Articles

Book Reviews

SPNHC: THE SECOND TEN YEARS (1995–2005)

Stephen L. Williams[1] **and Suzanne B. McLaren**[2]

[1]*Department of Museum Studies, Baylor University, Waco, Texas 76798-7154*
[2]*Section of Mammals, Carnegie Museum of Natural History, 5800 Baum Blvd., Pittsburgh, Pennsylvania 15206-3706*

Abstract.—In 1985, the Society for the Preservation of Natural History Collections (SPNHC) was created to meet the concerns of a growing number of individuals involved with the development, management, and care of natural history collections. After 20 years of existence, the Society continues to be unique among natural history professional organizations, because of its international scope and multidisciplinary approach to collections management and care. The second ten years of the organization is featured with national recognition for outstanding commitment to the preservation of collections, as well as a strong record of conducting annual meetings, providing continuing education opportunities, producing literature that adds to the knowledge base of the museum community, and a variety of successful projects. In celebration of the Society's twentieth anniversary, the history and accomplishments of SPNHC during the last decade are documented.

The Society for the Preservation of Natural History Collections (SPNHC) is a ''multidisciplinary organization composed of individuals who are interested in development and preservation of natural history collections. Natural history collections include specimens and supporting documentation, such as audio-visual materials, labels, library materials, field data, and similar archives. *Preservation* refers to any direct or indirect activity providing continued and improved care of these collections and supporting documents. The Society actively encourages the participation of individuals involved with all aspects of natural history collections'' (SPNHC 2004a). The purpose of SPNHC is to

- provide for and maintain an international association of persons who study and care for natural history collections. SPNHC also provides a bridge between natural history collection managers and technical, professional, governmental, and non-governmental organizations.
- encourage research on the essential requirements for preserving, storing, studying, and displaying natural history collections. SPNHC recognizes and rewards contributions to the understanding of natural history collection management and preservation.
- publish a professional journal and encourage the dissemination of information about natural history collections. SPNHC publishes natural history collection related technical materials, including *Collection Forum*, semi-annual newsletters, technical leaflets, best-practice guides, and several books.
- hold annual meetings and sponsor symposia and workshops to foster the exchange of ideas and information (SPNHC 2004a).

Williams (1995) documented the history of SPNHC during its first ten years of existence. This contribution follows Williams (1995) in documenting the history of SPNHC between 1995 and 2005.

The Bylaws

The Society's bylaws were revised in May of 1995 to more thoroughly address the activities of the Society and to meet compliance requirements. They have

Collection Forum 2005; 19(1–2):1–14

Table 1. SPNHC Officers from 1995 to 2005.

Inclusive years	Individuals/offices		
	President-Elect	*President*	*Past-President*
1994–1996	G. W. Hughes	C. L. Rose	G. R. Fitzgerald
1996–1998	S. Y. Shelton	G. W. Hughes	C. L. Rose
1998–2000	S. B. McLaren	S. Y. Shelton	G. W. Hughes
2000–2002	R. Huxley	S. B. McLaren	S. Y. Shelton
2002–2004	I. Hardy	R. Huxley	S. B. McLaren
2004–2006	T. White	I. Hardy	R. Huxley
	Secretary	*Treasurer*	*Managing Editor*
1995–1997	M. E. Taylor	Julia Golden	J. E. Simmons
1997–1999	M. E. Taylor	L. Palmer	K. Shaw
1999–2000	M. E. Taylor	L. Palmer	J. Waddington
2000–2004	E. Benamy	L. Palmer	J. Waddington
2004–2005	Judith Price	L. Palmer	J. Waddington

provided direction for the organization in developing useful policies and operational guidelines. Collectively these documents are available from the SPNHC Council in hardcopy format and on the SPNHC website (www.SPNHC.org).

The Council

The SPNHC leadership is provided by the Council which consists of six officers and six Members-at-Large. The officers include the President, Past-President, President-Elect, Treasurer, Secretary, and Managing Editor. The President, Secretary, and Members-at-Large are elected offices with specific terms; the Treasurer and Managing Editor are appointed for one- to two-year terms, with the provision of being renewed repeatedly by mutual agreement. Individuals elected to presidential positions accept a six-year commitment, but serve in three different capacities separated into two-year increments (President-Elect, President, and Past President). The Members-at-Large hold the longest term of three years; each year two Members-at-Large are retired and replaced. This structure provides consistency of direction and operations over time for the Council, as well as training for future officers (Williams 1995). The long-term service of Council members filling the non-presidential positions has provided stability to the Society over the past ten years. Executive officers and their terms are given in Table 1, while the Members-at-Large and their respective terms are given in Table 2.

The Committees

Much of the success of SPNHC is directly related to activities and accomplishments of the Standing Committees and Sessional Committees. The Standing Committees are long-term entities, continuing from the term of one President to the next. Standing Committees provide essential, organizational functions or services to the membership. Sessional Committees exist at the discretion of the President in office. For the most part, Sessional Committees serve a temporary purpose or a subset of the membership on a short-term basis.

Table 2. SPNHC Members-at-Large between 1995 and 2005.

Inclusive years	Individuals
1992–1995	L. Barkley and R. R. Waller
1993–1996	G. Brown and S. Y. Shelton
1994–1997	P. S. Cato and S. B. McLaren
1995–1998	E. E. Merritt and A. Pinzl
1996–1999	C. Leckie and A. Suzumoto
1997–2000	B. P. Moore and L. L. Thomas
1998–2001	E. Benamy and R. Huxley (subsequently became Secretary and President-Elect, respectively, and were replaced by R. Johnson and W. Gannon)
1999–2002	C. Ramotnik and J. Solomon
2000–2003	P. Work and G. Anderson
2001–2004	A. Pinzl and S. M. Woodward
2002–2005	C. Ramotnik and T. White (subsequently became President-elect and replaced by L. Ford in 2004)
2003–2006	L. Dietrich and J.-M. Gagnon
2004–2007	E. Benamy and R. K. Rabeler

Standing Committees

During the past ten years the nature of the Standing Committees has been considerably more stable than the previous 10 years. While the first ten years featured the creation, elimination, combination, and renaming of standing committees, the second ten years has merely involved the 1996 absorption of the Resources Committee into the Conservation Committee, and the 2001 renaming of the Awards and Recognition Committee as the Recognition and Grants Committee. At the end of the second ten years, the Society recognizes 12 Standing Committees. Four of these committees remain critical in fulfilling the functions of the organization (Bylaws, Election, Executive, and Finance committees), six are important in providing services to the general membership (Archives, Conference, Conservation, Documentation, Education & Training, and Recognition & Grants), and two committees (Membership and Publications) serve the general membership while also fulfilling organizational functions. Details about the current committees are provided in the following text.

Archives Committee.—''The Archives Committee preserves the institutional history of the Society . . . by accepting, storing, and providing access to the documentary records of the Society. Space is generously provided for this by the Smithsonian Institution Archives'' (SPNHC 2004b). Because of the association with the Smithsonian Archives, the Society endeavors to have the Committee Chair be a SPNHC member who is employed by the Smithsonian Institution. Accordingly, J. P. Angle chaired the Archives Committee from 1989 to 1996, followed by R. D. Fisher who has been chair since 1996.

Bylaws Committee.—''The Bylaws Committee is responsible for the continued development of the Society Bylaws as needed, as well as monitoring Society activities to ensure agreement with the Bylaws'' (SPNHC 2004b). The Committee has played an important role in centralizing and condensing the operational documents of the Society, as well as providing direction for policy and procedure development (Williams 1999). Because the presidential positions involve ongoing

Table 3. Annual meetings of SPNHC from 1995 to 2004.

Year	Host and location (date; theme)
1995	Royal Ontario Museum, Toronto, Ontario (2–6 June; *10th Anniversary of SPNHC*)
1996	The Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania (12–15 June; *Historic Natural History Collections*)
1997	University of Wisconsin-Madison, Madison, Wisconsin (8–13 July; *Natural History Collections on Campus*)
1998	University of Alberta, Edmonton, Alberta (25–30 May; *Collections on the Move: Strategies for the Next Millennium*)
1999	Smithsonian Center for Materials Research and Education *and* the National Museum of Natural History (27 June–2 July; *Research and Collections*)
2000	Nova Scotia Museum of Natural History *and* Geological Survey of Canada, Halifax, Nova Scotia (8–14 July; *Maritime Heritage*)
2001	California Academy of Sciences, San Francisco, California (21–26 June; *Living Collections*)
2002	Redpath Museum, McGill University *and* the Canadian Museum of Nature, Montréal, Québec (8–13 May; *Hazardous Collections and Mitigation*)
2003	Museum of Texas Tech University, Lubbock, Texas (15–19 June; *Modern Museums: Balancing Tradition and Technology*)
2004	American Museum of Natural History, New York (11–16 May; *Emergency Preparedness, Response, and Salvage*)

work with the Bylaws throughout a six-year commitment, the Committee is chaired by the Past-President. Hence, leadership of the Bylaws Committee changes every two years, synchronized with presidential terms (Table 1).

Conference Committee.—The Conference Committee ''coordinates the logistics and scheduling of the annual meetings, recommends sites for future meetings, and submits those recommendations to the SPNHC President for a full Council vote. The Conference Committee is responsible for soliciting invitations at least a year in advance from institutions to host the Annual Meeting of the Society'' (SPNHC 2004b). The Committee is chaired by the President-Elect because that individual will be serving as President during the years of the annual meetings in question, and because an official of the Society is needed to serve as liaison with hosting institutions of conferences (Williams 1995). As a result, the leadership of the Conference Committee changes every two years, synchronized with presidential terms (Table 1).

Historically, the annual meetings of SPNHC more or less have alternated between Canada and the United States (Table 3). However, at the end of the second ten years the 2005 annual meeting will be held in Great Britain. This will be the first meeting held outside North America, marking a major step toward the goal of having an international focus. The annual meeting normally occurs in May, June, or sometimes July, depending on local arrangements. During the past decade, local committees responsible for conducting the annual meetings, often have identified a theme for their respective conferences (Table 3). While the number of attendees at any particular meeting has not always been formally documented, the average number of participants at any single meeting is estimated to be around 150 individuals.

Conservation Committee.—''The Conservation Committee is responsible for acquiring, developing, and distributing information to the Society that will promote the long-term preservation of natural history objects and associated materials. The Conservation Committee encourages and facilitates collaborative projects among curators, collection managers, and conservators that contribute to best practices for collection care and the preservation of collections'' (SPNHC 2004b). For example, the Conservation Committee was involved in the *Symposium on Contaminated Collections: Preservation, Access, and Use,* in April 2001 (details are provided under ''Cooperative Projects''). The Committee also has assisted, directly or indirectly, in the production of Society publications, such as Rose et al. (1995), Metsger and Byers (1999), and special volumes of *Collection Forum* (Caldararo et al. 2001, Johnson 2001).

The Conservation Committee has been chaired by C. A Hawks and C. Leckie (co-chairs, 1993–1995), B. P. Moore (1995–1998), D. H. Dicus (1998–2000), L. Kronthal and J. Southward (co-chairs, 2000–2003), and B. Hamann and J. Southward (co-chairs, 2003–2005). Activities and membership interest in this Committee have made it one of the largest committees in the Society, ranging from 11 to 28 members (average, 21). The Committee accommodates its large membership by dividing activities into several subcommittees.

Especially important to the Conservation Committee are the sub-committees for research, resources, citations, and special projects. The research subcommittee is a source for monitoring research activities and directing research needs. The resources subcommittee is primarily concerned with providing two traveling exhibits of commercially available, conservation-quality, supplies that can be used in collections. The citations subcommittee is responsible for collecting references of recent literature for the *SPNHC Newsletter.* The special projects of the Conservation Committee initially involved a subcommittee in charge of the fluid assessment project. This work was completed in 1999, and the results were published in *Collection Forum* (Waller and Simmons 2003). With the completion of the wet assessment project, a project investigating adhesives was initiated.

Documentation Committee.—''The Documentation Committee is concerned with the permanence and quality of all documents associated with the management and care of natural history specimens. Committee goals are to: 1) identify major documentation issues; 2) build documentation guidelines; 3) gather documentation models for acquisition/deaccession, collection management, and collection development; 4) recommend minimum information standards for collections; and 5) develop terminology'' (SPNHC 2004b). Primary projects of the Committee have involved the NHCOLL-L Internet listserve, a terminology project resulting in the book *Museum Wise: Workplace Words Defined* (Cato et al. 2003), assisting with a workshop (*Use of Digital Technology in Museums*), and various studies pertaining to documentation standards, research, and legal issues. The Committee has been chaired by S. McLaren and J. Golden (co-chairs, 1993–1994), S. Kraft and J. Zak (co-chairs, 1994–1995), J. Zak (1995–1998), T. White (1999–2002), K. Goulette and T. White (co-chairs, 2002–2004), K. Goulette and R. Monk (co-chairs, 2004–2005).

Education and Training Committee.—The Education and Training Committee serves the Society by facilitating training opportunities and the exchange of information (SPNHC 2004b). Since 1988, the Committee has aided in coordination of logistics and acquisition of resources for most major workshops at the annual meetings (Table 4). The procurement of outside funding from corporations and

Table 4. Special training workshops provided at annual meetings between 1995 and 2004.

Year	Topic
1995	Managing the Modern Herbarium
1996	Valuation and Insurance of Natural History Collections
1997	Quality Management—Quality Collections Care
1998	Moving Collections
1999	Rigging: Lifting and Moving Large Objects; Finance and Funding: Linking Collection Care Needs to Money in the Museum; CO_2 Fumigation: Atmospheric Treatment of Museum Objects for Pest Control
2000	Permits Workshops: Across Borders
2001	Living Collections; Identifying Risks to Collections
2002	Chemical and Biological Emergency Preparedness and Response in Natural History Museums
2003	Use of Digital Technology in Museums
2004	Emergency Response and Salvage Techniques

foundations, as well as federal and provincial agencies, has improved the quality of the Society's workshops. The Committee also has played a major role in developing material for SPNHC publications (Metzger and Byers 1999). The Education and Training Committee has been chaired by S. C. Byers and E. E. Merritt (co-chairs, 1994–1996), I. A. Hardy (1997–2000), and L. Abraczinskas and L. Benson (co-chairs, 2000–2005). The chair position was vacant during the latter part of 1996 and early 1997.

Election Committee.—The Election Committee is responsible for nomination and election of officers (SPNHC 2004b). The Election Committee has been chaired by J. Price (1991–2000) and R. Rabeler (2000–2005).

Executive Committee.—The Executive Committee carries out the day-to-day business of the Society. It is composed of the executive officers, specifically the President, the Past-President, the President-Elect, the Secretary, the Treasurer, and the Managing Editor of the Society's journal (SPNHC 2004b). As a committee the members can legitimately conduct meetings and develop proposals for Council. In some instances, this Committee acts to address specific needs of the Society (Williams 1995). The current President serves as the chair of the Executive Committee, thus the leadership parallels the term of the President (Table 1).

Finance Committee.—The Finance Committee is responsible for monitoring the Society's financial accounts, handling reserve funds, developing fiscal policies, and attending to other financial matters required by Council. The Society receives funds from memberships and subscriptions, donations, grants, and revenue from book sales. There is an ongoing need to oversee income and expenses to provide funds for operations, protect the tax status of the organization, and fulfill the intent of designated donations. Collectively, this has resulted in a solid financial position that has allowed the Society to participate in new opportunities, such as federal grants and special committee projects (Williams 1995). Resourcefulness of SPNHC committees, substantial sales of Special Publications, and responsible financial management of revenues, have resulted in the net worth of the Society increasing about 260% during the past ten years; in turn, this has allowed the Society to proactively take advantage of opportunities that serve its mission and goals.

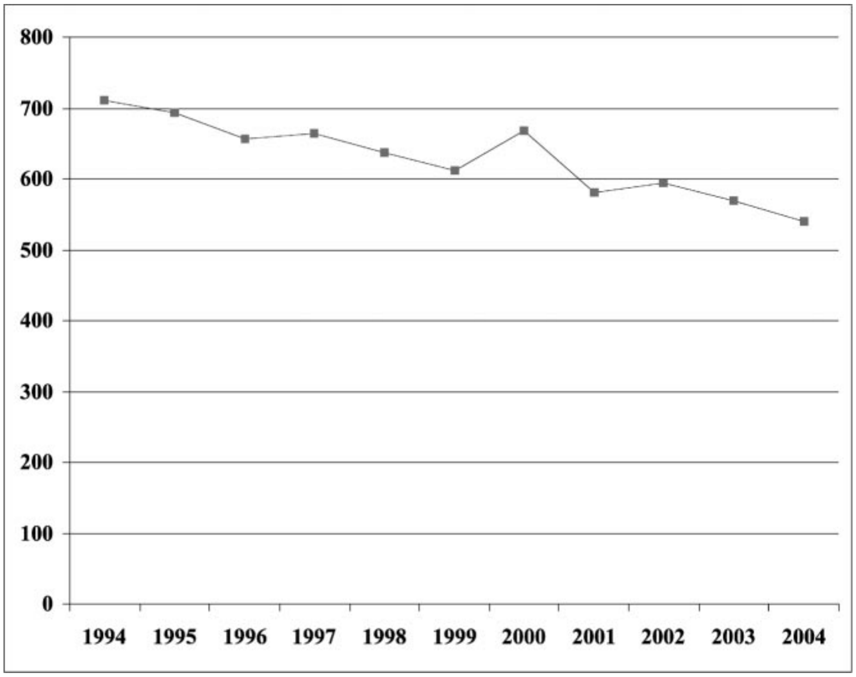

Figure 1. Total SPNHC membership (regular, life, associate, and subscribing members) between 1994 and 2004, derived from annual reports of the SPNHC Treasurer.

The SPNHC Treasurer typically serves on the Finance Committee, and sometimes co-chairs the Committee. The Committee has been chaired by J. Golden and S. B. McLaren (co-chairs, 1993–1999), S. L. Williams (1999–2002), and L. Palmer and R. Waller (co-chairs, 2002–2005).

Membership Committee.—The Membership Committee is responsible for activities that promote membership growth and encourage the retention of existing members (SPNHC 2004b). Part of this responsibility has involved the production and distribution of materials, such as brochures and posters, to solicit new memberships and promote products of the Society. In 2001, the Committee reported membership representation in the United States (63%), Canada (9%), United Kingdom (5%), and 20 other countries. The Membership Committee has been chaired by A. Pinzl (1992–1997), A. Pinzl and L. Benson (co-chairs, 1998–1999), A. Pinzl and J. MacKnight (co-chairs, 1999–2000), J. MacKnight and J. Mygatt (co-chairs, 2000–2002), J. MacKnight and J. Bryant (co-chairs, 2002–2004), and J. Bryant (2004–2005).

The total membership (regular members, life members, associate members, and subscribing members) in 1994 was 711 members. While on a year-to-year basis, it would seem that the total membership has been relatively stable over the past ten years, it has been dropping an average of 2.2% a year, such that the total loss in membership between 1994 and 2004 is 24.1% (Fig. 1). A notable increase in membership occurred in 1999–2000 followed by a significant decline the following year, possibly due to short-term support of Local Committee members of the Washington, DC annual meeting. The drop in membership between 2000 and

2004 has been 19.2%, compared to 11.8% between 1995 and 1999. This general decline may be partially a reflection of downsizing, amalgamation, and attrition experienced at member institutions. Retaining and building membership remains a formidable challenge for the Society.

Publications Committee.—The Publications Committee is charged with developing and maintaining publication policies, and using these policies to provide regular publications and website material that serve as a positive reflection of the Society's purpose. As a benefit of SPNHC membership, the Society publishes *Collection Forum* and the *SPNHC Newsletter*. *Collection Forum* is a high quality, peer-reviewed journal that serves the mission of the Society, whereas the *SPNHC Newsletter* is an outlet for timely information, organizational communications, and short articles. As an added benefit of membership, the Society has produced four issues of *SPNHC Leaflets*, to provide members with technical information, such as anoxic microenvironments (Burke 1996), adhesives and consolidants (Elder et al. 1997), identification of plastics (Williams et al. 1998), and dataloggers (Arenstein 2002).

