

# **Health and Safety Technical Resources on Pesticides for the Conservator**

**A Special Insert Contributed by**

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## Introduction

Recently there has been renewed interest in the general application of pesticides in museums and more specifically, pesticides directly applied to artifact collections. This resource guide has been compiled to assist the conservator in gaining a better understanding of the broad subject of pesticides in museums. The guide provides references to both published literature and website resources. Most references are briefly annotated. It must be noted that website addresses often change and it may be necessary to employ a search engine to find updated addresses if those listed here are no longer accessible.

References are listed in thirteen sub-categories, which are grouped into three broader sections. The first section consists of general pesticide resources, pesticide directories, references about pesticides and museums, as well as references and resources about pesticide use history, including museum case studies. The second section contains references and resources pertaining to health, safety, and toxicology; legislation and regulatory information; and pesticide analysis and mitigation. The third section includes references and resources pertaining to specific classes of pesticides, such as inorganic and organochlorine.

## Section I: General Pesticide Resources

Bloomquist, Jeffrey R. 1996. *Insecticides: Chemistries and Characteristics*. University of Minnesota. <http://ipm-world.umn.edu/chapters/bloomq.htm>. This chapter in an online textbook on pest control (Radcliffe's IPM World Textbook) describes the chemistry and action of different classes of insecticides.

Mallis, Arnold. 2003. *Handbook of Pest Control, 9th edition*. Cleveland, OH: Mallis Handbook & Technical Training Co. (In Press. The 1997 8th edition is now out of print.) The Mallis Handbook is a comprehensive guide to every facet of pest control. It is considered the "bible" for pest control experts and economic entomologists. There are chapters on fumigation, pheromones, sensitive environments (schools, hospitals, zoos, museums), pesticide safety, and there is a glossary of technical terms. Chapters are organized by pest or by topic. Each chapter is written by an expert and has extensive descriptions of insect life cycles and feeding habits, and each includes an extensive bibliography.

National Pesticide Information Center, <http://npic.orst.edu>.

Olkowski, William, S. Daar, and H. Olkowsiki. 1991. *Common Sense Pest Control*. Newtown, CT: Taunton Press. This textbook describes both chemical and non-chemical approaches to pest control.

Pesticides Action Network (PAN) Pesticides Database, [www.pesticideinfo.org/Index.html](http://www.pesticideinfo.org/Index.html). This site is a search engine for pesticide chemicals. Search results include chemical information, toxicity, regulatory information, impacts on water and aquatic organisms, and reference to related chemicals.

University of Nebraska, Pesticide Education Resources, <http://ianrwww.unl.edu/ianr/pat/ephome.htm>.

U.S. Environmental Protection Agency, Office of Pesticide Programs, [www.epa.gov/pesticides](http://www.epa.gov/pesticides).

Ware, George. 1996. *Complete Guide to Pest Control with and without Chemicals*. 3rd ed. Fresno, Calif.: Thomson Publications.

Ware, George W. 1999. *An Introduction to Insecticides*. 3rd ed. University of Minnesota. <http://ipmworld.umn.edu/chapters/ware.htm>. This chapter in an online textbook on pest control (Radcliffe's IPM World Textbook) describes the different classes of insecticides and their characteristics.

Ware, George W. 2000. *The Pesticide Book*. 5th ed. Fresno, Calif.: Thomson Publications. This textbook includes excellent sections on pesticide history, legislation, and health and safety issues.

## Pesticide Directories

California Environmental Protection Agency, Department of Pesticide Regulation, [www.cdpr.ca.gov](http://www.cdpr.ca.gov). Among the many useful tools on this website is a database of pesticide products and chemical ingredients, both active and inactive.

Eastern Branch of the American Association of Economic Entomologists. *Entoma; A Directory of Insect Pest Control Listing Insecticide Manufacturers*. Plainfield, N.J., 1935.

College Science Publishers *Entoma. Pesticide Handbook*. State College, Pa., 16th ed.; 1951-64.

Entomological Society of America. *Entoma, Pesticide Handbook*. College Park, Md., 17th ed.; 1965-. The serial *Entoma* is a very useful tool for historic pesticide use research as each annual issue lists manufacturers, trade names, and formulations for pesticides now long out of manufacture.

MeisterPro. 2003. *Crop Protection Handbook 2003*. Willoughby, OH: Meister Publishing Co. This directory includes a dictionary of over 13,000 pesticide formulations, a directory of pesticide suppliers and a section on regulatory compliance. The crop protection dictionary is also available for searching on line at [www.meisterpro.com](http://www.meisterpro.com).

