isolate, amplify, sequence, and identify micro-organisms is missed (e.g., S. Rölleke et al. 1996. Identification of bacteria in a biodegraded wall painting by denaturing gradient gel electrophoresis of PCR-amplified gene fragments coding for 16S rRNA. *Applied Environmental Microbiology* 62:2059–65), as is ATP-luminescence assessment for fungal activity states (F.E. Nieto-Fernandez et al. 1997. Assessing biodeterioration in wood using ATP photometry. Part 1, Nucleotide extraction and wood interference. *International Biodeterioration and Biodegradation* 39[1]:9–13; F.E. Nieto-Fernandez et al. 1997. Assessing biodeterioration in wood using ATP photometry. Part 2, Calculating a conversion factor for *Phanerochete chrysosporium* using ATP and adenylate energy charge. *International Biodeterioration and Biodegradation* 39[2–3]:159–64; F.E. Nieto-Fernandez et al. 1998. Assessing biodeterioration in wood using ATP photometry. Part 3, Estimation of the fungal biomass of *Phanerochete chrysosporium* in decayed wood using ATP and energy charge measurements. *International Biodeterioration and Biodegradation* 41[1]:35–39).

The authors missed many significant and newer references, especially those from two Dahlem workshops outlining background and research directions in the field of biodeterioration of stone. They are: Krumbein, W. E., et al., eds. 1994. *Durability and change: The science, responsibility, and cost of sustaining cultural heritage*. New York: John Wiley. 307; Baer, N. S., and R. Snethlage, eds. 1997. *Saving our architectural heritage: The conservation of historic stone structures*. New York: John Wiley. 448; Koestler, R. J., et al. 1997. Biodeterioration: Risk factors and their management. In *Saving our architectural heritage: The conservation of historic stone structures*, ed. N. S. Baer and R. Snethlage. Dahlem Workshop Report ES20. Chichester. New York: John Wiley. 25–36; Teutonico, J. M., et al. 1997. Group report: How can we ensure the responsible and effective use of treatments (cleaning, consolidation, protection)? In *Saving our architectural heritage: The conservation of historic stone structures*, ed. N. S. Baer and R. Snethlage. Dahlem Workshop Report ES20. Chichester. New York: John Wiley. 293–313.

Also missing are many citations from the Elsevier Science journal *International Biodeterioration and Biodegradation,* which devotes about a third of its pages to peer-reviewed articles on biodeterioration of cultural property.

In addition to missing references, the authors have misread or miscited some of their information. For example, they state that "alteration of stone monuments due to living organisms is usually indicative of an advanced state of deterioration predetermined by physical and chemical parameters" (p. vii). This is incorrect. Biodeterioration may precede or be concurrent with initial mechanical and physical deterioration factors (as stated in Becker et al. [1994] in the authors' reference list). Another example of incorrect understanding of the literature is in attributing the color of cyanobacteria to the gelatinous sheaths surrounding the cells (p. 14). The color is primarily the result of the carotenoids and phycobilins within the cells. Sometimes this color is modified by the gelatinous sheaths surrounding the cells. Another point about cyanobacteria is that they may live within a stone, not just on the surface as stated (p. 15).

In the section on fungi, table 2.2 (Fungi Found on Stone Monuments in Tropical Regions) seems like a filler section, as many fungi reported in the included references are not listed, and many more fungi from other references could have been added to make the list more representative of organisms found.

In the section on lichens, the authors should have made it clear that a lichen is an association of a fungus and a bacterium, not a mixture of bacterial species, as is implied. In about 60 percent of lichens, the phycobiont is a *Chlorococcales* sp.

Growth of the thallus, essentially fungal hyphae, does not only follow pre-existing cracks as stated (p. 20), but rather they may create their own pathways (Koestler et al. 1985, in the authors' reference list).