During the past ten years, the Society and the Publications Committee have been challenged by low submissions of publishable manuscripts. This has caused considerable disruption in the publication schedule such that *SPNHC Leaflets* was not published between 1998 and 2002, and *Collection Forum* was published irregularly after 1996. The *SPNHC Newsletter* has been produced twice a year, and more or less on schedule.

While the Society's serial publications have had difficulties, the Publications Committee can be proud of the books produced on behalf of the Society. The first to be published in the second ten-year period was the *Storage of Natural History Collections: A Preventive Conservation Approach* (Rose et al. 1995), followed by *Managing the Modern Herbarium* (Metsger and Byers 1999), and *Museum Wise: Workplace Words Defined* (Cato et al. 2003). As the end of the second ten-year period approaches, the Publications Committee is involved with books entitled *Museum Studies: Perspectives and Innovations* (a book honoring the memory of Carolyn Rose) and *Fundamentals of Health and Safety for Museum Professionals*. The Society has entertained external proposals for the translation of some SPNHC books to Spanish, French, and Chinese; no translation has come to fruition yet.

The Managing Editor serves as an appointed officer of the Society and as the Chair of the Publications Committee. The Committee Chairs have been J. E. Simmons (1993–1997), K. Shaw (1998–1999), and J. Waddington (2000–2005). The *SPNHC Newsletter* Editors have been P. M. Sumpter (1993–1995), S. L. Williams (1996–1997), T. White (1998–2001), C. Norris (2001–2003), and A. Bentley (2003–2005). The Webmaster has been T. Vidal from 1997–1998 and J. Greggs from 1998–2005.

Recognition and Grants Committee.—The Recognition and Grants Committee is responsible for ''developing and exercising standards and protocols, so that the Society can recognize and award deserving individuals for exceptional achievement'' (Williams 1995). The Society recognizes individuals through the *Carolyn Rose Award* (renamed in 2002), the *President's Award, Honorary Membership, Special Service Award,* and the *Faber Grant* (SPNHC 2004b). In 2001, because of tax-related questions about funding associated with the Faber Award, the name of the Committee was changed from the Awards and Recognition Committee to the Recognition and Grants Committee, and the *Faber Award* was changed to the *Faber Grant.* The Committee has been chaired by S. L. Williams (1994–1996), G. W. Brown (1996–2000), S. J. Krauth (2000–2002), and J. DeMouthe (2002–2004).

The highest honor of the Society is the *Carolyn Rose Award* (previously the *SPNHC Award*), which recognizes individuals for lifetime accomplishments that serve organizational mission and goals. Only two individuals have received and accepted this award, specifically Mary-Lou Florian and Carolyn L. Rose. Because of the role that Carolyn Rose fulfilled in the Society as a leader, mentor, and role model (Anon. 2003), contributing significantly to the national image and financial future of the Society, the *SPNHC Award* was renamed the *Carolyn Rose Award* shortly before her untimely passing.

The *President's Award* recognizes members for exceptional service to the Society. Eight individuals have received this award, specifically S. B. McLaren (1993), P. S. Cato (1995), J. Waddington (1998), S. L. Williams (1999), J. Golden (2000), C. L. Rose (2001), A. Pinzl (2002), and C. A. Hawks (2003).

Honorary Membership provides a mechanism for the Society to recognize and include an individual (non-member) as part of the organization for independent activities that are in close agreement with the mission and goals of SPNHC. Such independent activities might be political, social, financial, or professional in nature. In its 20 years of existence, the Society has not awarded any individual an *Honorary Membership.*

The *Special Service Award* was created in 1996, to recognize and thank individuals for outstanding short-term contributions to the activities of the Society, such as chairing local committees of annual meetings. The following individuals have been so recognized on one or more occasions: L. Barty, E. Benamy (2), I. Birker, F. Blondheim, B. Brown, G. Brown, K. Button, J. DeMouthe, D. Dicus, E. Dietrich, R. Fri, J.-M. Gagnon, J. Greggs, I. A. Hardy, J. Jacobs, S. Krauth, L. Latta-Guthrie, J. MacKnight, R. Monk, B. Moore, A. N'Gadi, C. Norris (2), J. Price, D. Quilligan, L. Schlenker, R. Simons, P. Sumpter, M. E. Taylor, L. Thomas, L. van Zelst, T. Vidal, D. von Endt, T. White (3), S. L. Williams, A. Wilson, and J. Zak.

Projects that help to advance the management and care of natural history collections are funded on a competitive basis through the Faber Grant. While the original intent of the grant was to motivate individuals to conduct and present original collection-related work, very few individuals have taken advantage of this opportunity, even after the amount of available funding was doubled. Recipients of the Faber Grant are J. Golden (1996), J. Pestovic (1999), L. Benson and R. Kubiatowcz (2001).

Sessional Committees

As previously stated, Sessional Committees are intended to address specific short-term needs for SPNHC. Sessional Committees that provided annual reports of activities during the past ten years are as follows:

- Sessional Committee on Long Range Planning (G. W. Hughes, Chair, 1995–1996) reviewed accomplishments of the first ten years of the Society, identified strengths and weaknesses, and proceeded to define a five year plan. As a result, the organization's mission was clarified, goals identified, and priorities established (Anon. 1996a). The Committee was resurrected (L. L. Thomas, Chair, 1998–2000) to evaluate the progress of what became known as the Five Year Plan. The Committee's work assessed each standing committees' activities in terms of the Society's overall goals. It was decided that Members-at-Large would take an active role in working with the committees to achieve these goals (Thomas 2000).

- Sessional Committee on Professionalism (S. L. Williams and K. Shepard, co-chairs, 1996–1998; E. Merritt, Chair, 1998–2000) investigated strategies for increasing professionalism in collection management and care, ultimately resulting in articles published in the *SPNHC Newsletter* (Cato and Sharp 1996, Williams 1997).
- Sessional Committee on Student Participation (C. A. Hawks, Chair, 2000–2002), recognizing that the future of the Society is dependent on new members, investigated strategies and made recommendations to develop student membership and participation.
- Sessional Committee on Transportation of Dangerous Goods (S. B. McLaren, Chair, 2003–2005) attempted to educate the SPNHC membership about the regulations and hazards of shipping inappropriate substances, resulting in a *SPNHC Newsletter* article (McLaren 2004).
- Sessional Committee on the SPNHC Website (J. Macklin, Chair, 2003–2005) assessed the SPNHC Website (2003–2004), and pursued enhancing the administration, design, and content of the Website (2004–2005).
- Sessional Committee on Threatened Collections (P. T. Work, Chair, 2003–2005) was established to assist the Society in determining how best to respond to crisis situations involving threatened or orphaned collections.
- Sessional Committee on a SPNHC Business Plan (R. Huxley, Chair, 2003–2005) was set up to create a business plan for the Society.
- Sessional Committee on Publicity and Outreach Relations (R. Arenstein, Chair, 2003–2005) was to review the best means to coordinate publicity for the Society.
- Sessional Committee on the Celebration of the 20th Anniversary (A. Pinzl, Chair, 2004–2005) was created to explore various ways to commemorate this milestone anniversary.

Cooperative Projects

Historically, SPNHC has been involved with cooperative projects with several other professional organizations, with the most recent instance being the joint meeting at the American Museum of Natural History with the International Society for Biological and Environmental Repositories (ISBER). Another example occurred in 2000, when President S. B. McLaren represented SPNHC and natural science collections on the White House Millennium Council to discuss the future of the Clinton Administration's *Save America's Treasures* program. Still another example is the collaboration with the National Park Service and the National Museum of the American Indian, in hosting a 2001 symposium, entitled *Preservation of Native American and Historical Natural History Collections Contaminated with Pesticide Residues* (Bischoff et al. 2001). While other examples of similar cooperative efforts exist, a review of newsletters and annual reports indicates long-term association with the American Association of Museums (AAM), American Institute for Conservation of Historic and Artistic Works (AIC), Heritage Preservation (previously known as the National Institute for Conservation), and the World Council for Collections Resources (WCCR).

The formal relationship with the AAM is based on SPNHC representation on the AAM Registrars Committee, by E. Merritt since 1999. During this time projects of special interest have included professional development (Cato and Sharp 1996), best practices (Cato et al. 2001), collection stewardship (Merritt 2002, 2003), and ensuring the future of collections (Merritt 2004).

Individuals with joint memberships in SPNHC and AIC have been instrumental in both organizations collaborating with each other on a variety of projects from the very beginning of SPNHC. During this time, C. L. Rose served as the primary liaison between the organizations and represented SPNHC on the AIC Advisory Council, which serves as a sounding board for finding solutions to fundamental problems and assessing new ideas. Through representatives, both organizations have deliberated on issues such as common terminology (Cato et al. 2003), professional ethics, professionalism, and health and safety. AIC also provided funding for the 2001 symposium dealing with pesticide residues in natural history collections. While both organizations have expressed an interest in having a joint annual meeting, this desire remains unfulfilled.

SPNHC has worked with Heritage Preservation on projects since the 1980s. During this time D. von Endt has been the liaison between the two organizations. One of the most significant projects has been the Heritage Health Index which is a project intended to quantify the status of collection preservation throughout the United States (Anon. 2002a). Natural science collections were designated as one of six categories to be surveyed, with SPNHC members invited to assist in the planning and design of the questionnaire. Members also provided input on the list of collections to be surveyed and follow-up to assure a high percentage of successful returns.

As a result of the 1992 International Symposium on Natural History Collections in Madrid, SPNHC achieved international exposure and became involved with the continuation of the WCCR (Anon. 1996b). This momentum was perpetuated under the direction of C. Collins as he coordinated the Second World Congress on the Preservation and Conservation of Natural History Collections, at the University of Cambridge, United Kingdom in 1996. SPNHC collaborated with other natural history organizations in providing oral presentations, poster presentations, and workshops that encouraged ‘‘over 320 individuals, representing about 175 institutions and 50 countries’’ to the meeting (Anon. 1996c).

The Supporters of SPNHC

The success and accomplishments of SPNHC would not have been possible without the organization’s strong supporters. Fundamental to its existence is a strong membership. Society operations are dependent on dedicated individuals who contribute through annual meetings, committee work, publication, and other activities. Institutional support usually involves the hosting of annual meetings. However, the support that institutions provide by sending staff to annual meetings and allowing them to participate in roles of leadership and service, is equally important to the Society. Furthermore, it is difficult to estimate the financial support provided by the institutions where Officers, Members-at-Large, and Committee Chairs are employed. Release time for publication reviews, *SPNHC Newsletter* and *Collection Forum* editing, as well as underwriting postage, telephone calls, office supplies, and a myriad of other kinds of support cannot be overstated. While there has been internal support, such as donations from the membership and institutions hosting annual meetings, increasing external support has come from governmental sources, foundations, and corporations.

The second ten years began with a completion of a project supported by the Institute of Museum and Library Services (IMLS), ultimately resulting in the publication of the second collection storage book (Rose et al. 1995). In 1997, IMLS also provided funding for an annual meeting workshop, entitled *Quality Management—Quality Museums* (Anon. 1997).

The National Park Service, through grants of the National Center for Preservation Training and Technology (NCPTT), has provided funding for two SPNHC projects. In 1999, an NCPTT grant was received to assess the conservation research priorities of natural history collections. Results of this project have been reported by Cato (1999, 2000a, 2000b) and Cato et al. (2001). In 2001, the NCPTT awarded SPNHC a grant for a collaborative project with the National Park Service and the National Museum of the American Indian to ‘‘address issues related to the use and repatriation of museum objects that may be contaminated with pesticides’’ (Anon. 2000, Bischoff et al. 2001). With additional funding from AIC and the Smithsonian National Museum of Natural History (Department of Anthropology), a four-day symposium was conducted at the National Conservation Training Center, Shepherdstown, West Virginia. A summary of the symposium, entitled *Preservation of Native American and Historical Natural History Collections Contaminated with Pesticide Residues*, was formally presented at the SPNHC and AIC annual meetings. The proceedings of the symposium were subsequently published in *Collection Forum* (Johnson 2001).

Other external funding has been important to the Society in supporting conferences and workshops. In addition to the financial and in-kind contributions from hosting institutions and local supporting resources, various foundations and corporations have sponsored some conference and workshop activities. Examples of foundation support include the Royal Ontario Museum Foundation and the Bay Foundation. Corporations that have repeatedly provided support through sponsorship, advertisement, or displaying products and services (listed alphabetically), include the Canadian Heritage Information Network, Delta Designs Ltd., Herbarium Supply Company, KE Software, Lane Science Equipment Corporation, Spacesaver Corporation, University Products Inc., Gaylord, and Viking Metal Cabinet Co. Inc.

In 2001, SPNHC was a recipient of the *Award for Outstanding Commitment to the Preservation and Care of Collections* from AIC and Heritage Preservation. This award commended ‘‘the sustained strategic effort made by SPNHC to improve the level of care provided to natural history collections in North America and around the world, its promotion of best practices through the journal *Collection Forum* and the *SPNHC Newsletter*, and the society’s pursuit of outside resources and collaborations to produce special publications and other resources, including posters, list-servers, and displays’’ (Anon. 2002b). The Society was a novel recipient, as an organization with no paid employees. Hence this Award acknowledged the tireless volunteer hours contributed by many people with demanding full-time jobs. The Award provided a special moment in time for members to savor the fruits of a mutual passion for collections.

Conclusion

As with Williams (1995), it is hoped that the information presented here ''will help those who participated in these events to reflect on what has been achieved,'' as well as to ''help new members understand how these events have been important to the history and future of the Society.'' Equally important, this information reflects both strengths and weaknesses of the Society, providing insight for meaningful improvement. This is a time to reflect on the accomplishments of the Society over the past 20 years, and new challenges that must be met to ensure future success. While SPNHC has a strong international reputation for serving the interests of natural history collections, producing quality literature for the museum community, and operating from a solid financial basis, it also faces challenges from irregular publication of *Collection Forum*, membership loss, and waning institutional support for collections and collection staffing.

Currently, SPNHC is the most important resource in the world for serving the interests of natural history collections. Also, because SPNHC represents an organized group of specialists, has mechanisms in place for building a body of knowledge and recognizing superior performance of individuals, and has repeatedly demonstrated its interest in professional excellence (Williams 1997), it remains a viable source for professional development of the field.

The *Award for Outstanding Commitment to the Preservation and Care of Collections* demonstrates the synergism of a collective effort under the direction of good leadership. At the beginning of the third decade, it is clear that the importance of both individual commitment and organizational cooperation has not diminished.

Acknowledgments

The authors are grateful to I. A. Hardy, S. Y. Shelton, and J. B. Waddington for critically reviewing early drafts of the manuscript. Also, appreciation is extended to A. Pinzl and an anonymous reviewer, for helpful suggestions and insights.

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HEAT TREATMENT OF ENTOMOLOGICAL DRAWERS USING THE THERMO LIGNUM® HEAT PROCESS

Phillip Ackery,[1] David Pinniger,[2] Adrian Doyle,[3] and Karen Roux[4]

[1]*Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD*
[2]*83, Westwood Green, Cookham, Berks SL6 9DE*
[3]*Department of Palaeontology, The Natural History Museum, Cromwell Road, London SW7 5BD*
[4]*Thermo Lignum UK Ltd, 19 Grand Union Centre, West Row, London W10 5AS*

Abstract.—The Natural History Museum's entomological collections are likely to undergo relocation, raising the need for a practical and effective regime for pest eradication within any moving strategy. The Thermo Lignum® heat process, incorporating controls on relative humidity variation, was evaluated as a possible practical option. Our results show that entomological drawers and their contents can be treated safely through this method, even with drawer lids in place; however, sufficient free space must be maintained around each individual drawer to allow for unhindered air circulation during the treatment process. When stacked closely, humidity within the drawers rose to unacceptable levels.

Introduction

Within The Natural History Museum's Entomology Department, almost 30 million insect specimens occupy over 130,000 drawers. Following recent investment, some 15% of the collection has been rehoused in steel cabinets that provide an effective barrier against dermestid intrusion. The remainder of the collection is still held in more traditional wooden cabinets and open-fronted racking. Much of this furniture has deteriorated over time, permitting major pest intrusion. The harboured population of dermestids includes primarily *Anthrenus sarnicus, Attagenus smirnovi*, and *Reesa vespulae* (Ackery et al. 1999). This pest exposure results in perhaps 40 recorded incidents of new pest damage in our entomology collections in any given year.

The Museum's Darwin Centre, when complete, will revolutionise the relationship between collections and our public. For the first time, the Museum will offer its visitors unprecedented physical and electronic access to both staff and holdings. New storage for Botany, Entomology, and Zoology is concomitant with this planned increased access, and will include controls on temperature, relative humidity, and daylight, as well as up-graded collections furniture. The likelihood of transferring pests to our pristine new stores led to investigations into suitable methods of pest eradication to be included in the logistics of the collection move.

Available Options for Collections Treatment

Our criteria for a time tabled treatment within a relocation programme include:

- the capacity to treat the collection in its entirety,
- a demonstrable effectiveness with drawer lids *in situ* (removal of drawer lids would impose an unacceptable risk to the specimens),
- a time-scale that does not constrain the entire operation, and
- no detriment to either the collection or collection users.

Reservations regarding chemical fumigants and modified atmospheres—for instance toxicity, penetration, length of treatment—are well documented (Pinniger

2001, Åkerlund and Berg 2001), and sufficient to preclude their use under our criteria. We regularly use low-temperature regimes for day-to-day pest eradication within our collections (Ackery et al. 2000). However, the need to bag-up individual drawers would provide a logistic nightmare for the scale of treatment that we are considering. Lethal high temperatures result in drying-out that poses unacceptable risks to both drawers and specimens. Using a modified conventional slide oven, we have demonstrated a 22% differential between minimum and maximum RH within an oven for a cycle that includes three hours above 50°C (Ackery et al. 2002). However, the short treatment cycle is very attractive in terms of logistics. This led us to consider the Thermo Lignum® process, which uses high temperatures but maintains relative humidity within the treatment chamber at a pre-set narrow limit of ±5%. The question that remained was what changes in relative humidity would be experienced by specimens held within relatively airtight drawers.

The Thermo Lignum® Process

Thermo Lignum® is a commercial company with a single UK base at Ladbroke Grove, West London. Its available walk-in treatment chamber has a capacity of 30 m^3. We investigated the WARMAIR technique that relies upon maintaining RH within a pre-set range as temperature rises (Roux and Leary 2001), raising core temperature to ca. 52°C and maintaining this temperature for three hours. The relationship between atmospheric temperature and humidity, and moisture content of a treated object, is non-linear. Therefore, the system constantly monitors both RH and temperature of the atmosphere within the chamber, and the core temperature of a surrogate object within the chamber. This object takes the form of a wood block selected to match closely the density of the objects under treatment, so avoiding unacceptably invasive monitoring of the treated objects themselves. The data obtained are used to modify the conditions within the chamber as required.

Test Methods and Results

The Entomology Department holds insect specimens in a wide range of drawers of various constructions and age (Table 1). Traditionally, a frame of tropical hardwood forms the basis of most, and all have a glazed lid. More recently, concerns with respect to renewable resources resulted in widespread use of other timbers, for instance American Lime (*Tilia americana*), as an alternative to tropical hardwood. Various materials have been used to form the bases—wood, plastic, metal, and even glass. In all probability, each drawer type has its own characteristic water bearing capacity. Intake of new drawers continues year by year, but most have been in the building for at least 50 yr where they have been subjected to considerable changes in relative humidity, as much as 35% variation on a largely seasonal basis (range = 17–52%). Practicalities dictated that the ambient level of relative humidity within the Department at the time of the tests governed the constraints on the chamber, not the actual water content of the wide variety of drawers under investigation.