MeisterPro. 2003. *Insect and Disease Control Guide*. Willoughby, Ohio: Meister Publishing Co. This guide provides crop specific information on hundreds of insecticides and fungicides.

USDA Beltsville Area Agricultural Research Service Pesticides Properties Database <http://wizard.arsusda.gov/acsl/ppdb.html>. This website provides a database of over 300 pesticide chemicals, which lists transport, degradation, and other characteristics, used to predict potential for pesticides to move into ground and surface water. Some of these characteristics are quite useful for understanding the persistence of different chemicals.

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## Pesticides and Museums

Caldararo, Niccolo, Lee Davis, Peter Palmer, and Janet Waddington, eds. *The Contamination of Museum Materials and the Repatriation Process for Native California: Proceedings of a Working Conference at the San Francisco State University, 29 September to 1 October 2000*. Collection Forum, Volume 16. The papers presented in these proceedings deal with the problems associated with the repatriation of pesticide contaminated museum collections. Several papers address testing and analysis techniques for pesticide residues.

Carpenter, Jim. 1985. Museums Can be Hazardous to Your Health. *Aviso*. June, pp. 1–2. The author reviews a report from NIOSH on hazards found in museums, including a variety of pesticides.

Child, Robert E. and David B. Pinniger. 1987. Insect Pest Control in U.K. Museums. *Recent Advances in the Conservation and Analysis of Artifacts*. London: Institute of Archaeology. pp. 303–307.

Child, Robert E. and David Pinniger. 1992. The Inefficient Use of Insecticides in Museums. *Life After Death: The Practical Conservation of Natural History Collections*. London: United Kingdom Institute for Conservation. pp. 15–16.

Dawson, J.E. 1992. *Solving Museum Insect Problems: Chemical Control*. CCI Technical Bulletin #15. Ottawa: Canadian Conservation Institute. This technical bulletin provides a very useful review of pesticide chemicals used in museums during the 1980s and earlier. Section ten of the report documents the properties and side effects of several chemicals and formulations from the different pesticide classes.

Florian, Mary-Lou. 1978. Biodeterioration of Museum Objects: An Ecological Approach to Control and Prevention. *Museum Roundup*. BC Museums Association. pp. 35–40. This article includes discussion of insecticides in use in museums in the 1970s such as dichlorvos, paradichlorobenzene, pentachlorophenol, and pyrethrins.

Hawks, Catharine A., Stephen L. Williams and Joan S. Gardener. 1984. *The Care of Tanned Skins in Mammal Research Collections*. *Museology*. No. 6. Lubbock, Tex.: Texas Tech Press. Included in this review of preparation and preservation techniques is discussion of a variety of pesticide chemicals then in use as fumigants, such as: ethylene oxide, ethylene dichloride, methyl bromide, Dow-fume, naphthalene and dichlorvos.

Hawks, Catharine and Kathryn Makos. 2000. Inherent and Acquired Hazards in Museum Objects: Implications for Care and Use of Collections. *CRM*. No. 5. pp. 31–37. This article discusses inherent and acquired hazards found in museum collections. Pesticide application to museum objects is an acquired hazard and the authors provide an excellent summary of the issues involved.

Hawks, Catharine and Kathryn Makos. 2001. Hidden Hazards: The Dark Side of Collections. *CIPP Post-*

*prints–2001*. Available from the CIPP webpage on the AIC website: <http://aic.stanford.edu/consp/cipp/post-prints2001.html#hawks>. This paper discusses a range of inherent and acquired hazards found in museums, including pesticides, and presents different methods to mitigate the risk from these hazards. In addition there are six tables, which include a table of materials used as pesticides and fungicides in museum collections and a table of materials that may have left persistent residues. There is also a table listing health and safety resources and suppliers. Updates of some of these tables may be acquired directly from the authors by e-mail.

Johnson, Jessica S. 1999. Masked Hazard. *Common Ground*. Fall issue. pp. 26–31. The author reviews the issues concerning pesticide residue contamination in museums and recommends several steps and precautions that can be taken to deal with associated problems.

Johnson, Jessica, ed. 2001. *Contaminated Collections: Preservation, Access and Use. Proceedings of A Symposium held at the National Conservation Training Center, Shepherdstown, West Virginia, April 6–9, 2001*. Collection Forum. Volume 17. The papers presented in these proceedings deal with the problems associated with contaminated museum collections, repatriation of contaminated collections, health and safety concerns, and analysis and mitigation of residues.

Linnie, M.J. 1990. Conservation: Pest Control in Museums—The Use of Chemicals and Associated Health Problems. *International Journal of Museum Management and Curatorship*, vol. 9. pp. 419–433. The author provides an overview of many of the chemicals used in museums and their documented health effects.