The authors should also have made some reference to the large number of studies by lichenologists in which they determine and map the environmental conditions underneath various lichens by identifying the species of lichen on the surface. For instance, some species like a high-salt environment, some like high moisture, some like less light than others, etc. (e.g., Romao, P. M. S., and Rattazzi A. 1996. Biodeterioration on megalithic monuments: Study of lichens' colonization on Tapadao and Zambujeiro Dolmens [Southern Portugal]. *International Biodeterioration and Biodegradation* 37[1]:23–35). Mapping the lichen species on the surface aids in spotting sections of a monument or stone surface that may be at particular risk.

The complexity of the interactions among biological, chemical, and physical factors (which has been called co-association) is alluded to in the introduction. A fuller development of this idea, with research suggestions, can be found in Koestler, R. J., et al. 1994. "How do environmental factors accelerate change?" In *Durability and change: The science, responsibility, and cost of sustaining cultural heritage,* ed. W. E. Krumbein et al. New York: John Wiley. 149–63.

Much of the chapter on selection of chemical treatment seems to be based upon George W. Ware's first edition of *The Pesticide Book* rather than the current fourth edition (Fresno, Calif.: Thomson, 1994). Much has changed in the pesticide world since the first edition. Almost none of the products listed in table 4.1 are registered for use on stone in the United States, although admittedly the standards are different in other countries, and many of these products are still in use elsewhere. It would have been useful to incorporate a listing of the availability of the chemicals in different regions.

A point that was not mentioned about the use of biocides is that the effectiveness of a biocide varies depending upon the substrate to which it is applied. For example, quaternary ammoniums will last longer when applied to stones containing clay as opposed to those without. This result is believed to be due to absorption of the biocide by the clay, so that it is retained longer in the stone (Young, M. E., et al. 1995. Assessment in a field setting of various biocides on sandstone. In *Preprints of methods of evaluating products for the conservation of porous building materials in monuments*. Rome: ICCROM. 93–99).

Biocides and protective coatings may interact with each other, causing unintended results. As well, these results may be different depending upon the order in which the treatments were applied (Nugari, M-P., et al. 2000. Effects of combined application of biocides and protectives on marble. In *9th International Congress on Deterioration and Conservation of Stone*, Venice, Italy. Amsterdam: Elsevier 2:225–33).

The authors perpetuate a basic misconception about biology when they state that "Some organisms, especially bacterial, can *develop* [my emphasis] resistance to a particular biocide over time." This is not exactly what happens. In any species of bacteria, there are many genetic variations present in a given population. Some variations are susceptible to a particular biocide and will not grow, while some are partially or completely unaffected and will continue to grow. In other words, it is not that a particular bacterium is developing resistance, but rather that the unaffected variations continue to grow.

The authors also have an incomplete understanding of biofilms and biocide interactions. A biofilm is not only present in aquatic environments (as stated by the authors), but may be present on many surfaces. A biofilm may contain many different microbes, including actinomycetes, algae, bacteria, cyanobacteria, fungi, and yeast, along with many different biopolymers. The complex nature of a biofilm almost ensures that any biocide applied to two different biofilms will have different effects. A biocide applied to a biofilm may have no effect, a small effect, the desired effect, or even a deleterious effect, by encouraging the growth of other organisms.

The section discussing current research status and areas for further investigation is not well thought out, and too much is missing. The simple listing of suggestions given should have been referenced as to source and should have been developed further.

An important concept that has not been mentioned in this overview is the possible protective role of biological growths on stone surfaces (e.g., Urzi, C., and Krumbein, W. E. 1994. Microbiological impacts on the cultural heritage. In *Durability and change: The science, responsibility, and cost of sustaining cultural heritage*, ed. W. E. Krumbein et al. New York: John Wiley. 107–35. For a recent summary of this issue see: Dornieden, T., et al. 2000. Patina. Physical and chemical interactions of sub-aerial biofilms with objects of art. In *Of microbes and art: The role of microbial communities in the degradation and protection of cultural heritage*, ed. O. Ciferri et al. New York: Plenum Publishing. 105–19).

One final very basic concept that should have been stressed is the important difference between tropical and nontropical regions, in that the environmental stress to a biocide is much greater in the tropics due to a longer (i.e., continuous) growing season and greater amounts of rain.