Specimens in storage are buffered against sudden changes in relative humidity by the fabric of the collection furniture although collection use often entails removing the lids from drawers; so specimens have been routinely exposed to quite extreme changes in relative humidity to their apparent non-detriment for 150 yr

Table 1. Summary of specifications and experimental criteria adopted for Tests 1–5.

Drawer type	Description	Test 1	Test 2	Test 3	Test 4	Test 5
A. 1980s intake moth box	Tropical hardwood frame, plywood base, glazed lid, Plastazote lined c.50×39×5.5cms	In isolation, with specimens	2 examples in isolation, with specimens			
B. Pre-1940 Rothschild drawer	Tropical hardwood frame, glazed lid and base c.56×55.5×7cms		In isolation, with specimens			
C. Pre-1950 Butterfly drawer	Tropical hardwood frame, glazed lid and base c.53×46×6.5 cms		In isolation, with specimens			Stacked, with specimens
D. Pre-1950 Hill drawer	Tropical hardwood frame, plywood base, glazed lid c.45.5×45.5×5cms		In isolation, with specimens			Stacked, with specimens
E. 2001 intake moth box	American Lime frame, plywood base, glazed lid, Plastazote lined c.50×39×5.5cms		Racked/stacked, with specimens	Stacked/isolated, no specimens		Stacked, with specimens
F. 1960s intake moth box	Tropical hardwood frame, plywood base, glazed lid, Plastazote lined c.50×39×5.5cms				Racked/stacked/ isolated, no specimens	

or more. Given such past exposure, we regarded a 10% change in relative humidity within our test drawers as a reasonable limit of acceptability over the duration of the treatment cycle. This is at some variance with statements now enshrined in the general conservation literature. For instance the British Standards Institute's *Recommendations for the Storage and Exhibition of Archival Material* (British Standards Institute 2000) suggests a tolerance of ±5% about the fixed point. This figure was exceeded in all but one of our trials.

In each test run, Tinytag Ultra® data loggers (Model TGU-1500) were used to monitor changes in temperature and relative humidity, both within the chamber and within the test drawers. While this model of monitor can be safely subjected to temperatures up to 85°C, its operating maximum is only slightly above 50°C and this will be the recorded figure for all temperatures in excess. This is the reason for the exaggerated plateau on our graphs (Figs. 1–3), where actual chamber temperature, as noted on the chamber's integral monitors, is just beyond that recordable by our Tinytags.

A logger was placed centrally within each test drawer, held in place by Velcro. An additional logger was fixed to the outer surface of one of the test drawers to give a reading independent of the integral loggers incorporated within the chamber. Each run followed the same general pattern—a gradual rise in temperature over a period of six hr, then three hr at the operating maximum core temperature of 52°C, followed by a variable period (dependent upon external conditions) over which temperatures returned to ambient.

Test 1. Initial Test on a Single Drawer

Given that an entomological drawer comprises a relatively well-sealed volume of air, our expectation was that with an increase in temperature, the water bearing capacity of the air within would also increase with a resultant and unacceptable plummet in relative humidity. Traces for the duration of this first test (Ackery et al. 2001), carried out on a 1980s vintage moth box (drawer type A) indicate, not surprisingly, that temperature within the test drawer lagged slightly behind the chamber temperature. The surprise lay in the RH traces (Fig. 1). Instead of the anticipated unacceptable drop within the test drawer, the level rose toward the RH setting of the chamber. It should be noted that for this run the constraints on the chamber were set at 55%, the ambient storage conditions of other non-museum items included in the run, not the drawer. With this encouraging result, we then tested a variety of drawer types employed in the Department.

Test 2. Follow-up Test on a Range of Drawers

Five drawers of differing constructions, each containing specimens, were tested isolated on open shelving to ensure full air circulation. These comprised two type A drawers, one holding small flies and the other large butterflies, so presenting widely differing surface areas, both of specimens and labels; drawers of types B and C containing butterflies on slat strips, each slat a wood/cork 'sandwich'; and a type D drawer which held butterflies in both Plastazote and cork-lined unit trays. During the test run the temperature of these drawers closely followed the temperature in the chamber, as seen in the original Test 1. Individual traces of RH from the isolated drawers remained within the 10% acceptable limit (Table 2, Fig. 2). This was regardless of content and drawer structure.

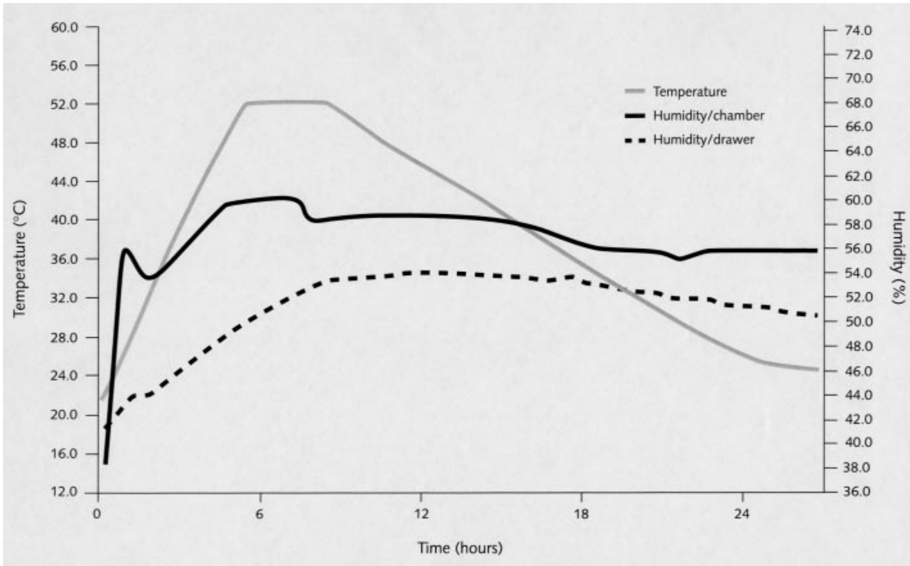

Figure 1. *Test 1*—a single trial drawer within the Thermo Lignum® chamber. Traces for temperature, chamber humidity, and within-drawer humidity.

In addition, two recent intake moth boxes (type E) with added specimens were monitored to test for stacking effects. One moth box was placed centrally in a stack of ten type E drawers. These drawers actually rested upon each other so that the test drawer was effectively sealed against the adjacent drawers. With the glass inset within the lid of each drawer, a layer of air was trapped between each. The other moth box was likewise centrally positioned, one of ten drawers within a rack. These drawers, individually supported by side runners, were held about 5 mm clear of those immediately above and below. The rack itself had a wooden back.

Table 2. Summary of relative humidity by test, test condition and drawer type.

Drawer type	Content	Test	Ambient RH	Maximum RH	Differ-ential	Condition
A	With specimens	1	33%	54%	21%	Isolated
A	With specimens	2	45%	52%	7%	Isolated
A	With specimens	2	45%	52%	7%	Isolated
B	With specimens	2	45%	53%	8%	Isolated
C	With specimens	2	45%	54%	9%	Isolated
D	With specimens	2	45%	47%	2%	Isolated
E	With specimens	2	45%	60%	15%	Racked, 0.5cm gap
E	With specimens	2	45%	70%	25%	Stacked
E	Empty	3	44%	54%	10%	Isolated
E	Empty	3	44%	69%	25%	Stacked
F	Empty	4	46%	54%	8%	Isolated
F	Empty	4	46%	54%	8%	Racked, 0.5cm gap
F	Empty	4	46%	54%	8%	Stacked
C	With specimens	5	33%	57%	24%	Stacked
D	With specimens	5	33%	47%	14%	Stacked
E	With specimens	5	33%	66%	33%	Stacked

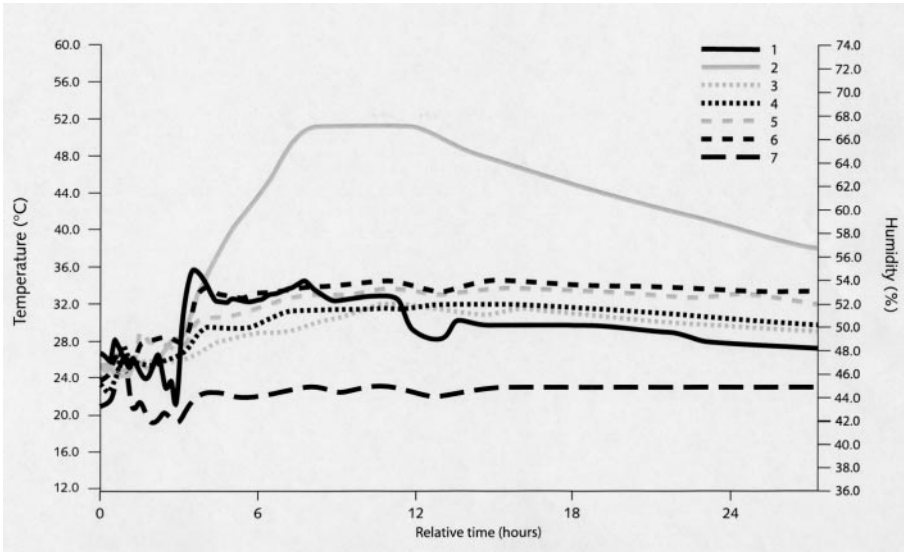

Figure 2. *Test 2*—chamber temperature and individual traces for relative humidity within isolated drawers. 1, chamber RH; 2, chamber temperature; 3, isolated drawer A RH; 4, isolated drawer A RH; 5, isolated drawer B RH; 6, isolated drawer C RH; 7, isolated drawer D RH.

The drawers stacked and racked showed a significant lag, both in heating and cooling, no doubt due to the buffering effects of surrounding materials, although the overall time at maximum temperature was hardly changed. Traces from the examples in the rack and stack exhibited startling departures from the departmental ambient RH of 45% (Table 2, Fig. 3). Relative humidity within the racked drawer rose initially to 60% and then fell back to 45%. The result for the stacked drawer was even more marked, initially approaching 70% before falling back to 45%. This raised several questions that were addressed in subsequent tests.

Additional Questions and Tests

Tests 3 and 5 also included recent intake drawers (Table 1). As these drawers perhaps had not stabilised to departmental conditions, we surmised that water content could be an issue. However, Test 5 also clearly demonstrated comparable stacking effect in a vintage drawer—a Butterfly Drawer (type C—maximum RH ca. 57% compared to the departmental ambient of 33%). The rise in RH in other tested drawer types, again monitored in stacked situations, was rather less dramatic and in one instance, a 1960s vintage moth box (Type F, Test 4), it did not exceed 10%.

Whatever the drawer type and vintage, regardless of presence or absence of specimens, if treated in isolation, variation in RH remained within our chosen acceptable limits. To address just what constitutes 'isolation,' we monitored additionally 10 empty Type E moth boxes, in two stacks. Individual drawers of the first stack of five were held apart by 2 cm batons. The rise in RH for the central three drawers strayed just beyond 10%, reaching a maximum of 12% (the top drawer, fully exposed on its upper surface registered a 7.3% rise in RH; the bottom drawer, on an impermeable base, a 17% rise in RH). Results from drawers in the second stack held at varying distances apart (bottom drawer on a permeable base

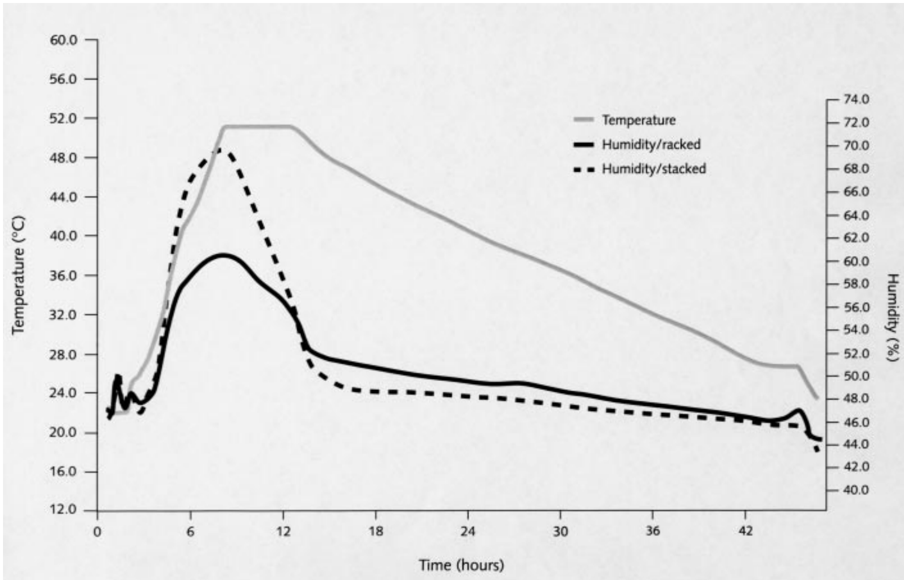

Figure 3. *Test 2*—chamber temperature and relative humidity within stacked and racked drawers indicating RH straying well beyond an acceptable 10% increase.

and then progressively 2.6, 4.2, 5.5, and 6.9 cm apart) were ambiguous, not suggestive of a simple linear relationship between distance apart and rise in RH, although for each drawer the rise in RH approached our acceptable 10% change (minimum change 8.3%; maximum change 10.4%).

Discussion and Conclusions

Whenever a drawer was treated in isolation, the chamber maintained relative humidity inside the test drawer within a 10% change. When drawers were stacked, results were less clear. The observed rapid rise in RH during the initial stage of the treatment could be due to water being released from the drawer matrix. Insulation under stacked conditions then tends to delay the return of RH to the set chamber conditions if the drawers are well sealed (Strang 2001). There are perhaps three possible and related reasons for such stacking effects not being universally observed, each associated with the multiplicity of drawer designs involved in the tests. The constraints set upon the chamber were generic, based upon ambient RH in the Department at the time of the test rather than water content of the various types of individual drawer tested. Also the structure of the drawers themselves ensure that some will have far more water-bearing fabric than others—a butterfly drawer is predominantly glass while other drawers have wooden or impermeable bases lined with cork, moll, or Plastazote. In addition, the various internal volumes of the drawers themselves will interact with the water-bearing properties of their fabric. Whatever problems might be inherent in generic chamber settings and various drawer structures, it seems that treating in isolation, say 4–5 cm apart, will allow sufficient air circulation for the controlled conditions of the chamber to be imposed upon the micro-environment within the closed drawers. This is similar in principle to the 'rule of thumb' proposed by Strang (2001) for heat treatment of herbarium specimens: ''specimens. . . . can be safely stacked to a thickness of a centimetre between modified herbarium press cardboard.''

The effects of heat treatment on specimens—verdigris, grease, DNA—are addressed elsewhere (Ackery et al. 2004). Our results with respect to RH variation within largely sealed entomological drawers, would suggest that in-bulk treatment of insect collections, using the Thermo Lignum® method, is feasible. We would not anticipate detrimental drying-out of materials as long as there is free air circulation around the drawers. A 5 cm gap appears optimum, and to achieve this drawers would need to be held for treatment within permeable and adaptable cage-like containers. A system of fans, preferably integral within the chamber, would no doubt have significant benefits in ensuring more rapid air circulation. Other practical issues should also be assessed: cost in relation to the known extent of the problem; logistics within the sort of fixed time-scale that we are considering; treatment capacity in relation to the 130,000 drawers that make up the collection; and turn-around time and the accessibility of such a facility.

Acknowledgments

We are especially grateful for the interest and enthusiasm of all those who participated in our workshop on the Thermo Lignum® process in October, 2001, thanking particularly Tom Strang (Canadian Conservation Institute) for his insights. In addition, we are indebted to Paul Leary (Thermo Lignum®, UK), Steve McInerny, Kim Goodger, and Jim Reynolds (The Natural History Museum, London) for practical and logistic help, and Chris Michael (Meaco, UK) for supporting our work through the generous loan of loggers.

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Associate Editor: Susan M. Woodward

MULTIPLE INTERACTING FACTORS AFFECT pH IN MUSEUM STORAGE SOLUTIONS

Chad W. Hargrave, Katherine G. Sutherland, Edie Marsh-Matthews, and William J. Matthews

Sam Noble Oklahoma Museum of Natural History and Department of Zoology, University of Oklahoma, Norman, Oklahoma 73072, USA

Abstract.—Maintaining a stable storage solution environment within desirable limits is an important goal for long-term specimen conservation in archival collections. In a 70-day study, we tested the effects of label type, presence of formalin-fixed fish specimens, and source of water (tap water vs. distilled water) used to mix alcohol solutions on the pH of 50% isopropanol and 70% ethanol solutions in standard museum jars. In treatments without formalin-fixed specimens, Resistall label paper reduced storage solution pH more than non-Resistall cotton label paper, thermal printed labels, and no label controls, but, unexpectedly, the differences among label types were absent when formalin-fixed fish specimens were included in the jar. The initial pH of the storage solution (determined largely by water source and alcohol type) was an important factor that strongly influenced the final pH of the solution. We suggest that interactions among factors can influence solution pH and should be considered when designing storage protocols for fluid collections. Although our results are likely unique to our tap water source, the results strongly suggest that collections that use tap water to make up solutions for archival storage should evaluate the chemical conditions of their tap water source and, if necessary, use an appropriate water purification system to alleviate unfavorable storage fluid conditions.

Introduction

Long-term quality of fluid-preserved specimens is a function of multiple factors such as effectiveness of initial specimen fixation, and alcohol concentration and pH of storage solutions (Simmons 2002). Rapid and thorough fixation prevents protein autolysis, coagulates cell contents, and sterilizes specimens (Simmons 1995, Stoddard 1989). This increases specimen firmness and maintains body shape, which is important for morphological studies. Proper alcohol concentration of the storage solution prevents specimen dehydration and microbial activity, enhancing specimen longevity. The pH of storage solutions is important because acidic conditions below about pH of 6.4 cause decalcification of bony structures (Dingerkus 1982, Jones and Owen 1987, Quay 1974, Simmons 1991, 2002, Smith 1965, Zweifel 1996), and alkaline conditions substantially above a pH of 7.0 cause clearing of soft tissues and proteins (Dingerkus 1982, Stoddard 1989, Taylor 1977). Both conditions limit usefulness of specimens as research tools. Thus, maintaining a stable storage solution environment within desirable pH limits is of major concern for long-term specimen conservation in archival fluid collections and increases the probability that specimens will be of sufficient quality for addressing museum-based research questions.

In fluid collections, specimens are submerged in the storage solution (typically ethanol or isopropanol) within sealed jars, which creates an independent environment that is influenced by the initial fluid condition, by chemical or microbial processes occurring within the jar, and by external conditions such as light, temperature, and humidity (Cannell et al. 1988, Phillips 1988, Simmons 1991, 2002, Smith 1965, Taylor 1977). Therefore, storage solution preparation, as well as

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characteristics of items placed within the solution, have the potential to change the fluid chemistry and affect long-term specimen quality (Duckworth et al. 1993, Rose 1991, Simmons 1991). For example, storage solution pH can decrease due to oxidation of residual formalin leaching from the fixed specimens despite prior water or alcohol washes (Laframboise et al. 1993, Simmons and Waller 1994, Simmons 1995, Andrei and Genoways 1999, Van Guelpen 1999, Waller and Simmons 2003) when specimens are fixed in acidic formalin (Quay 1974) prior to placement in the long-term storage solution (Ford and Simmons 1997, Simmons 2002). Additionally, printed labels or tags that are immersed in the storage solution along with the specimens can affect solution chemistry and potentially cause specimen deterioration (Hawks and Williams 1986, Kishinami 1989). For example, Andrei and Genoways (1999) showed that Byron Weston Resistall paper lowered pH of 70% ethanol solutions mixed with distilled water in jars without specimens. The acidifying effects described above could negatively affect calcified structures of specimens, and should be considered for long-term specimen conservation.