McGiffin Jr., Robert F. 1983. *Furniture Care and Conservation*. Nashville, Tenn.: American Association for State and Local History. In chapter ten there is a discussion of insect control for furniture collections and the use of pesticides. Ethylene oxide, paradichlorobenzene and dichlorvos are among the pesticides recommended for use.

McGiffin Jr., Robert F. 1985. *A Current Status Report on Fumigation in Museums and Historical Agencies*. Technical Report #4. Nashville, TN: American Association for State and Local History. This report reviews several pesticide chemicals used for fumigation in museums in the 1980s.

Odegaard, Nancy, Marilen Pool, and Alyce Sadongei, eds. 2000. *Old Poisons New Problems: Information and Resource Guide for Contaminated Cultural Materials in Museum Collections*. Based on a workshop held at the Arizona State Museum, University of Arizona, Tucson, Arizona, March 16–17, 2000. (In press) In addition to discussion of the issues surrounding pesticide contamination of cultural materials in museums, this book provides several useful charts and glossaries pertaining to the identification, historic use, regulation, and toxicity of pesticide chemicals known to have been used in museums. There is also a chapter on analytical testing of pesticide chemicals and there is an extensive bibliography.

Odegaard, Nancy. 2000. Contaminated Cultural Materials in Museum Collections: Reflections and Recommendations for a NAGPRA Issue. *WAAC Newsletter*. 22(2):18–20.

Pinniger, David. 1990. *Insect Pests in Museums*. Debigigh, Clwyd: Archetype Publications Ltd. The author reviews pest control measures used in U.K. museums, including the use of a variety of pesticides.

Rossol, M. and W.C. Jessup 1996. No Magic Bullets: Ethical Considerations for Pest Management Strategies. *International Journal of Museum Management and Curatorship*, 15(2):145–168. This article presents some of the ethical, legal, and regulatory aspects of pest management. Also included are a review of different pesticides by classification, some of the health hazards associated with pesticide use, a review of governmental regulations and legislation, and recommendations concerning contracts with commercial pest control operators.

Strang, Thomas J.K. and John E. Dawson. 1991. *Controlling Museum Fungal Problems*. Technical Bulletin No. 12. Ottawa: Canadian Conservation Institute.

Strang, Thomas J.K. and John E. Dawson. 1991. *Controlling Vertebrate Pests in Museums*. Technical Bulletin No. 13. Ottawa: Canadian Conservation Institute.

Zycherman, Lynda A. and J. Richard Schrock, eds. 1988. *A Guide to Museum Pest Control*. Washington, DC: American Institute for Conservation and the Association of Systematics Collections. This guide is an update to Edwards et al. (1981) and provides more detail on the effects of pesticides on health and on artifact materials. There is particular emphasis on the study of ethylene oxide and dichlorvos. There is also an excellent and extensive bibliography.

#### [Pesticide Use History: Case Studies and Research Resources](#)

Anon. 1959. Pest Control in Art Galleries and Natural History Museums. *Pest Control*. 27(11):9–16. A review of pesticides historically used at the Field Museum, the Smithsonian, and the Cleveland Museum of Natural History.

Burns, Ned J. 1940. *Field Manual for Museums*. Washington, D.C.: US Government Printing Office. Chapter seven of this manual provides technical methods for museums, including pest control. Also included are recommendations for a variety of pesticides for different collection material types.

Chapin, James P. 1929. *The Preparation of Birds for Study*. NY: American Museum of Natural History. This guide of techniques for preserving birds as specimens at the AMNH recommends the use of arsenicals, borax, and naphthalene.

DeOng, E.R. 1948. *Chemistry and Uses of Pesticides*. NY: Reinhold Publishing Corp. This book contains a dictionary of insecticides, which is useful for historical research on early pesticide use. There is also a brief section of early pesticide legislation in the United States.

Edwards, Stephen R., Bruce M. Bell, Mary Elizabeth King et. al. 1981. *Pest Control in Museums: A Status Report (1980)*. Lawrence, KS: Association of Systematics Collections. This book is a useful historical reference for pesticide use in museums from the 1970s and earlier, as it provides the results of a pesticide use survey conducted at several museums.

Farber, Paul Lawrence. 1977. The Development of Taxidermy and the History of Ornithology. *Isis*. 68(244):550–566. This article provides a review of the early historical materials and techniques employed in ornithological specimen preservation.

Goldberg, Lisa. 1996. A History of Pest Control Measures in the Anthropology Collections, National Museum of Natural History, Smithsonian Institution. *Journal of the American Institute for Conservation*. 35(1):23–43. The author provides extensive information about the historical use of pesticides in this survey of pest control measures for the NMNH. Included are several tables, which describe names, properties, health related statistics, regulatory status, and health effects for several pesticide chemicals.