Overall, I cannot recommend *Biodeterioration of Stone in Tropical Environments: An Overview* in its current version, in or out of the tropics. There is just too much misleading, misinterpreted, missing, or wrong information to recommend it. No clear rationale is given as to why microbial environments in the tropics should be considered as special and not just as variants of a temperate region. Indeed, since some 80% of the references deal with temperate microbial deterioration, it seems that the authors do not make a clear distinction. All of these errors could be corrected by a revision. If this were done, then I feel that the overview could indeed live up to its name.

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JEANETTE M. CARDAMONE AND MARY T. BAKER, EDS., *HISTORIC TEXTILES, PAPERS, AND POLYMERS IN MUSEUMS.* ACS Symposium Series 779. Washington, D.C.: American Chemical Society, 2001. 227 pages, hardcover $110.00. Available from Oxford University Press, www.oup-usa.org/acs/. ISBN 0-8412-3652-6.

This volume contains papers presented in 1998 at two symposia hosted by the American Chemical Society, "Historic Textiles and Paper" and "Polymers in Museums." The volume is divided into two parts, "Textiles and Papers in Museums" and "Polymers in Museums," and includes topics ranging from the identification, characterization, or accelerated aging of fibers (cellulose, silk, and wool), cellulose acetate, and cellulose nitrate to profiling surface topography of polymers. The papers generally are rich in content and well edited. Some researchers will find the entire volume useful, if not interesting, while others may prefer to obtain the volume through interlibrary loan before purchasing it for their own library.

Jeanette M. Cardamone edited the first part, "Textiles and Papers in Museums." Her introductory article, "Historic Textiles and Paper," describes a range of issues, challenges, and research about these materials, and provides context for the eight articles in the part.

"The Aging, Degradation, and Conservation of Historic Materials Made from Cellulosic Fibers" describes the historical cultivation and use of cotton and flax fibers and also addresses fiber morphology, fiber properties, cellulose structural change, cellulose degradation, deacidification, aged cellulosic textiles, photolytic degradation, biodegradation, and air pollution. "Chemical and Physical Changes in Naturally and Accelerated Aged Cellulose" describes work done to replicate the natural aging of cellulose by artificial means, analysis of degradation products by gas chromatography, and testing of the physical properties that led the authors to conclude it is physically and chemically safe to store cellulosic materials in a variable but moderate environment and that chemical stability increases at cooler temperatures and lower relative humidities. "FTIR Study of Dyed and Undyed Cotton Fibers Recovered from a Marine Environment" describes using Fourier transform infrared reflectometry (FTIR) microscopy to study the crystallinity indices of dyed and undyed cotton fibers from a deep-ocean shipwreck, which showed that increased crystallinity will result in less absorbent and less flexible fibers. "Characterization of Chemical and Physical Microstructure of Historic Fibers Through Microchemical Reaction" describes the use of light microscopy and FTIR microspectroscopy to study internal structural differences in historic fibers that may influence the determination of future conservation treatments. "Degradation and Color Fading of Cotton Fabrics Dyed with Natural Dyes and Mordants" describes an evaluation of the effects of six mordants, iron and aluminum salts, and two major components of natural dyes on the photodegradation rates of cotton fabrics using weathering tests, and analysis and measurements using inductively coupled plasma atomic emission spectroscopy, electron spin resonance, color measurement, and tensile tests. "Degradation and Color Fading of Silk Fabrics Dyed with Natural Dyes and Mordants" describes an evaluation of the effects of dyes and mordants on the photodegradation and photofading of raw and degummed silk fabrics through artificial light exposure, color measurements, tensile testing, and determination of mordants in fabrics.

"Measuring Silk Deterioration by High-Performance Size-Exclusion Chromatography, Viscometry, and Electrophoresis" describes work that showed that three analytical techniques developed for measuring silk deterioration (high-performance size-exclusion chromatography, viscometry, and electrophoresis) provide very sensitive and complementary information about small changes in silk molecular weight