The purpose of this experiment was to investigate the effects of label type, source of water used to mix storage fluids, and presence of formalin-fixed specimens on pH of 70% ethanol and 50% isopropanol solutions. Additionally, we were interested in the interactions among these factors. We tested three label types that are commonly used in archival fluid collections: 100% cotton Byron Weston Resistall paper, 100% cotton Byron Weston Ledger (non-Resistall) paper, and synthetic spunbonded polyethylene labels for thermal printers. The effects of these label types on storage fluid pH have not been evaluated, nor have their interactions with other confounding factors such as presence of formalin-fixed specimens or different storage fluids. Formalin-fixed specimens may introduce residual formalin, proteins, and lipids into the storage solutions that may interact with label effects (Waller and Simmons 2003). Thus, we included a treatment to examine effects of formalin-fixed specimens on solution pH. We used two types of water to mix storage solutions (tap water and distilled water) because different waters may interact with label effects by introducing an array of ions or impurities to the storage solution (Waller and Simmons 2003). We addressed the effects of these factors on pH in ethanol and isopropanol solutions because both fluids are used in archival fluid collections.

Materials and Methods

We tested the effects of label paper type, water used to mix alcohol solutions, and presence of formalin-fixed specimens (fish) on pH of 70% ethanol (ETOH) and 50% isopropanol (ISOH) using a completely crossed 4 factorial design (levels per treatment: $4 \times 2 \times 2 \times 2$) with 5 replicates per treatment. Treatments were randomly assigned to one of 160 jars. Jars were 250 ml (standard 8-oz jar) flint glass with threaded plastic lids and polyethylene foam liners. The experiment was conducted in the fish archival storage room at the Sam Noble Oklahoma Museum of Natural History (SNOMNH), University of Oklahoma, from 23 September–2 December 2002. The room is kept dark and maintained at 70°C and 54% relative humidity; lights are protected with UV filters.

Treatments.—We used 3 label types: 28# Byron Weston 100% cotton paper (non-Resistall); Byron Weston 28# Resistall paper (Resistall); and DataMax thermally printed synthetic label (Thermal). The control contained no label. Paper labels were printed using a Hewlett Packard Laser Jet 2100 TN printer and synthetic labels were printed with a DataMax Class I thermal printer. All labels were printed with an identical amount of information and cut to 10 cm wide by 7.5 cm high. For the water treatment, we mixed storage solutions with tap water from SNOMNH and purchased commercially available, bottled distilled water. The SNOMNH tap water was from the municipal water source treated by the City of Norman Water Treatment Plant and had the following chemical properties averaged over a two mo period (September–October 2002): pH (9.08 ± 1.12 SD); total alkalinity (82.86 ± 6.35 mg/l); total hardness (98.67 ± 8.43 mg/l); total calcium hardness (42.63 ± 4.03); total magnesium hardness (55.75 ± 6.17 mg/l); chloride (26.79 ± 0.70 mg/l), and chlorine residual (3.01 ± 0.14 mg/l). Water was mixed with 95% ethanol or 100% isopropanol to produce final concentrations of 70% ethanol and 50% isopropanol for both water types, determined by mixing solutions in a 1000 ml graduated cylinder. Water treatments and alcohol treatments were randomly assigned within each level of label treatment. For the fish treatment, fish were added to randomly selected jars at a density of 14 g/jar and alcohol level was identical among all jars. Thus, fishless jars had 240 ml of alcohol solution and jars with fish had 230 ml of solution. About 4% of the solution volume was replaced by formalin-fixed fish specimens. Because the ratio of specimens to fluid volume can significantly impact fluid chemistry (Waller and Simmons 2003), we chose 4% fish volume, which is well below the average 30% found in the SNOMNH, for a conservative estimate of the effects of formalin-fixed specimens on storage solution quality. Additionally, we decreased solution volume in fish treatments rather than keeping fluid volume constant to simulate actual museum practices, which usually involve fully filling jars with solution after specimens are added. The fish (*Gambusia affinis*) were collected from a pond near the University of Oklahoma campus using a seine and preserved in 10% unbuffered formalin. Formalin was mixed in the field at an approximate concentration of 10% formalin using pond water from the collection site. This method for mixing formalin is often the method used by ichthyologists. Fish were kept in formalin for 72 h, brought to the museum, and washed in a series of three water changes (one change every 24 h) with fresh tap water. Individual fish were small and similar in size. Individual fish weight averaged 2.2 g ± 0.17 SD and varied from 0.01 to 1.23 g.

The storage solution pH was monitored with a digital Corning pH meter (model pH-10) purchased from Fisher Scientific. The pH of the solutions was measured prior to addition of label and fish treatments (day 0) and on days 1–6, 10, 21, and 70 when values appeared to have stabilized. The pH meter probe was washed in 2 consecutive washes using distilled water after each measurement, and recalibrated with pH 7 (potassium phosphate monobasic and sodium hydroxide) and pH 4 (potassium biphthalate) standard buffer solutions, purchased from Fisher Scientific, after every 10 measurements.

We used a repeated measures ANOVA with sample time as the repeated measure to test for changes in pH over time, and to test for differences and interactions in pH among the four treatments. Separate four-way ANOVAs and independent contrasts were used to examine difference in pH among treatments at each sample

Table 1. Repeated measures ANOVA table showing degrees of freedom (df), *F* statistic, and *P* value for differences in pH of storage fluids due to treatment type, interaction between treatments, and interaction between treatments and time.

Source of variation	df	*F*-statistic	*P*-value
Between treatment effects			
Label type	3, 141	138.13	<0.0001
Fish presence	1, 141	583.05	<0.0001
Water type	1, 141	2414.02	<0.0001
Alcohol type	1, 141	33.68	<0.0001
Label × fish	3, 141	92.41	<0.0001
Label × water	3, 141	16.74	<0.0001
Label × alcohol	3, 141	0.95	0.4178
Fish × water	1, 141	362.43	<0.0001
Fish × alcohol	1, 141	16.01	0.0001
Water × alcohol	1, 141	18.87	<0.0001
Within treatment effects			
Time	9, 1269	467.77	<0.0001
Time × label	27, 1269	13.24	<0.0001
Time × fish	9, 1269	98.24	<0.0001
Time × water	9, 1269	107.84	<0.0001
Time × alcohol	9, 1269	7.93	<0.0001

time. All statistical calculations were performed using SAS (2000). Significance was declared at an alpha level of $\alpha = 0.05$.

Results

The pH of tap water and distilled water used to mix alcohol solutions on day 0 (23 September 2002) averaged 9.00 (±0.02 SD) and 7.00 (±0.01), respectively. The pH of alcohol solutions prior to addition of fish or label treatments (day 0) averaged 10.00 (±0.01) and 10.28 (±0.01) for 50% ISOH and 70% ETOH solutions, respectively, when mixed with tap water. The pH of the alcohol solutions was lower when mixed with distilled water (7.78 ± 0.01 and 8.26 ± 0.02 for ISOH and ETOH, respectively). Solution pH differed significantly for all treatments, and all but one among-treatment interactions were significant in the repeated measures ANOVA (Table 1). Solution pH changed significantly with time but tended to level-out as indicated by significant time by treatment interactions (Table 1).

Treatment differences and among-treatment interactions in the separate four-way ANOVAs at each sample day were similar to the overall repeated measures ANOVA (Table 2). On average, ETOH solutions had a higher pH than ISOH, and both alcohol solutions when fish were absent were more alkaline when mixed with tap water than when mixed with distilled water (Fig. 1). The presence of fish lowered pH to near 7.0 for solutions mixed with distilled water vs. 8.0 for solution mixed with tap water (Fig. 1). Further, the pH of the solutions was significantly different among several label types in treatments without formalin-fixed fish specimens, whereas, when fish were present, the pH of solutions did not differ significantly among label types (Table 2). In the absence of fish, Resistall had the greatest acidifying effect on pH regardless of water source and

Table 2. Significance levels for main treatment and two-way interaction effects on pH of storage fluids from separate four-way ANOVAs at each sample time followed by independent contrasts from each four-way ANOVA showing significant levels among different label types in treatments with and without fish (No = no label; non- = non-Resistall cotton label).

Source of variation	Sample day 0	1	2	3	4	5	6	10	21	70
Label type	ns	***	***	***	***	***	***	***	***	***
Fish presence	ns	***	***	***	***	***	***	***	***	***
Water type	***	***	***	***	***	***	***	***	***	***
Alcohol type	***	***	ns	***	***	*	ns	***	**	**
Label × fish	ns	***	***	***	***	***	***	***	***	***
Label × water	ns	*	ns	***	**	***	***	***	***	***
Label × alcohol	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Fish × water	ns	***	***	***	***	***	***	***	***	***
Fish × alcohol	ns	ns	**	ns	*	***	***	***	***	***
Water × alcohol	***	ns	*	ns	**	**	*	***	***	**
Contrasts between labels for jars without fish										
No vs. non-Resistall	ns	*	*	ns	**	*	*	**	*	**
No vs. thermal	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
No vs. Resistall	ns	***	***	***	***	***	***	***	***	***
non- vs. thermal	ns	ns	ns	ns	**	*	*	**	ns	*
non- vs. Resistall	ns	***	***	***	***	***	***	***	***	***
Thermal vs. Resistall	ns	***	***	***	***	***	***	***	***	***
Contrasts between labels for jars with fish										
No vs. non-Resistall	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
No vs. thermal	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
No vs. Resistall	ns	**	ns	ns	ns	ns	ns	ns	ns	ns
non- vs. thermal	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
non- vs. Resistall	ns	**	ns	ns	ns	ns	ns	ns	ns	ns
Thermal vs. Resistall	ns	**	ns	ns	ns	ns	ns	ns	ns	ns

ns, significance at $P > 0.05$; *, significance at $P \leq 0.05$; **, significance at $P \leq 0.01$; ***, significance at $P \leq 0.001$.

alcohol type, non-Resistall labels had a slight acidifying effect, and thermal label and control treatments had similar and slightly greater solution pH (Fig. 1). Effects of label type on solution pH varied with solution type. For example, in solutions mixed with distilled water and with no fish present, Resistall labels decreased pH substantially below 7.0, but Resistall labels reduced pH in solutions mixed with tap water and without fish to only about 8.5 (Fig. 1).

Discussion

Resistall paper had the greatest single acidifying effect on storage fluid pH regardless of alcohol type or water source. Non-Resistall labels also reduced fluid pH but this decrease in pH was small compared to the effects of Resistall labels. The pH of solutions with thermally printed labels did not differ significantly from control treatments. Although label type affected pH, the change in pH existed only in the absence of fish specimens.

The type of alcohol and source of water used to mix the solution influenced the initial pH of the solution, which affected the final pH of the storage fluids across all label treatments. For example, final pH of solutions was more alkaline

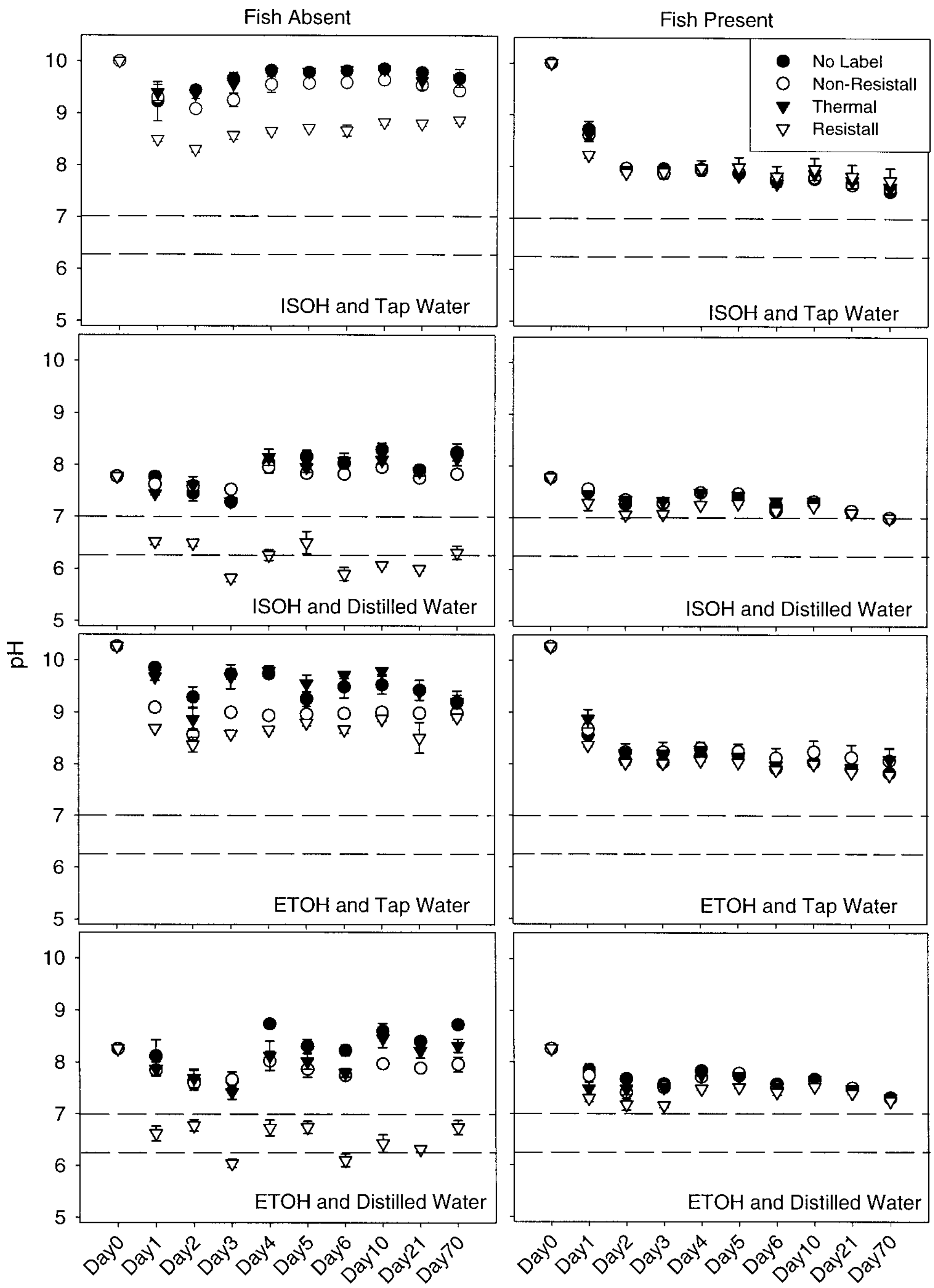

Figure 1. Changes in pH of 50% isopropanol (ISOH) and 70% ethanol (ETOH) solutions mixed with tap water and distilled water containing no label (filled circle), non-Resistall cotton paper label (open circle), synthetic thermally printed label (filled triangle), or Resistall paper label (open triangle), for treatments with and without formalin-fixed fish specimens, over a 70-day period. Error bars represent one standard error, and dashed lines indicate upper and lower desirable pH limits of 7.0 and 6.4.

for solutions with higher initial pH and was more acidic in solutions with lower initial pH. The tap water at SNOMNH caused higher solution pH because of impurities in this water source relative to distilled water. The pH of solutions mixed with tap water were above the acceptable upper limit of 7.0, and, therefore, tissue clearing would be likely under these fluid conditions. Although the final pH was influenced by the initial pH of the solution, the proportional response in pH to label type was similar across all treatments without formalin-fixed specimens. For example, Resistall labels lowered pH of all types of storage fluids in the absence of fish, and this decrease was lower in solutions mixed with distilled water (lower initial pH) than in solutions mixed with tap water (high initial pH). This illustrates the importance of testing initial storage solution conditions and understanding how mixing protocols might affect these initial solution properties. For example, the long-term quality of archived specimens could be at risk if tap water with chemical properties similar to those used in this study was used to mix alcohol solutions.

The presence of formalin-fixed fish specimens lowered the pH in all treatments except those with Resistall labels, which could have resulted from leaching residual formalin, or acidic proteins and lipids from the specimens into the storage solution (Waller and Simmons 2003). The fish treatment interacted with water source, resulting in slightly greater pH when the alcohol was mixed with tap water than when mixed with distilled water. Further, the presence of fish interacted with the acidifying effects of labels on storage fluids, challenging the results of studies conducted in the absence of specimens (e.g., Andrei and Genoways 1999). Fish specimens apparently ameliorated the effects of Resistall label paper on solution pH. In solutions without fish, Resistall labels reduced storage fluid pH to 6.4 and below. However, when fish were present, pH was identical among all label treatments with the lowest pH values near 7.0. In this study, the effects of Resistall paper on fluids without specimens were very similar to the results described by Andrei and Genoways (1999), who did not include specimens when examining effects of Resistall paper. However, the effect of Resistall labels on fluid pH changed when fish were added. This warrants caution when interpreting or implementing results from experiments limited to a single condition because we have shown that multiple factors can interact under varying contexts to change the magnitude and direction of an effect on fluid pH.

Our study showed that interactions among factors can result in unexpected changes in storage solution quality. In general, alcohol solutions tended to be slightly more alkaline with ETOH than ISOH. The presence of formalin-fixed specimens reduced pH of alcohol mixed with distilled water to levels approaching the uppermost desirable limit (7.0), however, pH remained high (about 8.0) when tap water (specific to SNOMNH) was used to mix the storage fluid. Consequently, the source of water used to mix the storage fluids can affect pH. Museums should be aware of tap water chemistry, and water purification systems should be used to treat tap water for mixing storage solutions if the chemical properties of that water source result in unsuitable initial storage fluid conditions. In terms of pH, label type may not be as important as previously suspected (Hawks and Williams 1986, Kishinami 1989, Andrei and Genoways 1999) in affecting long-term specimen quality due to the presence of formalin-fixed specimens, which apparently alleviate effects of labels on solution pH. Thus, understanding how factors that may affect storage fluid quality interact is requisite to maintaining high quality in archived specimens. To promote long-term specimen quality, museums should measure fluid conditions prior to adding specimens or labels, periodically monitor storage fluids, and understand potential interactions among fluid conditions. Implementing a thoughtful and well designed preventative protocol and monitoring regime is the best approach in assuring that desirable conditions are maintained in archival fluids collections. Because many additional factors (not varied in this study) such as storage solution concentration, container volume, and ratio of specimen to storage solution volume can significantly affect fluid chemistry (Waller and Simmons 2003), additional studies are needed that tease apart the potential interacting effects of these potentially other important parameters.

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Associate Editor: Cindy Ramotnik

POLICY THEORY AND APPLICATION FOR MUSEUMS

Stephen L. Williams

Department of Museum Studies, Baylor University, Waco, Texas 76798, USA

Abstract.—The museum community is inundated with literature about organizational policies, yet there are few examples of policies being successfully implemented within a given organization. Recognized reasons for this include inappropriate concern, inappropriate process, inappropriate product, or any combination of these reasons. To address the issue, basic concepts of policy theory are applied to policy development and implementation. Policy development involves a foundation stage, a strategic planning stage, and a conceptualization stage for individual policies. The conceptualization stage can be the most challenging part of policy development because it requires careful consideration of policy purpose and policy objectives. Policy implementation requires that the policy document be holistically administered by the organizational leadership, and be understood, familiar, and supported by the organizational membership.