Hall, A.J. 1966. *Textile Finishing*. 3rd ed. London: Heywood Books. This book includes a discussion of chemicals used to mothproof textiles in manufacturing from the 1920s to the 1960s including silicofluorides and a variety of organochlorines. There is also some discussion of fungicide chemicals used on textiles.

Hough, W.A.M. 1889. The Preservation of Museum Specimens from Insects and the Effects of Dampness. In *Annual Report of the Board of Regents of the Smithsonian Institution for the Year Ending June 30, 1887*. Part 2. Washington, DC: Government Printing Office. pp. 549–558. This article is a very useful historical reference on pesticides likely used in museum collections in the 19th century.

Jackson, Hartley H.T. 1926. The Care of Museum Specimens of Recent Mammals. *Journal of Mammology*. 7(2):113–119. This article includes recommendations of a variety of pesticide chemicals for the fumigation of natural history specimens in museums in the 1920s.

Lutz, Frank E. 1930. *How to Collect and Preserve Insects*. 7th ed. AMNH Guide Leaflet No. 39. New York: American Museum of Natural History. The author recommends the use of cyanide as a killing agent, camphor and naphthalene for storage, and carbon disulfide as an insecticide.

Mail, G. Allen. 1948. New Chemical Spells Doom for Moths. *Pest Control and Sanitation*. 3(6):11–13. This article describes a number of pesticide chemicals used as mothproofers, including silicofluorides, paradichlorobenzene, naphthalene, and DDT.

Mallis, Arnold. 1954. *Handbook of Pest Control*. New York: MacNair-Dorland Co. This book is an excellent historical resource describing characteristics of pesticides available up to the 1950s. Many of the pesticides described in this edition are not found in more recent editions.

O'Neil, Maryadele, ed. 2001. *The Merck Index*. 13th ed. Whitehouse Station, NJ: Merck & Co., Inc. This encyclopedia of chemicals is an excellent reference tool. Older editions provide information on chemicals used in pesticide formulations no longer manufactured.

Peltz, Perri and Monona Rossol. 1983. *Safe Pesticide Procedures for Museum Collections*. New York: Center for Occupational Hazards. This report is an overview of a conference held in New York in 1983 on the use of pesticides in museums. It provides information on chemical and non-chemical methods of pest control recommended at that time.

Reagan, Barbara M. 1982. Eradication of Insects from Wool Textiles. *Journal of the American Institute for Conservation*. 21(2):1-34. This is an in-depth review of chemical and nonchemical methods used to control insects from damaging woolen textiles. There are useful descriptions and tables of fumigants, repellants, sprays, mothproofing agents, and other agents.

Story, Keith O. 1985. *Approaches to Pest Management in Museums*. Suitland, MD: Conservation Analytical Laboratory, Smithsonian Institution. Part I of this manual describes a variety of insect pests found in museums. Part II describes a variety of non-chemical (cultural and structural) and chemical pest management approaches. There is a useful discussion of pesticide chemicals. This manual is a useful reference for pesticides used in museums in the 1970s and 1980s. There is also an index of chemical trade names and a glossary of terms.

VanGelder, Richard G. 1965. Another Man's Poison. *Curator*. 8(1):55-71. The author recommends the use of arsenic trioxide for the direct treatment of mammal specimens and paradichlorobenzene or naphthalene for storage.

Williams, Stephen L., and Catharine A. Hawks. 1985. History of Preparation Materials Used for Recent Mammal Specimens. In H. H. Genoways, C. Jones, and O.L. Rossolimo, eds. *Mammal Collection Management*. Lubbock: Texas Tech University Press, pp. 21-49. The authors provide an excellent review of materials and techniques historically used in the preparation and preservation of recent mammal specimens. Included is a particularly useful appendix of primary and supplementary materials used along with associated references.

## Section II: Pesticide Health, Safety, and Toxicology

Agency for Toxic Substances and Disease Registry, [www.atsdr.cdc.gov/atsdrhome.html](http://www.atsdr.cdc.gov/atsdrhome.html).

American Industrial Hygiene Association, [www.aiha.org](http://www.aiha.org).

The Chemical Database, the Department of Chemistry at the University of Akron, <http://ull.chemistry.uakron.edu/erd>.

Extension Toxicology Network "Exttoxnet," <http://ace.orst.edu/info/exttoxnet/ghindex/html>.