Introduction

A study of policies in the museum literature reveals varying levels of usefulness. While Malaro (1979, 1985, 1994, 1995, 1998) has been a primary promoter of policies in museums, the topic has been perpetuated by many others (Cato and Williams 1993, 1998, Hoagland 1994, McGuire et al. 1993, Northeast Document Center 1994, Porter 1985, Simmons 1991, Williams 1999, Yang 1989). To add to this volume of information, others have addressed specific policies, such as those for conservation (Keene 1996), deaccessioning (Malaro 1988), personnel (Miller 1980), pest control (Edwards et al. 1981, Zycherman and Schrock 1988), repatriation (AAM 1988), safety (Bharier 1987, Holt 1987), sampling (Cato 1993, Cato and Schmidly 1991), and others. In spite of the volume of policy literature, and the dependency on policy for successful organizational operations, it is interesting that policies are not more effectively incorporated into museum management. This is evident because the lack of functional policies leads to mismanagement (Kittleman 1976). Because of this the use of written policies is strongly encouraged through processes such as organizational accreditation (AAM-IMS 1992).

While the museum community has been struggling with policy development and implementation, fields such as policy administration and policy sciences have expanded policy theory and application well beyond the limits familiar to most people in the museum community (Bullock et al. 1983, Goehlert and Martin 1985, Lynn and Gould 1980, Mayer and Greenwood 1980, Murin et al. 1981, Robey 1984a, 1984b). To address this situation, this contribution evaluates common problems of museum policies, and demonstrates how simple approaches based on policy theory can provide more functional policies for most museums.

Policy is defined as ''any plan or course of action adopted by a government, political party, business organization, or the like, designed to influence and determine decisions, actions, or other matters'' (Morris 1978). Because policies (particularly written policies) are relevant only when other individuals are involved, it is easy to understand that *the primary purpose of policy is to manage people.* Good policies provide desirable management to all individuals of an organization,

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regardless of their hierarchical position in the organization. Such management in turn provides a valuable structure for an organization in achieving its mission and goals. For organizational leadership, policy provides direction, defines objectives, and develops consistency with day-to-day operations. It also establishes organizational expectations, thus promoting predictable results among staff members (Cato and Williams 1993, 1998, Porter 1985). While the primary and secondary purposes of policy are obviously critical to successful organizational function, there also are tertiary purposes of policy that cannot be ignored. Depending on the organizational structure, these purposes may vary. However, for most museums tertiary purposes include litigation protection (Malaro 1979, Porter 1985), community image building (Lasswell 1971, Malaro 1995), and accreditation requirements (AAM-IMS 1992).

As important as policy can be to an organization it is interesting that it often is ineffective, particularly in museums. It is proposed that this ineffectiveness often can be attributed to (1) *inappropriate concern,* (2) *inappropriate process,* (3) *inappropriate product,* or (4) any combination of these factors.

The extreme case of *inappropriate concern* involves the total absence of policy. However, it may be more common for policies to exist but not be written. In other cases written policies may exist, but they are not implemented or enforced. In these situations, it is common for policies to be applied sporadically and inconsistently, sometimes opportunistically applying the ‘‘P-word’’ verbally when the written policy itself does not exist. In these situations, organizational leadership often has not experienced the benefits of good policy application, thus any concern for policy is replaced with alternative methods of operation.

Even when good policies support the mission and goals of an organization it is possible for policies to suffer as a result of one or more *inappropriate processes.* For instance, problems may occur if unilateral policy development takes place without input from those that are expected to implement policy. Also, problems may occur if parties lacking authority are solely responsible for policy development. Desirable policy development includes feedback from all parties involved (Cato and Williams 1998, Dietrich et al. 1997, Malaro 1998). However, there are other processes that are sometimes used that may affect policy effectiveness. Ad hoc policy development is commonly applied as a spontaneous or reactive response to a problem. New policies are developed as problems arise, and this is done often without reviewing existing policies to determine if there is duplication or conflict. Another inappropriate process occurs when an organization incorporates existing policies of a sister-organization as if it were its own. This process often reflects crisis management as the organization suddenly needs written policies to pursue opportunities such as accreditation or grant funding.

Even though the concern and process may be appropriate for effective policy development and implementation, an *inappropriate product* can negate the effort. An example is an excessively large policy manual that would challenge anyone’s ability to fully comprehend and comply with policy intent. Such length is common in situations where written policies ramble without clear objectives, or where policies and procedures are combined. However, even policies of reasonable length can be difficult to implement if the product lacks clarity, is outdated, or is not readily available to all people. Similarly, a product that has gaps, redundancies, and conflicts can be difficult to use. For instance, accreditation requirements for organizational policies specifically regarding Native Americans (AAM 1988), can be inappropriate if the objective is achieved with broader organizational policies that address respect and sensitivity for *all* cultures and compliance with *all* governmental regulations. However, the most common inappropriate product is the single, outdated, ''Policy and Procedure Manual'' that is stored in a secluded location for future prosperity, such that staff, volunteers, and job applicants have little knowledge of organizational objectives.

While there may be other reasons for policies to fail, the result of policy failure is that policy development often is perceived as difficult, and policy implementation often is avoided, poorly addressed, or misdirected. Ultimately, the objectives intended with the policies are not achieved, and this directly impacts organizational mission and goals. At this point it is appropriate to recognize the more fundamental problems involving effective policy development and implementation. Although some resources are available that should address these problems (Cato and Williams 1993, Hoagland 1994, Malaro 1995, 1998, Porter 1985), it is clear that (1) basic policy theory itself is poorly understood, (2) specific methods for policy development are not readily available, and (3) strategies for policy implementation are not fully exploited. As a result, very few museum workers have experienced or appreciated the benefits that come from working with good policies.

Policy Theory

As previously discussed, the fundamental purpose of policy is simply to manage people in effectively pursuing organizational mission and goals. This means that all policies (for example, personnel policy, health and safety policy, and public relations policy) should exist for the purpose of pursuing organizational mission and goals. Because organizational working parameters are defined by the governance and leadership (Cato and Williams 1998, Lord and Lord 1997, Malaro 1994, Ullberg and Ullberg 1981), it stands to reason that the same parties must have the authority and responsibility to define the strategies, in terms of policies, to successfully achieve the organization's mission. If the mission and goals of an organization rarely change under normal conditions, then the supporting policies would be equally stable (Porter 1985, Williams 1999). In fact, such changes would occur only at the discretion of the governance and leadership of the organization when the policies no longer support the mission and goals of the organization.

Assuming that policies are implemented and enforced to serve the needs of an organization, it is understood that the policies apply to everyone in the organization. Therefore, it is critical for all individuals to understand, support, and comply with organizational policies. This is facilitated by recognizing that desirable qualities for policies include brevity, simplicity, clarity (e.g., understanding compliance vs. non-compliance), comprehensiveness, flexibility, and availability (Cato and Williams 1998, Porter 1985, Williams 1999). Ideally, policy would be a regularly updated written document with minimal redundancies, inconsistencies, and omissions. To expeditiously incorporate these qualities in the full set of organizational policies, policy-making should be approached holistically, seeking feedback from all parties concerned (Cato and Williams 1998, Dietrich et al. 1997, Malaro 1998). Finally, the authority responsible for policy development must be able and willing to enforce policy in all cases of non-compliance.

While policy theory is dependent on special process and the authority of the organizational governance and leadership, any organizational structure (e.g., social, political, national) is dependent on responsible constituents to fulfill the objectives defined by the policies. Such fulfillment is achieved by the existence of supporting procedures, often developed by the same constituents (Cato and Williams 1998). If the procedures prove ineffective, they must be revised immediately and as often as necessary to ensure policy objectives are fulfilled in a timely manner. Policy and procedures must not be intermingled. Policies state the objectives that are developed by organizational governance and leadership; procedures are the method of fulfilling the objectives. Mixing policy and procedures undercuts the working mechanisms supporting policies and procedures (Cato and Williams 1998, Lord and Lord 1997, Mosher 1982, Williams 1999). When policy and procedures are intermingled, changing the simplest of procedures requires the authorization of the organizational governance and leadership. Changes requiring the governance and leadership approval should be restricted to policies, and not procedures.

Policy Development

Policy development can be broadly divided into three progressive stages: (1) foundation stage, (2) strategic planning stage, and (3) conceptualization stage. The foundation stage establishes the functional framework for all organizational policies; the strategic planning stage anticipates effective implementation of individual policies; and the conceptualization stage incorporates specific components needed for individual policies.

Foundation Stage

This stage establishes the foundation to implement and enforce organizational policies. Because it incorporates the framework and perspectives of the broadest organizational operations, it accommodates the creation and application of policies within the organization. Effective implementation of policies becomes difficult without this stage.

The foundation stage begins with a section for the *statement of organizational purpose* (Fig. 1A). This may be the same as the mission and goals of the organization. However, it is appropriate for the organization's purpose also to recognize the services provided and the clients served (Hoagland 1994, Malaro 1998, Porter 1985).

Next is the *statement of scope* (Fig. 1B). This recognizes the organizational authority and structure (for example, director and board), and explains policy compliance expectations. This section also may include critical information such as definitions for understanding subsequent policies (Hoagland 1994, Malaro 1998, Porter 1985).

The third section addresses *general operational policies* (Fig. 1C). For example, general compliance with governmental law and regulations is a standard expectation. Other useful operational policies set the working parameters of organizational meetings (e.g., agendas, schedules, participation) and committees (e.g., chair position, structure, function, and operation). Similarly, other statements of general compliance with organizational bylaws and code of ethics may be included. The topic of ethics deserves special mention. Although ethics have been

A. Statement of Institutional / Organizational Purpose.
   Mission and goals.
   Clients and services.

B. Scope Statements.
   Institutional / organizational authority and structure.
   Policy compliance.
   Definitions.

C. General Operational Policies.
   Compliance with laws and regulations.
   Institutional / organizational meetings.
   Committee structures and operations.
   Compliance with code of ethics.

D. Personnel.

E. Fiscal.

F. Pest Management.

G. Health and Safety.

H. Emergency Management.

I. Acquisitions.

J. Collections.
   Access.
   Loan.
   Sampling.
   Treatment.
   Documentation.
   Preventive Conservation.
   Deaccessioning.
   Disposal.
   Etc.

K. Etc.

Figure 1. Example of a organizational policy outline, showing foundation development (A–C) and hierarchical placement of policies (D–K).

directly linked with policies (Cato and Williams 1993, Fletcher 2000, Hoagland 1994, Porter 1985), ethics differ in that conceptually they are not enforceable (Nicholson and Williams 2003); however, policies that advocate ethics are enforceable.

Strategic Planning Stage

The first step in strategic planning is recognizing the appropriate location of given policies relative to the entire organizational policy document. All too often important institutional policies are buried within some subsections when their application is needed at a higher level within organizational operations. For example, policies related to *personnel* (Fig. 1D), *finances* (Fig. 1E), *pest management* (Fig. 1F), *health and safety* (Fig. 1G), and *emergency management* (Fig. 1H) should not appear under ''collections policies'' because they must be applied throughout the organization if they are to be effective. It is not logical for collections personnel to be managing pest problems if other areas, such as gift shops and dining areas, are not managing pest problems as well. Similarly, health and safety and emergency management policies also must be applied throughout the organization to be effective.

It might seem logical to place *acquisitions* policy as part of collection policies (Cato and Williams 1993, Hoagland 1994, Malaro 1998, Porter 1985), but frequently items are transferred or donated to an organization without involving any aspect of the collections. In such situations a policy specific to collections does not allow the organization to control acquisitions. This can result in failure to respond in an appropriate manner, such as obtaining clear title or acknowledging donors. Because control of acquisitions is important to the organization, it is appropriate that acquisitions policy be placed at a higher level within organizational policies (Fig. 1I). A good acquisitions policy is very important to an organization, and it should not be confused with a policy for accessioning that occasionally appears in the literature (Hoagland 1994:13). Acquisition policy achieves control of acquisitions, whereas accessioning may be only a procedure that supports a more comprehensive registration policy of the organization. A good acquisitions policy can accommodate the accessioning procedures of an organization, whereas the reverse may not be true.

Reassigning critical policy components from their traditional arrangements may involve some dramatic changes that greatly improve organizational operations. For example, strategic planning of policies would make traditional approaches for collections somewhat obsolete. Instead, some policies that serve collections would occur outside of collections policies, and new collections policies (Fig. 1J) would be restricted primarily to access, loans, sampling, treatment, documentation, preventive conservation, deaccessioning, and disposal (Cato and Williams 1993, Hoagland 1994). These changes reflect a different organization of policies to improve functionality for the benefit of the organization, and the benefit of the collections as well.

Conceptualization Stage

The previously discussed stages are relatively easy to achieve. The individual policy conceptualization stage is more challenging, particularly when the qualities of good policies mentioned above are incorporated. The following guidelines are to be applied to individual policies (e.g., pest management, health and safety, emergency management, acquisitions, access, loans, sampling, treatment, documentation, preventive conservation, deaccessioning, disposal). Pest management policy (Fig. 1F; Fig. 2) is used to demonstrate how the policy conceptualization stage leads to a completed written policy document. Every policy should include (1) a policy purpose statement, (2) primary objectives, (3) secondary objectives, (4) authority recognition, (5) procedure references (optional), and (6) enforcement provision (Cato and Williams 1998).

The *policy purpose statement* defines the intent of the policy. This is important for the understanding and familiarity of individuals expected to conform to the policy. It should not be confused with the organizational ''statement of purpose'' (Malaro 1998, Porter 1985). Because the policy purpose statement describes the reason the policy is needed, it is a useful self-evaluation step for the policy-makers as they develop each policy in support of organizational mission and goals. In the case of pest management the purpose statement (Fig. 2A) is:

> *The museum staff acts responsibly to prevent insect pests and other destructive organisms from damaging items or resources maintained by the museum.*

This statement is simple, brief, and clear. It is sufficiently flexible and comprehensive to include both collection and non-collection areas.

The most difficult part of policy development is recognizing the *primary objectives* behind a given policy. It is very easy to be distracted by peripheral issues so that the primary objectives of the policy (Lasswell 1971, Mayer and Greenwood 1980, Williams 1999) are no longer evident. For instance, policies involving response to emergency alarms should focus first on human safety and not property security. In another example, a decision about compensation time for over-time workers is a personnel issue, but more importantly, it may be an issue of whether the museum remains open or not. The best way of defining primary objectives is to persistently ask *why* until the objective is obvious, thus deriving the ''lowest common denominator'' of the policy objective. In the case of pest management, four primary objectives are recognized (Fig. 2B–E):

> *The museum staff strives continuously to keep the museum pest-free.*
>
> *An integrated pest management program is maintained at all times throughout the museum.*
>
> *In the event of infestations, responsible pest management activities are implemented immediately, emphasizing non-chemical control methods before toxic substances are used.*
>
> *The use of toxic substances for pest management is performed in full compliance with governmental regulations and manufacturer's instructions.*

These objectives address the major issues surrounding pests in museums, such as prevention, response, and legal compliance. By identifying the ''lowest common denominator,'' and stating each objective in a brief, simple, and clear manner, even the most obstinate board member or staff member should understand and support the policy.

Sometimes it is necessary to include *secondary objectives* to provide clarifi-

A. The museum staff acts responsibly to prevent insect pests and other destructive organisms from damaging items or resources maintained by the museum.

B. The museum staff strives continuously to keep the museum pest-free. To help reach this goal, food, unpreserved animals, unpreserved plants, and other high-risk materials (living or non-living) are restricted to specifically designated areas of the museum. Under no circumstance are such materials permitted near areas where collections are maintained on a permanent or temporary basis.

C. An integrated pest management program is maintained at all times throughout the museum. This program includes good housekeeping, good work habits, appropriate utilization of space and equipment, monitoring, and documentation.

D. In the event of infestations, responsible pest management activities are implemented immediately, emphasizing non-chemical control methods before toxic substances are used. Both infestations and treatments are fully documented, reports are submitted to the appropriate parties, and all records are maintained in permanent files.

E. The use of toxic substances for pest management is performed in full compliance with governmental regulations and manufacturer's instructions. Appropriate precautions are taken to protect human health and safety, to avoid environmental pollution, and to minimize the loss of integrity of materials in the collections.

F. The Director of the Museum is responsible for developing and implementing effective mechanisms to fully administrate the pest management program of the museum. As part of this process, written procedures are available to implement the pest management policy. Failure to comply with this policy or its procedures results in corrective measures.

Figure 2. Example of a completed policy (pest management) developed from concepts and strategies presented in the text.

cation of policy intent. In the example given, there is a risk of misinterpreting terminology or intent, such as ‘‘integrated pest management’’ or ‘‘use of toxic substances.’’ Stating secondary objectives ensures clear understanding of and compliance with the primary objectives. For example, the secondary objective of ‘‘an integrated pest management program is maintained at all times throughout the museum’’ (Fig. 2C) would be:

This program includes good housekeeping, good work habits, appropriate utilization of space and equipment, monitoring, and documentation.

In this case, important components of integrated pest management are incorporated into policy.

The secondary objective of ‘‘the use of toxic substances for pest management is performed in full compliance with governmental regulations and manufacturers instructions’’ (Fig. 2E) would be:

Appropriate precautions are taken to protect human health and safety, to avoid environmental pollution, and to minimize the loss of integrity of materials in the collections.

In this example, compliance with governmental regulations extends beyond pesticide regulations and includes other regulations that address personnel health and safety, as well as the environment. Again, brief, simple, and clear objectives at the primary and secondary levels, increases understanding, familiarity, and ultimately compliance.

With the policy purpose statement and objective statements in place, it is important to have a statement of *authority recognition.* While this may occur at the foundation stage of policy development, its use within specific policies provides clear definition of responsibilities (Fig. 2F). For example:

The Director of the Museum is responsible for developing and implementing effective mechanisms to fully administrate the pest management program of the museum.

In this example, the responsible party is identified, and the comprehensive nature of this responsibility is defined. It also is intentionally flexible with the understanding that the leadership may delegate responsibilities to other individuals or a committee.

Depending on the policy in question, it can be useful to *reference procedures* as a mechanism of ensuring the existence of written procedures that support organizational mission and goals. For instance, in developing pest management policy it would be useful to add a statement (Fig. 2F) such as:

As part of this process, written procedures are available to implement the pest management policy.

While this statement requires the existence of written procedures for policy compliance, it does not dictate the nature of procedures. This approach ensures the separation of policy and procedure administration, with the leadership assuming responsibility for policy development, and the constituents assuming responsibility for procedure development.

Finally, for any policy to be effective an *enforcement provision* must be included. For the sake of discussion, this is addressed within the policy example itself (Fig. 2F), but the same effect may be achieved with the foundation stage previously discussed. An example of the enforcement provision is:

> *Failure to comply with this policy or its procedures results in corrective measures.*

This statement is important because compliance with both policies *and* procedures is expected. However, there is considerable flexibility with the enforcement of the pest management policy. While it is possible that non-compliance may be a personnel issue, it also is possible that non-compliance may be a misinterpretation of the policy. In either case, corrective measures will result.

In the example of pest management policy, the primary components are in place, specifically (1) a policy purpose statement, (2) primary objectives, (3) secondary objectives, (4) authority recognition, (5) procedure references (optional), and (6) enforcement provision. It is recommended to format the policies with these statements in designated subdivisions (Fig. 2A–F). In a continuous text format, specific concepts, relationships, and relevance can be obscured. The final step in policy development is to review the policy document to ensure that inappropriate wording and procedures have not inadvertently been incorporated.

In reviewing final drafts of the policy document, it is easy to use words that do not say what is intended. One of the primary problems with wording is the tendency to write in the future tense instead of the present tense. For example, there is a problem interpreting compliance and non-compliance with statements such as:

> *The Director of the Museum* ***shall be responsible*** *for developing and implementing effective mechanisms to fully administrate the pest management program of the museum. As part of the process, written procedures* ***will be available*** *to implement the pest management policy. Failure to comply with this policy or its procedures* ***will result*** *in corrective measures.*

In this example, the use of the future tense allows questionable situations to potentially be in compliance, simply as a future action, thus leaving the intent of a policy unfulfilled for the moment. To correct such situations future tense is replaced with present tense wording. An improvement to the example above is:

> *The Director of the Museum* ***is responsible*** *for developing and implementing effective mechanisms to fully administrate the pest management program of the museum. As part of the process, written procedures* ***are available*** *to implement the pest management policy. Failure to comply with this policy or its procedures* ***results*** *in corrective measures.*

With these simple changes there is no misunderstanding about compliance or non-compliance, and the intent of the policy is clearly understood.

As previously stated, the greatest difficulty in policy development is finding the ‘‘lowest common denominator’’ that best represents policy objectives. If this is not effectively done, it is possible for procedures to be inadvertently added to the final policy document. Because of this the final draft should be examined to eliminate these additions, if for no other reason than to avoid problems of administration and modification. Procedures may be involved if the information included in the policy is descriptive, instructive, lengthy, confusing, or not applicable to all organizational members (Williams 1999). The same is true if parts of the document are subject to change for reasons other than institutional need, such as changes in laws and regulations. Procedures support policies, and are written or changed by those responsible for implementing policy, thus procedures must be separated from the policy document.

Policy Implementation

The best set of policies ever developed will be useless and ineffective if not properly implemented. Policy implementation occurs at two levels. The initial responsibility lies with the organizational leadership; the final responsibility is with each individual in the organization.

As previously discussed, it is essential that policies be in the form of a written document, incorporating the features detailed for policy theory and policy development. Once in place it is critical that the leadership administer the policies throughout the organization, making the written document available to every individual that is expected to comply with the policies, as well as to individuals seeking employment in the organization. While communicating policy objectives is important, communicating expectations of compliance and corrective measures for non-compliance is equally important. The leadership must periodically review the effectiveness of each policy in achieving organizational mission and goals. In situations where a policy is not working as needed, appropriate action must be taken by the leadership to correct the problem.

Each individual in the organization is responsible for carrying out policies, and thus must understand, be familiar with, and support the organizational policies. This is facilitated with each individual having a personal copy of the written policy document.

Summary

It is important to get back to basics and recognize that that the primary purpose of policies is to manage people so that organizational mission and goals are achieved. Many policies are ineffective for various reasons, including inappropriate concern, inappropriate process, and inappropriate product. While it is important to recognize why policies may not function properly, it is equally important to provide viable alternatives. From a theoretical perspective, the ideal policy is a brief, simple, clear, comprehensive, flexible, and written document endorsed by the organization leadership to serve organizational mission and goals. This paper shows how to apply policy theory to establish a working foundation, utilize strategic planning, and develop policy in a systematic manner. Each policy starts with a purpose statement, and then proceeds with clarification of basic objectives. After these steps, secondary objectives are added and provisions are made for authority recognition and enforcement. The final touches involve selecting appropriate wording, and possibly separating procedures from the policy document. The implementation of policy is the responsibility of both the organizational leadership and the organizational membership.

Effective policy development is a powerful tool within the organizational structure. The process described above has greater significance in that a policy can be condensed into a few basic statements of purpose, objectives, and structure. By understanding policy theory and application, policies developed as described above can be equally applicable in other organizations, particularly those with similar mission and goals. It is conceivable that the majority of museums could function with very similar policies. If so, this could be a path leading to museum standards.

Acknowledgments

I am grateful to John Simmons (University of Kansas) for valuable in-depth discussions regarding policy applications, and to Kathy Williams and John Simmons for critically reviewing the manuscript. Appreciation is extended to the Society for the Preservation of Natural History Collections and the American Association of Museums for the opportunity to present information in this contribution to participants at their respective annual meetings.

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Associate Editor: Cindy Ramotnik

DECONTAMINATION OF ETHNOLOGICAL COLLECTIONS USING SUPERCRITICAL CARBON DIOXIDE

Helene Tello,[1] **Erich Jelen,**[2] **and Achim Unger**[3]

[1]*Staatliche Museen zu Berlin, Ethnologisches Museum, Arnimallee 27, D–14195 Berlin, Germany*
[2]*Fraunhofer-Institut für Umwelt, Sicherheits- und Energietechnik UMSICHT, Osterfelder Strasse 3, D–46047 Oberhausen, Germany*
[3]*Staatliche Museen zu Berlin, Rathgen-Forschungslabor, Schlossstraße 1A, D–14059 Berlin, Germany*

Abstract.—Examinations of objects in the Ethnological Museum in Berlin showed that materials such as leather, fur, hair, hide, skins, and feathers contained highly toxic arsenic and mercury compounds as well as chlorine-containing pesticides such as DDT (dichlorodiphenyltrichloroethane), lindane (γ-hexachlorocyclohexane), and PCP (pentachlorophenol). Normal cleaning techniques cannot remove the embedded residues from the heavy metals and pesticides that still remain in layers near the surface.

A series of tests was carried out using high-pressure extraction with carbon dioxide. This method utilizes the good solvent properties of CO_2 in its supercritical state (above 31°C and 73.8 bar). The survey was conducted in a laboratory plant for screening experiments of the Fraunhofer-Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen, Nordrhein-Westfalen, Germany.

The experiments have shown that ethnological objects, with the exception of fur, can be decontaminated without substantial damage to the materials through the use of supercritical carbon dioxide (SC-CO_2) at 40°C and 350 bar.

The Ethnological Museum Berlin has more than 500,000 objects in its holdings, which are mostly made of wood, leather, fur, hide, feathers, hair, plant fibres, and woven textiles. Since June 2001, reports from conservators at the Ethnological Museum about physical ailments that appeared in the course of handling some of the objects instigated the collecting of random samples from individual objects as well as surface and airborne dust and the air in various rooms to test for possible contamination with pesticides. Test results showed that materials such as leather, fur, hair, hide, skins, and feathers contained highly toxic arsenic and mercury compounds as well as chlorine-containing pesticides such as DDT (dichlorodiphenyltrichloroethane), lindane (γ-hexachlorocyclohexane), and PCP (pentachlorophenol). They further revealed that these substances were also present in increased concentrations in dust. It has been estimated that two-thirds of the collections are seriously contaminated with arsenic and mercury as well as pesticides.

In all probability objects made of organic materials had already been treated in the country of origin with substances such as arsenic(III) oxide (white arsenic) and mercury (II) chloride as a preventive measure against pest infestation during the period of transport, which itself sometimes took months. Pesticides like DDT, lindane, and PCP, for instance, were used quite often during and shortly after World War II. During the War large parts of the collections from Berlin-Dahlem were stored in various places in and outside of Berlin, where they were sprayed and fumigated with preventive pesticides on an almost regular basis (Hartmann 1955a, 1955b, Koch 1955). At the end of the war the victorious forces confiscated the Berlin collections and transported them to Leningrad (now St. Petersburg), Russia, in the East and Celle, Germany, in the West. The Allies later returned

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their war booty in the 1950s. The collections taken by the Soviet Army were turned over to the former German Democratic Republic and preserved in Leipzig. After reunification these collections were returned to Berlin. In the storage areas in Celle as well as in Leipzig treatment with pesticides was undertaken.

Pesticide contamination in museum collections, especially those with ethnological objects, is a world-wide problem (Caldararo et al. 2001, Johnson 2001). For instance at the Hoopa Tribal Museum in California, USA, repatriated items have to be stored in plastic bags to protect Hoopa museum staff, museum visitors and the other museum objects from pesticide contamination (Davis and Caldararo 2000).

Because of the concurrent presence of heavy metal compounds and pesticides the risk for technical personal, conservators and art historians was assessed as being relatively high. There is a risk of poisoning through inhalation of dust and repeated direct (skin) contact for museum staff workers who handle objects containing arsenic compounds. The dust can cause a strong irritation and inflammation of the lining of the respiratory system and the eyes. Dust from mercury (II) chloride likewise has an irritating effect on the skin and mucous membranes. Furthermore, it can cause damage to the kidneys and the nervous system. The chlorine-containing compounds DDT, lindane, and PCP have a neuro-toxic effect. PCP is also considered carcinogenic, and it is suspected that DDT could cause cancer in humans.

The dust found on objects in the collections can be removed in a dry or wet state. Therefore, HEPA filters should be used during cleaning. However, some residues from the heavy metal compounds and pesticides still remain embedded in layers near the surface and cannot be removed using normal cleaning techniques. The usual organic solvents are useful to a limited extent, but might cause an uncontrolled mobilization of the pesticides.

Carbon dioxide is a non-flammable, colourless, and odourless gas, which exhibits a number of unusual characteristics. It can exist in four states: gaseous, liquid, solid (dry ice), and supercritical. The critical point is the temperature and pressure at which the properties of a liquid and its vapour become indistinguishable, forming a single phase. The supercritical state is the state of a compound above its critical point. Thus in the supercritical state, a compound behaves as a liquid in conditions under which it would normally be a vapour. The critical point of CO_2 (31°C and 73.8 bar) is relatively low. In the supercritical phase there are no more physical differences between liquid and gaseous CO_2 other than it has a low viscosity and a very low surface tension. Thus in the supercritical condition it is an excellent solvent. Industrial applications are the extraction of hops and the decaffeination of coffee. Because of the low critical point of CO_2 it can be used to advantage when treating temperature-sensitive ethnological materials. Besides, CO_2 has an inert nature. Chemical reactions with the components of the material during decontamination are thereby essentially excluded. The decontamination procedure is a circulation process and the CO_2 can be reused after pressure release from the supercritical state to the gaseous state. During this step CO_2 loses its solvent properties and the pollutants can be collected in a separator.

Chlorine-containing pesticides can be extracted with CO_2 from materials such as wood (Unger 1998, Jelen et al. 2003, Unger et al. 2004) and textiles (von Ulmann 2002) in high-pressure plants manufactured e.g., by the UHDE Company in Hagen, Nordrhein-Westfalen, Germany. The interaction of SC-CO_2 with paint layers was tested by Kang et al. (2002). The research on this field was honoured with the special prize of the European Grand Prix for innovation awards in Monte Carlo, Monaco, 2003, and one of the MESSER innovation prizes in Krefeld, Germany, 2004. Until the present study it was unclear as to whether arsenic and mercury compounds can be removed from organic materials using this method.

A series of tests was carried out that were directed specifically at this question. Contaminated pieces were selected from the holdings of the Ethnological Museum, including a fur band, a feather bundle, tapa, hide, an object of leather, cord and hair, and woven textiles of wool and cotton. The condition of the sample material was documented and examined macro- and microscopically and photographically before and after treatment. Determination of the initial amounts of arsenic, mercury, DDT, lindane, and PCP was made by parallel testing: in most cases samples were divided, whereby one part was held in reserve, the other used in the analysis. Arsenic and mercury were determined using inductively coupled plasma mass spectroscopy (ICP-MS) before and after treatment. Gas chromatography (GC) with an electron capture detector (ECD) was used for quantitative analysis of chlorine-containing pesticides before and after high-pressure extraction.

The tests were conducted in a laboratory plant for screening experiments of the Fraunhofer-Institute for Environmental, Safety and Energy Technology UMSICHT in Oberhausen, Nordrhein-Westfalen, Germany. Extraction on ethnological objects was carried out at 40°C and 350 bar. The pressure build-up lasted about 15 min, and the time of extraction was seven hours. The pressure release lasted one hour and the mass flow of CO_2 was recorded at 2 kg/h. Ethanol in a concentration of 95% served as a cosolvent with and without the additional use of trimercaptotriazine (TMT) (a compound forming metal chelates) to remove arsenic and mercury. Conditions during all experiments were recorded and controlled with the aid of a computer. The mass of the samples was measured before and after the experiment and any visual changes registered photographically.

Following the extraction a distinct and visually noticeable loss in mass was ascertained in some of the individual materials. It can be assumed that the CO_2 not only removes pollutants but also dust, grease, and water. It was not possible, however, to analyze the amount of grease and water before and after treatment. Most objects showed a cleaning effect but no marked changes in tactile properties. One exception was samples of fur, whose tactile properties got worse depending on the test parameters.

Further, through the use of pure CO_2 the amount of mercury in the individual materials could be distinctly reduced by 70% to 90% (based on ICP-MS values). The addition of ethanol as a modifier and TMT to form chelates during the process did not cause any enhancement of the results. Arsenic compounds in the different materials could not be removed through treatment with pure CO_2. Only the addition of ethanol and TMT enabled a reduction of arsenic in fur of about 50%. In most cases the decontamination rate of DDT ranged from 80% to nearly 100%, and for lindane from 60% to 90%. Apparently DDT and lindane were decreased to a greater extent than PCP, whose decontamination rate reached at the most 50% only. In this regard there is an urgent need for more tests in the future.

The experiments have shown that ethnological objects, with the exception of fur, can be decontaminated without substantial damage to the materials through the use of SC-CO_2 following specific and appropriate process parameters. More tests must be made on fur, in which the process parameter varies and other modifiers can be employed, since the lubrication of hide and leather is problematic. In addition, the conditions under which the tests are conducted should be differentiated in view of the diverse materials comprised by ethnological objects. Nevertheless, the possibility remains that certain objects cannot be decontaminated due to their structure, size, and chemical composition.

To conclude, the contamination by heavy metals and pesticides of collections in the Ethnological Museum Berlin presents a grave problem because of the large number of objects and the many responsibilities that they entail. Local and foreign visitors doing research in the collections, preparations for exhibitions and their disassembling as well as the constantly growing number of objects for loans on a national and international level require rapid and expedient action by all those involved. But the promising use of SC-CO_2 maybe can help to solve some of these issues. At present more experiments with ethnological materials and objects take place to characterize possible changes. The method is not readily available to museums but for the near future a high-pressure extraction plant for the decontamination of contaminated art objects is being planned.

Acknowledgments

The financial support of the Deutsche Bundesstiftung Umwelt (DBU) is gratefully acknowledged.

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LASER-PRINTED LABELS IN WET COLLECTIONS: WILL THEY HOLD UP?

Krista Zala,[1] **N. Dean Pentcheff,**[2] **and Regina Wetzer**[1]

[1]*Natural History Museum of Los Angeles County, Research and Collections, 900 Exposition Blvd., Los Angeles, California 90007, USA*
[2]*Loyola Marymount University, 1 LMU Drive, Los Angeles, California 90045, USA*

Abstract.—Biological specimens are identified by a printed label detailing their collection and curation information. Deterioration of specimen labels can render specimens scientifically valueless. Given that this problem is a threat to wet-preserved collections, it is critically important to know which label preparation techniques will withstand decades of immersion in common preservatives. Traditional print methods that have lasted for centuries, such as writing in pencil or India ink on cotton rag paper, are time-consuming and not amenable to producing multiple copies of labels. Laser-printing technology greatly increases label production rates, but its durability on assorted label papers or stored in common preservatives has not been quantitatively tested.

This 14-yr study examines the durability of laser print on five museum-quality papers. We evaluate the effects of post-printing heat and acrylic-coating treatments on print durability in the presence of two preservative types, formalin and ethanol. All treatments remained legible at the end of the trial. The treatments that maintained the greatest print legibility were acrylic-coated (vs. uncoated) labels and labels immersed in ethanol (vs. formalin solution). Paper type and microwave treatment did not affect print durability.

Introduction

Cost-effective methods for creating durable specimen labels are of paramount concern for collection managers. The practice of writing locality information and specimen identifications by hand on cotton rag paper, using either graphite pencil or India ink, has resulted in labels that remain intact for decades or centuries. Unfortunately, handwriting styles can be hard to read due to poor penmanship or old-fashioned styles that are difficult to decipher. Generating labels by typewriting began to replace handwriting following the widespread availability and use of typewriters in the 20th century. Typewriter print standardizes the lettering and a non-bleeding durable ink minimizes blurring and fading. Still, this method has its shortcomings; for example, producing small (6- to 9-point) type is difficult and aligning type on small labels can be a slow and cumbersome process.

Handwriting with pencil and typing both require pressure to make a mark on the paper, so if the mark fades, tracing the depression may allow data recovery. Liquid inks have the advantage of being absorbed into paper and thus are more resistant to abrasion. However, both methods are time-consuming and each copy in label production is subject to human error. As the roles of collection management staff expand and the numbers of acquisitions increase, any effort to shorten or improve the printing of labels is welcomed.

Electronic technologies offer several efficient alternatives to traditional labeling methods, but the long-term durability of labels created from printing equipment developed in the last few decades remains unknown. Technologies of note include daisy-wheel, dot-matrix, and laser printers. The daisy-wheel is a character printer, where a disk with raised letters along its edge rotates, and a hammer strikes the disk against an ink ribbon, transferring ink to paper and making an imprint on

Collection Forum 2005; 19(1–2):49–56

the page. Print speeds range from 0.5 to 3 pages per minute (ppm). A desired change in font or typeface requires changing the wheel itself, an unwieldy procedure for specimen labeling. Although largely replaced by other technologies, daisy-wheel printers and replacement parts are still available. In dot-matrix printers, pins are struck against an ink ribbon, also leaving ink and an imprint on the paper. Print speed is three ppm, but the aesthetic quality of print is lower than most other methods (Sims 1990), and its low number of dots per inch (dpi) can make text appear faint.

Advantages of laser printing include the chemical stability of the toner and the notably faster print speed. An eight ppm minimum speed for high quality print means that label creation is not the rate-determining step in curating specimen lots. Despite these advantages, laser-printed labels have been controversial since their introduction in the 1980s because of concerns about the durability of the print in fluid preservatives (Wheeler et al. 2001, Nelson 1990, Sims 1989, 1990). Most concerns stem from its different print technology (Apple Computers 1985). A laser light selectively discharges a positively-charged drum in the form of the characters or image to be printed. The discharged portions of the drum attract the positively-charged dry toner powder. Dry toner for monochrome laser printers consists of a black pigment combined with small particles composed of plastic resins, soot, and partly magnetized metal oxides. The toner sticks to the negatively-charged paper surface and the powder is discharged so it detaches from the drum. The sheet of paper passes through fusion rollers that bond the loose toner to the paper using heat and pressure, yielding crisp and clear type. Unlike ink and impact printing methods, laser printing deposits a raised, melted powder but the toner neither penetrates the paper nor leaves a depression, which raises issues of label durability, specifically, durability of fused toner and toner-paper bond strength (Wheeler et al. 2001), and effects of preservatives and specimens on the print.

Several ichthyology collection managers have observed rapid print loss of laser-printed labels in wet-preserved collections (A. Suzumoto pers. comm., J. Seigel pers. comm., A. Bentley pers. comm.). Snyder (1999) cites high lipid content of specimens as a probable primary agent in loosening the toner-paper bond, with the preservative possibly accelerating the deterioration process.

Heat and pressure are factors in toner adhesion (National Archives of Australia 2000). Thus, strategies for enhancing the bonds between toner and paper have generally relied on various heat applications. Printing methods include feeding a page through the printer twice (keeping it blank the first time), or printing labels at the end of a lengthy print run when the fusion rollers are presumed to be hotter than usual. Common post-printing methods of heat application include using a flat-iron press, oven, or microwave oven. One post-printing chemical treatment to strengthen or protect the toner-paper bond is clear acrylic spray. This method has been used by one of us (RW) at the San Diego Natural History Museum and by collection managers at Cornell University, NY (D. Nelson pers. comm.) and the Academy of Natural Sciences, PA (W. Saul pers. comm.).

Previous attempts to test the durability of these methods have generated mixed results. An unpublished study comparing heat treatments and papers found that baking and dry-mount pressing labels (e.g., as used for mounting photographic prints) preserved print far better than heating them in microwave ovens (K. Kishinami pers. comm.). K. Reed (pers. comm.) compared print quality of labels printed by different methods. Labels were immersed in commonly used museum preservatives (including 70% ethanol, 95% ethanol, and 10% formalin solution) and water for 13 mo. Laser-printed labels remained in excellent condition after immersion in these preservatives, with no evidence of deteriorating sharpness of letters.

Sims (1989) found that mainframe laser printers that use increased heat and pressure printed durable labels whereas print on labels from a desktop laser printer flaked off the paper. Labels printed with a desktop laser printer and placed in jars of ethanol with fish specimens failed an abrasion test (Nelson 1990). In this qualitative assessment, Nelson stated that after immersing labels for three weeks in standard museum preservatives, ‘‘a light rubbing with a finger easily removed the print from the paper surface.’’ Wheeler et al. (2001) reported that laser-printed labels at the Royal Ontario Museum have remained immersed in ethanol ‘‘for over ten years with no apparent loss of label quality,’’ whereas entire letters were lost from labels shipped with loan specimens nine months after immersion. Without more information about specimen storage conditions, preservative solutions, and types of biological specimens involved, it is impossible to explain these divergent results.

No peer-reviewed literature exists addressing the issue of durability of laser-printed labels in wet-preserved collections. This is surprising given the interest expressed in various professional communications (Nelson 1990, Sims 1989, 1990, Wheeler et al. 2001). We investigate the long-term durability of labels generated using a desktop laser printer. Four factors were tested for their effect on print durability: preservative (70% ethanol or 10% formalin), paper type, post-printing heat treatment, and post-printing chemical treatment.

Materials and Methods

We tested five paper types, all 100% cotton rag: Resistall Ledger 36 lbs (Byron Weston, Dalton, MA), Permalife Ledger 32 lbs (Latmer and Mayer, Pittsburgh, PA), Suture Label 102 lbs, lot #4-2-1388 (Domtar, Montreal, Quebec), Wet Strength Laundry Tag 70 lbs lot #4-3-2707 (Domtar), and Supra 100 45 lbs (Paper Technologies, Laguna Nigel, CA). Requests to collection managers of natural history museums for readily available 100% cotton rag papers suitable for wet collections established three common paper types. At the time of the experiment’s design, Resistall Ledger was used at the Canadian Museum of Nature (P. Frank pers. comm.) and the Natural History Museum of Los Angeles County (NHMLAC) (RW); Permalife was used at the Bishop Museum (A. Suzumoto pers. comm.) and the San Diego Natural History Museum (RW); and Wet Strength Laundry tag was used at the United States National Museum and the Academy of Natural Sciences (W. Saul pers. comm.) and at the Museum of Zoology, University of Michigan (Nelson 1990). Requests to paper manufacturing companies for same yielded two more paper types: Domtar’s Suture Label and Paper Technologies’ Supra 100.

Labels were printed in March 1989 using the Apple LaserWriter Plus equipped with a Canon LBP-CX laser-xerographic engine (a monochrome 300 dpi laser printer that prints at 8 ppm at 200°C). Labels were printed eight to a sheet using a new factory-filled toner cartridge from Canon. After printing, sheets were sliced into 5.0 cm by 12.5 cm labels. Two labels of each paper type were treated in one of four ways: (a) heated in a household microwave for 3 min on its highest setting, (b) sprayed with a clear acrylic spray (manufactured by Krylon®) and air-dried overnight, (c) both heated and sprayed with acrylic, or (d) untreated after printing. Each label was placed in its own 118-ml glass specimen jar containing either 10% unbuffered formalin solution or 70% ethanol solution in distilled water, such that the printed side of the label was flush against the inner wall of the jar. Formalin is actually a 37.5% formaldehyde solution, thus a 10% formalin solution is 3.75% formaldehyde. Each jar was sealed with a polypropylene lid containing a Teflon® liner to minimize evaporation and changes in preservative concentration. Jars were stored together in a single closed cardboard box to shield them from light. Samples were not held in a temperature-controlled environment, a condition shared by many museum collections (Fink et al. 1979). During the 14 yr of this experiment, jars were moved among four institutions, involving 2 cross-country moves. There was no noticeable evaporation or leakage from the jars during this time.

The experiment was terminated in March 2003. Labels were inspected using a microscope at 60× magnification and graded. Damage was so slight that there were no significant differences between treatments (results not reported here). To increase discernable differences between treatments, labels were subjected to a quantifiable accelerated aging process. The Technical Association of the Pulp and Paper Industry (TAPPI) T-830 Digital Ink Rub Tester, available at California Polytechnic Institute, San Luis Obispo, was used to abrade the labels. The Digital Ink Rub Tester has a stage on which the test paper is mounted. A 0.9 kg (2 lb) rubber-lined weight fits over the stage. The weight was fitted with glass microscope slides to simulate rubbing of the test label against the glass wall of a specimen jar. In operation, the testing machine moves the weighted glass slides over the fixed specimen for 50 back-and-forth cycles.

Printed labels were dried and then cut into six pieces with dimensions of 2.5 cm by 4.1 cm. Two samples were taken from each label, each of which had 10 rows with the letters ‘‘ar’’ printed on them. Each label sample was mounted on a 5 cm by 21.25 cm piece of Resistall paper using Lohmann Adhesive’s Duplofol 0.10 mm double-sided adhesive tape to prevent the sample from slipping during the test. All samples were re-wetted with 70% ethanol, subjected to 50 rub cycles, then dried and returned to the NHMLAC for analysis. Experimental conditions prevented re-wetting with formalin.

To prevent evaluator bias, a random number was assigned to each sample. One of us (KZ) evaluated all label damage using a binocular dissecting scope at 60× magnification and two fiber optic lights. Samples were ranked based on a scoring system defining levels of toner flaking where 1 = chipped, 2 = cracked, and 8 = section missing (Fig. 1). Weights were assigned to each of the categories to try to represent the effect on readability. We also performed an analysis assigning each damage category a value of 1 and it yielded the same statistical results (analysis not shown). When letters showed multiple areas of flaking, we counted the number of areas subjected to the three categories of toner damage, multiplied each by respective rank, and summed the values in the three categories.

A total of eighty samples (5 paper treatments × 2 preservative treatments × 2 heat treatments × 2 chemical treatments × 2 samples per label) was evaluated

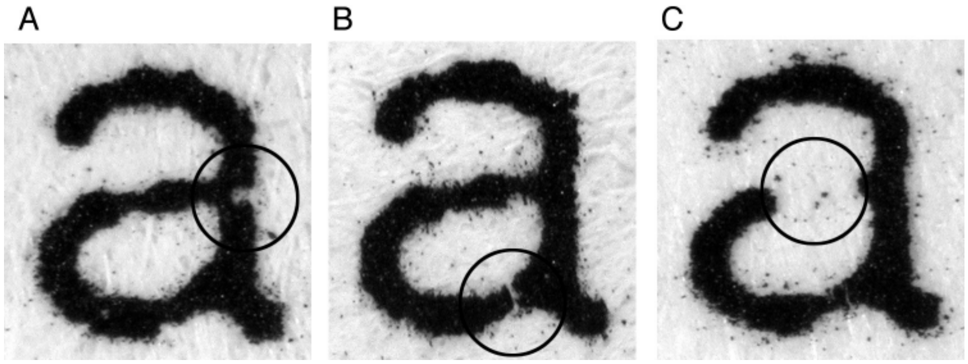

Figure 1. Examples of three categories of toner flaking where defined A = chipped; B = cracked; and C = section missing.

and ranked using the summed damage scores in a single ordinal scheme. The value of tied ranks was replaced with the mean rank of each tie group (Zar 1998). Four comparisons of the ranked samples were performed: (1) acrylic coated vs. uncoated; (2) microwave heated vs. not heated; (3) ethanol vs. formalin preservative; and (4) paper types. The first three treatment pairs were compared using the normal approximation to the Mann-Whitney *U*-test, adjusted for continuity. This test is appropriate for non-parametric comparisons where there are more than 20 samples in a group (Zar 1998). A Kruskal-Wallace test was used to compare the five paper treatments (Zar 1998). A significance level of alpha = 0.05 was used. Critical values of alpha = 0.0125 were used for the tests based on a Bonferroni correction of alpha to account for the multiple comparisons (Miller 1981). A Spearman rank correlation was used to determine the strength of the association between the replicates within the ranked data (Zar 1998).

Results

All letters were fully readable after the 14-yr immersion and remained in readable condition after the TAPPI T-830 accelerated aging procedure. In some instances the paper was abraded or frayed, mainly at the edges, with damage attributed to edge effects. No bleeding or fading of print was observed. Most damage to print was either ''chipping'' or ''cracking,'' with few letters sustaining ''section missing'' damage.

Statistical analysis of the four sets of comparisons of ranked samples showed a significant effect of two of the four treatments (Fig. 2). Statistical results were the same when performed on equally weighted damage categories (not shown). Labels coated with acrylic (Krylon®) spray were significantly less damaged than uncoated labels ($P < 0.001$). Labels immersed in 70% ethanol solution were significantly less damaged than labels immersed in 10% formalin solution ($P < 0.001$). There was no significant difference ($P > 0.05$) between microwaved and non-microwaved samples or between paper types.

A Spearman rank correlation between the forty pairs of replicate samples yielded a correlation $r^2 = 0.60$ ($p < 0.001$), indicating a strong similarity in rank between replicates. This supports the consistency of the effects of treatment and analysis on the samples.

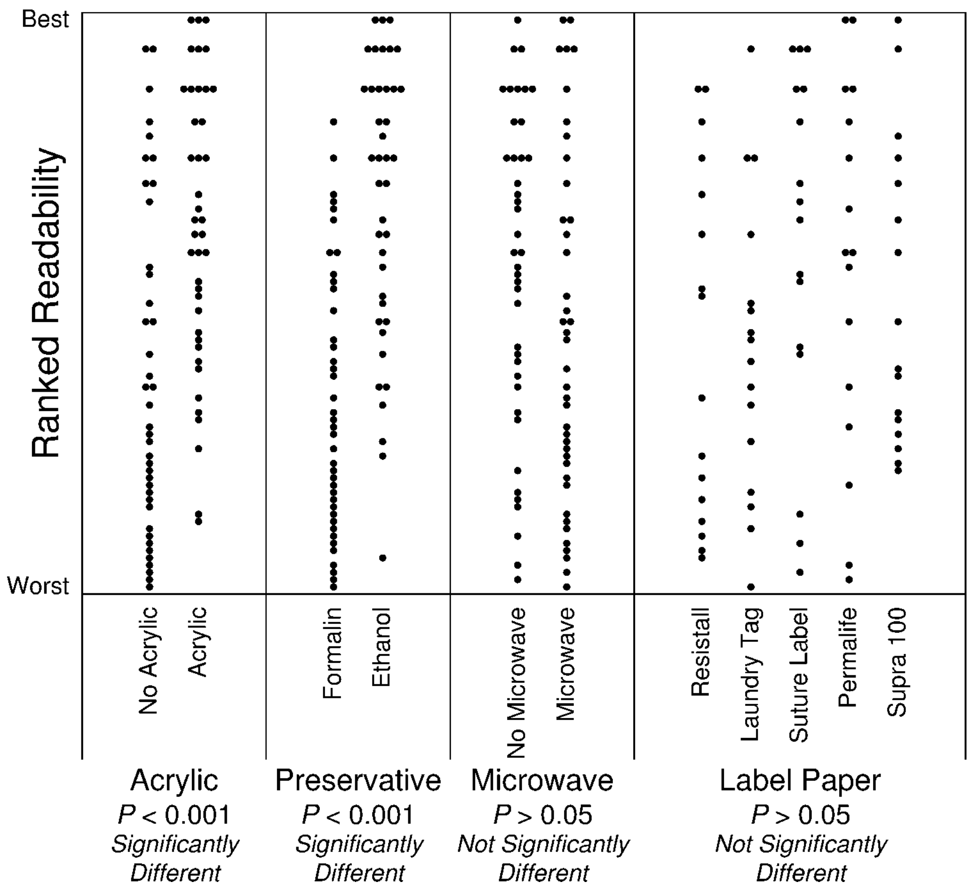

Figure 2. Comparisons of ranked readability for treatment groups of samples. Within each treatment, parallel dots indicate tied ranks. Significance levels for comparisons within treatment groups are given beneath each group (see Materials and Methods for details).

Discussion

Our results indicate that application of acrylic coating to labels after laser printing increases the durability of the label. One explanation for this increase in durability is that the spray coating may shield the toner-paper bond from detrimental effects of the preservative. Observed under magnification, acrylic-coated print appears fluid and shiny, which contrasts with the more dull and particulate appearance of uncoated toner. The toner's liquid appearance suggests that the acrylic may ''melt'' it, thereby further bonding the toner to itself.

C. Hawks (pers. comm.) cited two possible drawbacks to the use of acrylic coating: paper stiffening and delamination (the separation of layers) of the coating from the paper. Hawks postulated that (1) stiff paper threatens label integrity, particularly if labels need to be flexed or folded to fit the container, and (2) delamination could render a label illegible if the toner bonds more strongly to the spray than to the paper and the coating delaminates, because the print would peel with the coating from the paper. Our experiments did not directly address either issue, but we saw neither of these problems. We do not know how much acrylic leaches from the paper in alcohol or formalin solutions, nor do we know how acrylic affects specimens. No connection between specimen deterioration and acrylic-coating has been reported in the literature, but the threat of damage to specimens from acrylic-coated labels remains a deterrent for some collection managers.

Our data indicate that preservatives have differing effects on label durability. Differences may stem from the chemical properties of preservatives (e.g., pH levels). Formalin solution is acidic. This situation may be ameliorated or exacerbated by the use of agents to buffer formalin. The acidity of even a 10% solution may weaken the toner-paper bond, while ethanol's negligible dissociation may have little or no effect. There is a possibility that the subsequent exposure of formalin-preserved labels to ethanol during the Ink Rub Test may have compromised label integrity more than labels immersed in ethanol only. It is worth noting, however, that successive exposure of labels from formalin to alcohol frequently occurs as collections are transferred from formalin to alcohol solutions.

Microwave treatment, a print-preserving method, had no significant effect in this study. This treatment's failure to affect samples is most likely attributable to the heating mechanism employed. Microwave ovens work by emitting radio waves at approximately 2.5 GHz. This frequency heats food components including water, fats, and sugars, but has little effect on plastics, ceramics, and glass. The toner used in this experiment (and by most laser printers) is a plastic polymer, which likely remains unaffected by the microwave's range of radio waves. Because of this, we feel we did not adequately test heat application as a means of increasing label durability. Although we do not recommend microwave treatment as it had no significant effect on print durability, we believe that direct heat application merits further investigation.

Desktop laser printers on the market today have not changed their optimal printing specifications. They still print at roughly 200°C, and can handle up to 36 lb bond paper. Heavier bond papers likely achieve lower surface temperatures than their thinner, lighter counterparts in their rapid pass between the fusion rollers. The manufacturer's suggested optimal paper weight for the LaserWriter Plus is 16–20 lb bond. Its full range is 8–34 lb bond paper (Apple Computers 1985). Several of the papers tested were considerably heavier than 34 lb bond. However, despite testing a range of paper weight, no paper type held the toner-paper bond significantly better than any other, which suggests that paper weight (i.e., thickness) may not have affected the bonding processes. None of the five papers tested is rejected for laser-printed labels.

The results of this study provide no reason to suggest that laser printed labels should not be used with biological specimen lots stored in 70% ethanol or 10% formalin. Labels in alcohol may be more durable, but both solutions are acceptable. Until biological and chemical agents affecting the toner-paper bond are identified, laser-printed labels placed in jars with specimens cannot be unconditionally recommended. Similarly, until the effects of acrylic spray on specimens are tested, acrylic-coating cannot be recommended as a treatment for any labels that share fluid preservative with specimens.

This study establishes the ability of laser-printed labels on a variety of cotton rag papers to withstand immersion in commonly used preservative solutions for 14 yr without discernable deterioration. Microwave treatment is ineffective in increasing durability. Coating with Krylon® acrylic spray does increase durability, but may be undesirable because of unknown interactions between acrylic and biological specimens. As 14 yr is a relatively short time in the life of a preserved scientific specimen, we also recommend having a redundant labeling method using different media, e.g., a small label with the catalog number written in India ink, to ensure against data loss over time.

We are aware that none of the similar studies we have cited is published in a peer-reviewed journal, which clearly indicates a need for more scientifically formulated, replicable experiments with quantitative results. Future research should address the interactions of biological specimens with laser printed labels and the effect of acrylic spray on specimens.

Acknowledgments

We are grateful to our colleagues Kathy Omura and Darolyn Striley for participating in the road trips between Los Angeles and San Luis Obispo and for their good humor and untiring help in preparing samples for the TAPPI-standard Digital Ink Rub Tester. We thank Walter Horelick of the Graphic Communication Department at California Polytechnic Institute, San Luis Obispo, for enabling our access to the facilities and for his hospitality. We gratefully acknowledge Peter Frank, Cathy Hawks, Carla Kishinami, Doug Nelson, Karen Reed, William Saul, Jeff Seigel, John Simmons, Arnold Suzumoto, and countless other collections care staff with whom we have had invaluable discussions about specimen label preparation over the years. Thanks also go to Simon Grove and Andy Bentley for their helpful comments on label issues. This manuscript benefited from comments by Andy Bentley, Paisley Cato, John Simmons, and Arnold Suzumoto. Finally, this project acknowledges the support of National Science Foundation Collections Grant, DBI-0138674.

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Associate Editor: Cindy Ramotnik

COLLECTION IDEAS: EARTHQUAKE STRAPPING

Tania Collas

Research & Collections Division, Natural History Museum of Los Angeles County, 900 Exposition Blvd., Los Angeles, California 90007

Abstract.—Staff members from the Natural History Museum have started an earthquake strapping project to mitigate potential earthquake damage to collections, addressing the most vulnerable collections first. Our method of earthquake strapping is low cost, easy to install and use, and adaptable to many different types of collection storage units. This article describes the steps in making the earthquake straps and provides examples of their use in museum collection storage areas.

Purpose

Los Angeles, California and its environs experience thousands of earthquakes every year (Jones and Benthien 2004). Although most are small and go unnoticed, a large earthquake capable of causing damage is inevitable (Ziony and Kockelman 1985). At the Natural History Museum of Los Angeles County, earthquake strapping is an important part of a campaign to mitigate potential earthquake damage to collections. This paper presents a simple but effective strapping method as an example that may be useful for other museums interested in earthquake preparedness. These durable straps are low cost, easy to install and use, and adaptable to different types and shapes of collection storage units. Non-experienced staff can make these straps with brief training and minimal supervision. When the earthquake straps are used in conjunction with structural and other non-structural stabilization techniques, they can be a significant factor in preventing damage to collections during earthquakes.

Description

The finished earthquake straps are shown in Figure 1. The longer strap is attached across the front of the shelves and has a buckle to allow access. The smaller straps without buckles run across the sides of the shelves. Ideally, the straps are bolted to the metal frame of the shelves through existing holes, but they can be attached anywhere a hole can be drilled to accommodate a bolt or a screw. The earthquake straps can be installed in the configuration that best protects the objects (Figs. 2, 3) and can be quickly unbuckled for access to the contents of the shelf. These straps do not require any sewing since the receptacle part of the buckle is held in place by a grommet. The grommets ensure that the webbing will not tear or fray. Preparation and installation of the straps for a bank of shelves takes just a few hours. Earthquake strapping is a project that can move forward in small steps, so that progress is visible without a dramatic increase in workload.

Materials, Tools, and Supplies

Arch punch
Butane micro torch
Grommets and washers
Grommet inserting handle and base
Impact-resistant safety goggles

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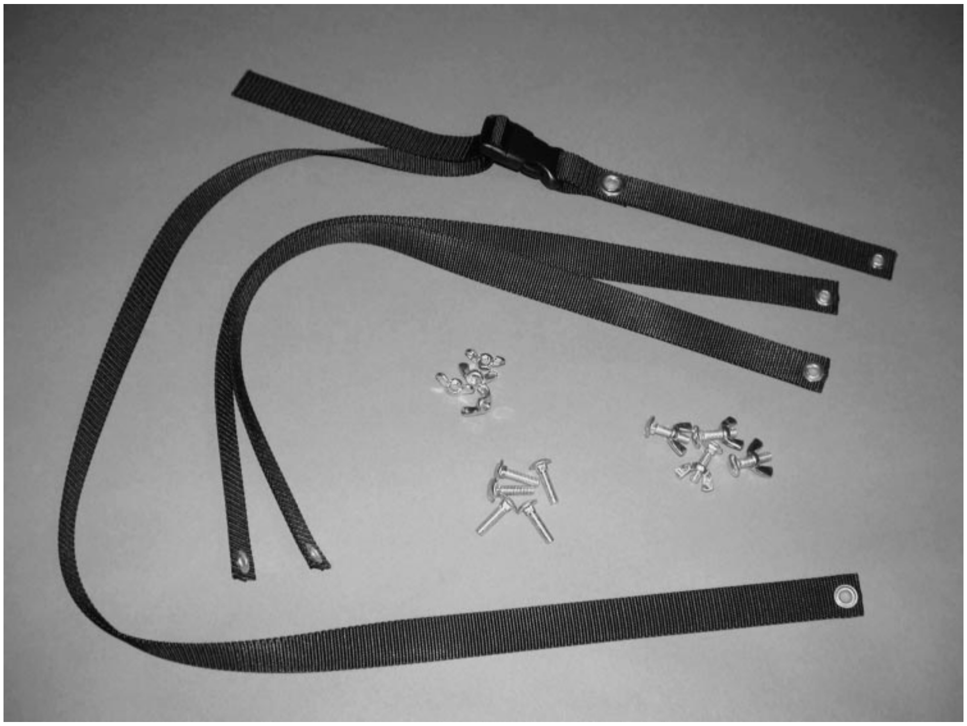

Figure 1. Earthquake straps ready for installation.

Nylon webbing
Plastic buckles
Plastic or wood cutting board
Plastic-headed hammer
Wing nuts and bolts

The grommet supplies can be purchased together as a kit that includes the grommets, washers, hole-cutting tool, inserting handle, and base. However, an arch

Figure 2. Straps as installed on shelf with boxes.

Figure 3. Alternate configuration for straps.

punch is recommended for cutting the holes because it will hold a sharp edge better than the cutting tool that comes with the grommet kit. A plastic or wood cutting board should be used to prevent the punch from becoming dull. A sturdy hammering surface, such as an anvil, and a plastic-headed hammer will cut down on noise from hammering and make the hammer strokes more effective, saving time as well. Wing nuts are used with bolts to secure the straps to the shelf frames so staff can easily install or adjust the location of the straps without tools.

Construction

1. Cut the nylon webbing straps to the appropriate length for the shelves. For a uniform appearance once installed, keep the short half of the strap a consistent length, such as 12 in. (30 cm).
2. Melt the ends of the webbing slightly using the butane micro torch to prevent fraying.
3. Cut a ¼ in. hole at one end of each half of the strap where it will attach to the shelves.
4. Thread the other end of the short half of the strap through the slot in the receptacle part of the buckle. Then cut a ⅜ in. hole through two thicknesses of the webbing for the grommet that will hold this part of the buckle.
5. Insert and hammer the grommets.
6. Thread the non-grommet end of the long half of the strap through the insert part of the buckle. The length of this half of the strap will be adjustable.

7. Bolt the straps to the existing holes in the shelves and buckle them together, tightening as necessary.

As a general precaution, impact safety goggles should be worn while hammering.

Comments

The webbing used at the Natural History Museum is rated to hold 2000 pounds (908 kg). In fact, lighter weight webbing would be equally effective because the weak point is the buckle, which has an average break point of 243 pounds (110 kg). Lighter weight webbing would also be easier to cut for the grommets. Although the strength of the plastic buckle is more than adequate for most collection objects on shelves, metal closures may provide greater protection for heavy items.

Suppliers and Parts

Ralston-Cunningham Inc.
P.O. Box 3507
Bellevue, WA 98009
Phone: (425) 455-0316
Fax: (425) 454-7603
Nylon webbing (heavy) #7400 1″ width, black, 100 yards/roll (2000 lbs [908 kg] test strength)
Nylon webbing (less heavy) #X630 1, 1″ width, black (900 lbs [409 kg] test strength)
Plastic buckles #CSR1 1″, black (243 lbs [110 kg] average test strength, 201 lbs [91 kg] lowest test break point)

McMaster-Carr Supply Co.
P.O. Box 7690
Chicago, IL 60680-7690
Phone: (562) 695-2449
Fax: (562) 695-2323
www.mcmaster.com
Arch punch, ¼″ diam. 3427A11
Arch punch, ⅜″ diam. 3427A13
Butane micro torch #75195A13
Fuel cell refills for torch #75195A14 2/pack
Grommets: #9604K22 brass washer grommets size ‘‘0’’, ¼’’ hole 50/pack
#9604K24 brass washer grommets size ‘‘2’’, ⅜’’ hole 50/pack
Grommet kits: #9610K11 grommet kit for size ‘‘0’’ grommets
#9610K13 grommet kit for size ‘‘2’’ grommets

Available at most hardware stores:
Impact-resistant safety goggles
Plastic-headed hammer
Plastic or wood cutting board
Wing nuts and bolts

Acknowledgments

I would like to thank Vicki Gambill, Chief Registrar at the Natural History Museum of Los Angeles County, for helping to initiate this project and the Los Angeles County Museum of Art for sharing their earthquake strap design with NHMLAC.

Literature Cited

Jones, L. and M. Benthien. 2004. *Putting Down Roots in Earthquake Country*. Southern California Earthquake Center, Los Angeles. 32 pp.

Ziony, J.I. and W.J. Kockelman. 1985. Introduction. Pp. 1–12 in *Evaluating Earthquake Hazards in the Los Angeles Region—An Earth-Science Perspective, U.S. Geological Survey Professional Paper 1360* (J.I. Ziony, ed.). United States Government Printing Office, Washington, DC. 505 pp.

REVIEWERS

We are grateful to the following people, who reviewed manuscripts for Collection Forum:

L. Abraczinskas, M.A. Bogan, C. Cook, H. Coxon, E. Dietrich, J. Fenn, L. Ford, T. Giermakowski, S. Gotte, D. Grattan, T.E. Ladedz, R. Monk, A. Pinzl, J. Price, G.F. Russell, T. Strang, A. Suzumoto, D. Wood.

BOOK REVIEWS

A LEGAL PRIMER ON MANAGING MUSEUM COLLECTIONS, 2nd Edition, 1998, Marie C. Malaro. (Smithsonian Institution Press, Washington, DC, 507 pp.) In the preface the author states that the book is written with three purposes in mind: 1) to make it understandable for the ''novice'' whether that person is an attorney, a staff member, or a trustee; 2) to focus on collection related legal issues; and 3) to avoid legal entanglements by looking at issues from a prevention standpoint. She succeeds on all points.

Part One, *The Museum*, begins with a comprehensive definition of a museum, probably the best one I have ever read. Also included are important discussions on board standards of conduct, power, responsibility, and legal expectations. The role of the state attorney general, taxing authorities, and federal agencies in matters of oversight is thoroughly discussed with the use of case studies. Trustees will take away a clear understanding of their roles and legal responsibilities and it should help staff to clearly understand museum management and the legal parameters involved for their boards.

Part Two, *The Collection,* is comprised of 17 chapters dealing with almost every aspect of collection management. Each chapter (e.g., acquisition, unclaimed loans, insurance, etc.) is not only a comprehensive discussion of process, policy and problems but the author also examines in great detail a large number of legal issues and entanglements that often plague museums and collection managers. Process and policy topics throughout the book might often be cursory for some SPNHC members, but for those new to the profession or where policy and process are lacking or inadequate, the discussions and case studies will be found to be invaluable. The legal issues presented and the problems that accompany them are articulately written, well-documented with legal citations and, once again, backed by or explained through discussions of case studies. Each chapter is thoroughly footnoted for further reference.

At the beginning of every chapter there is a comprehensive outline. If one is using the book as a reference tool, you can clearly see if the author covers the issue you are interested in without the necessity of reading the whole chapter. All acts, public laws, and statutes relating to collections that are in the book are listed in the Index and also can be found either in the footnotes or in Appendixes A–E. Also of use are the many samples of policies (e.g., collection, acquisition), forms (e.g., loans, receipts, release), guidelines (e.g., insurance), and more. They are listed immediately after the Table of Contents and can be used as templates, which is a great feature when creating documents.

''*Legal Primer*'' is a ''one size fits all'' text that is directed to the legal issues of ALL museums. It does not exclude any disciplines in its discussions nor is it skewed more toward any one than another. The book is also a template on its own for proper museum collections management and essentially a ''how to do it right'' textbook. Add in the legal issues and the book becomes multi-purpose with an amazing array of information to offer. The author's use of case studies help the lay reader more clearly follow the legal path and they definitely provide the reader with some guidance on how and when to make choices for their particular issues. This book is not, however, a ''how to'' book on fixing every collection problem that comes along, but it would be a good place to start. Given the international membership of SPNHC, I think it is important to mention that while the collections management process and policy sections are relevant to everyone, the legal issues, case studies, and footnotes relate for the most part to United States law. The book does cover international law where applicable, such as the chapter on international loans.

From the viewpoint of this trustee, legal problems for museums can be very costly, both monetarily and in damage to reputation. Staff and trustees must be better educated and prepared to handle collection related legal issues and to have a better idea of when action is prudent. Ms. Malaro clearly and expertly defines legal responsibility and obligation for collections at all management levels throughout her book and the approach of avoidance and prevention should be of great interest to the entire management team. It is a comprehensive, detailed and well-documented book to be used both as an educational tool and a resource. For these reasons I recommend this book as a ‘‘must read’’ for museum trustees and staff. It should also be one of the standard resource books for collection departments and for the board room. The book lists in paperback at around $32.00 and $60.00 for hardback.—*Pamela M. Bruder, 5821 Rutgers Road, La Jolla, California 92037, Trustee Emeritus, San Diego Natural History Museum; Trustee, The Heard Museum.*

THE USE OF OXYGEN-FREE ENVIRONMENTS IN THE CONTROL OF MUSEUM INSECT PESTS, 2003, Shin Maekawa and Kerstin Elert. (*Tools for Conservation Series,* Getty Conservation Institute, Los Angeles, CA, 158 pp. with a CD-ROM.) As Maekawa and Elert state in their introduction, scientists at the Getty Conservation Institute/GCI have been actively conducting research on solutions to the problem of pest control in museum environments for more than fifteen years. This publication builds on the research published in two earlier GCI volumes in the Research in Conservation series (1998) and turns the theory of those two publications into practice.

During this time, most of the developmental work of low-oxygen concentration treatments for museum pest control has been done by GCI and others. This book is not quite the complete overview of all that work, but it compiles the GCI knowledge and experience comprehensively. Five chapters and five appendices provide background information and describe the ins and outs of anoxia treatments.

The first chapter, ‘‘Insect mortality using anoxia,’’ describes the entomological basis for low-ox insect control. It seems to be an extensive summary of the data, yet the authors present only the ‘fast’ mortality data and arrive at their conditions: 14 days exposure at 25°C, 0.3% O_2 and moderate RH. This is twice as fast as the more conservative North-European and Australian recommendations of 4 weeks exposure at 25°C and concentrations of less than 1% O_2. Part of the difference has to do with the oxygen concentration, yet the experience in stored product protection shows that 0.3% O_2 can not always be reached. Differences in susceptibility between wild insect strains and inbred cultures, geographical differences and aspects like delayed development after exposure to high CO_2 and low O_2 concentrations, should be taken into account.

Chapter 2, ‘‘Methods and materials for the anoxia of insects in museum objects,’’ gives detailed descriptions of oxygen-barrier film, heat sealers, oxygen monitoring devices, humidity monitors, and leak detectors. It deals with composition of materials, principles of equipment, availability, and choice: everything you need to know to carry out treatments. The authors point out that it is possible to keep costs low, but in their designs, they go for the best and budget has not been their biggest concern.

Chapter 3, ‘‘Small-scale anoxia using an oxygen absorber,’’ describes the theory of low-ox treatments of objects in plastic bags with oxygen absorbers to create the low-ox environment, an option favoured for single item treatments. It is mainly a chapter on Ageless™ oxygen absorbers, a product from the food industry that Maekawa has worked with since the mid 1980s. He certainly knows his stuff. The chapter is strong on theory, describing the possible changes in relative humidity due to moisture release of Ageless™ and to purging with dry nitrogen gas. In practice those problems often prove to be not that bad when materials have enough buffering capacity and purging is done quickly.

Chapter 4, ‘‘Large-scale anoxia using external nitrogen sources,’’ focuses on the various nitrogen sources, gas cylinders, liquid nitrogen, generators, and the tricks of using them, like humidifying the dry gas. It also describes the fabrication of treatment tents and the availability of commercial fumigation or controlled atmosphere treatment (CAT) bubbles. Finally, it discusses rigid chambers, converting old fumigation chambers or building new ones. Some years ago I had interesting discussions with a gas company to convert cargo containers into a rigid chambers, an interesting consideration for institutions that do not have the space in-house.

Chapter 5, ‘‘Protocols for insect eradication in nitrogen (Anoxia),’’ puts all the theory into practice in four protocols. Protocol A is the bag treatment (volumes up to 1 m^3), also useful for oxygen-free storage of oxidation prone materials. Step by step the reader is led through the entire treatment process from sealing bags to opening them after treatment. There is a section on trouble shooting and a list of materials and suppliers. Protocol B is for large, user-made tents (up to 10 m^3) and shows the authors’ strength in the area of engineering. Again, step by step the reader is walked through the whole process. Protocol C is for using large commercially available enclosures, but in the section of choosing a protocol it never shows up as an option. It goes to show how much the authors enjoy constructing their own tent. Protocol D is for large rigid chambers, an investment that is well worth considering for museums that do low-ox treatments on a regular basis. Because construction relies on professionals, this protocol only provides the basic guidelines.

The remaining twenty pages of the book contain extensive appendices with protocol tools (constructing a humidifying system, leak proofing and testing, calculations for Ageless™ and silica gel), technical data (Ageless™ chemistry, reaction rate), table of conversion factors, manufacturers and suppliers, and a summary of the protocols.

The CD-ROM that comes with the book contains the entire text in PDF-format, very handy for those who want to print specific parts of it as work copies.

Altogether this publication is a good overview of the technical side of low-ox treatments and provides a lot of background information on materials and equipment. It describes the engineer's approach to pest control and if you ever want to do your own low-ox treatment, this publication certainly helps you out. Despite the enormous enthusiasm with which Maekawa and Elert build their own treatment tents and share their experiences with the world, reality shows that only a few of the daring follow their example; others may have to resort to commercial companies for large-scale treatments. Fortunately, in those countries where methyl bromide has already been banned, developments have led to the availability of commercial low-ox treatment facilities. Having a talk with the operators and explaining the specific needs of museum collections can save a lot of work if you do not need to do treatments regularly. The authors mention in their introduction that they recommend low-ox treatments for eradicating museum insect pests and that this publication is rather specific and practical and must be placed in the context of integrated pest management. For most natural history museums freezing will be the standard disinfestation technique as the response step in the integrated cycle of avoid-block-detect-confine-respond. But for all those delicate collections that one does not want to treat with either low or high temperatures, lox-ox treatment is a good solution, and Maekawa and Elert provide a very useful helping hand in doing it.—*Agnes W. Brokerhof, Instituut Collectie Nederland (ICN, Netherlands Institute for Cultural Heritage), PO Box 76709, 1070 KA Amsterdam, The Netherlands.*

STUFFED ANIMALS AND PICKLED HEADS: THE CULTURE AND EVOLUTION OF NATURAL HISTORY MUSEUMS, 2001, Stephen T. Asma (Oxford University Press, New York, 302 pp. plus introduction.) In *Stuffed Animals and Pickled Heads,* Stephen Asma seeks to transport the reader back to the early days of natural history museums, in order to better explain the roles museums played in the origins of the contemporary natural sciences.

Rather than deal with every facet of a natural history museum's responsibilities and operations, Asma chooses to focus on the phenomena of the natural history specimen and the natural history exhibit—their origins, development, and the thoughts and methods behind their creation—as the best reflections of the histories of the scientific disciplines. To this end, Asma mingles the legacies of medical and anatomical museums with those natural history institutions.

Asma maintains that a person's experience while viewing a prepared specimen is cultural rather than scientific, and that natural history museums dramatize the transformation of several strands of Western civilization's intellectual traditions. For Asma, these museums (despite their involvement in research) are cultural institutions, and fill the same role as historic sites, art galleries and performing arts centers.

If natural history museums are cultural institutions, then what aspects of human culture do they represent? Asma asserts that the earliest museums of nature and science were, in actuality, detailed portraits of their creators' personal views of nature, much as early museums of art were portraits of the tastes and sensitivities of influential collectors. Asma cites two institutions that reflect the culminating philosophical assertions of both English and French Enlightenment scientists. First, the Hunterian Museum of Medicine (Royal College of Surgeons, London) shows the varying forms of living things as reflections of their having been shaped by similar functions; the second, Baron George Cuvier's Gallery of Comparative Anatomy, portrays the diversity of life as an outcome of animals having been shaped by their precise roles in nature's scheme.

According to Asma, these viewpoints still exert significant influences, and ''nationalism'' persists in how natural history is presented to the public. The recently remodeled Paris Natural History Museum and its Grand Gallery of Evolution serves as an example of this ''nationalism.'' Here, Darwinian natural selection—indeed the achievements of Darwin himself—command very little space, when compared to generous efforts to portray a Cuvierian (or, more accurately, a Buffonian) portrait of a world endowed with a dazzling array of life forms, each playing very specific, unchanging roles.

Asma presently serves as a professor of philosophy, and his approach to his subject reflects his enthusiasm for interdisciplinary studies, as well as its tendency toward a more informal style of scholarship. Readers of other popular, non-fiction works inspired by natural history may find Asma's style to be somewhat derivative. And moving through Asma's discourses on the history of science might seem at times to be a tedious read for a career scientist, history scholar or museum professional, but these histories are certain to cover fresh ground for the average reader.—*James M. Bryant, Riverside Municipal Museum, 3580 Mission Inn Avenue, Riverside, California 92501.*

Museum Collection Resources Display Available for Loan

The Resources Subcommittee of the Conservation Committee (SPNHC) maintains two displays of supplies and materials used by many museums for the storage and preservation of natural history collections. Examples of items included in the displays are: materials used in the construction of storage containers and specimen supports; equipment for monitoring storage environments (e.g., humidity, temperature, air quality, insects); and a variety of containers for the storage of collections and documentation. Some of the products are discipline-specific (e.g., pH-neutral glassine for interleaving between herbarium sheets) but most can be used in multidisciplinary collections (e.g., Ethafoam™ for lining shelves and drawers; Tyvek™ tape for box and tray construction). The displays are available for loan to interested parties for meetings, conferences, and other museum-related activities. Shipping costs to and from the requested venues are the responsibility of the borrower. There is no loan fee but SPNHC invites borrowers to make a voluntary contribution to cover the costs of routine maintenance. For additional information, or to borrow a display, contact:

Cindy Ramotnick
US Geological Survey
Department of Biology
University of New Mexico
Albuquerque, New Mexico 87131
telephone (505) 346-2870
fax (505) 277-0304
email ramotnik@unm.edu

or

Janet Waddington
Department of Palaeobiology
Royal Ontario Museum
100 Queen's Park
Toronto, Ontario M5S 2C6
telephone (416) 586-5593
fax (416) 586-5863
email janetw@rom.on.ca