Hayes, W.J., Jr., and E.R. Laws, Jr. (eds.), 1991. *Handbook of Pesticide Toxicology*. 3 volumes. Academic Press. This book covers general principles of pesticide toxicology, effects of pesticide classes, and data on 256 compounds that have documented human effects.

Makos, Kathryn A. and Elizabeth C. Dietrich. 1995. Health and Environmental Safety. In *Storage of Natural History Collections: A Preventive Conservation Approach*. Vol. 1 (C.L. Rose, C.A. Hawks, and H.H. Genoways, eds.) Iowa City: Society for the Preservation of Natural History Collections. pp. 233-252. Among the hazards reviewed by the authors are pesticide contaminants in museum collections. There is discussion of identification, including analytical techniques, and monitoring for inhalation hazards. There is also a section on work practice controls or guidelines for protection from exposure.

Makos, Kathryn A. 2001. Hazard Identification and Exposure Assessment Related to Handling and Use of Contaminated Collection Materials and Sacred Objects. In *The Contamination of Museum Materials and the Repatriation Process for Native California: Proceedings of a Working Conference at the San Francisco State University, 29 September to 1 October 2000*. Collection Forum. Volume 16. pp. 93-112.

National Institute for Occupational Safety and Health, [www.cdc.gov/niosh/homepage.html](http://www.cdc.gov/niosh/homepage.html).

National Institute for Occupational Safety and Health. 2002. *NIOSH Pocket Guide to Chemical Hazards: And Other Databases*. DHHS (NIOSH) Publication No. 2002-140. On CD-ROM. June 2002. This CD-ROM is an excellent resource for health and safety information on hazardous chemicals, many of which are found in pesticide formulations. Other databases on the list include information on equipment, analytical methods, and personal protective clothing. The disk is updated every year. If not acquired from the Health and Safety Committee Booth, call (800) 35-NIOSH for a free copy, or go to [www.cdc.gov/niosh/homepage.html](http://www.cdc.gov/niosh/homepage.html).

National Library of Medicine, Specialized Information Service, <http://sis.nlm.nih.gov>. Among the several databases provided on this website are: toxicology and environmental health, chemical information, and a directory of health organizations. There is also a handy new database on household products, which provides ingredients, details on health and safety, manufacturer information, and MSDS data. Household use pesticides are included in the products covered by this database.

Watterson, A., Van Nostrand Reinhold. 1989. *Pesticide Users' Health and Safety Handbook: An International Guide* (out of print).

World Health Organization, International Programme on Chemical Safety. 2002. *The WHO Recommended Classification of Pesticide by Hazard and Guidelines to Classification, 2001–2002*. [www.inchem.org/documents/pds/pdsother/class.pdf](http://www.inchem.org/documents/pds/pdsother/class.pdf).

World Health Organization, International Programme on Chemical Safety, Pesticide Data Sheets and Health and Safety Guides, [www.inchem.org/pages/pds.html](http://www.inchem.org/pages/pds.html), [www.inchem.org/pages/hsg.html](http://www.inchem.org/pages/hsg.html).

### Pesticide Legislation and Regulation

Institute of Agriculture and Natural Resources. 1999. *Federally Registered and Restricted Use Pesticides: June 1999*. University of Nebraska Cooperative Extension Bulletin EC99-2500-A. Lincoln: University of Nebraska.

Marco, Gino J., Robert M. Hollingworth, and Jack R. Plimmer. 1991. *Regulation of Agrochemicals: A Driving Force in their Evolution*. Washington, DC: American Chemical Society. This book contains an excellent review of the history of the agrochemical industry, including pesticide chemicals, and the legislation affecting them.

Pesticide.Net, [www.pestlaw.com](http://www.pestlaw.com). This website provides news and information regarding pesticide related regulations and legislation.

U.S. Environmental Protection Agency. Office of Pesticide Programs. 1998. *Status of Pesticides in Special Review and Reregistration*. EPA-738-R-98-002. This report provides information about the regulatory status of pesticide chemicals, including dates of registration, pending reviews, and cancellations.

U.S. Environmental Protection Agency. Office of Pesticide Programs, <http://epa.gov/pesticides>.

### Pesticide Analysis and Mitigation

Boulton, Ann. 1986. The Examination, Treatment and Analysis of a Pair of Boots from the Aleutian Islands, Including a Note About Possible Pesticide Contamination. *Journal of the American Institute for Conservation*. 25(1):1–13.

Collas, Tania and Allyson Lazar. 2003. Sampling Strategies and Testing Procedures for Identifying Arsenic and Mercury Pesticide Residues. *WAAC Newsletter*. 25(2):19–23.

Found, Christine and Kate Helwig. 1995. The Reliability of Spot Tests for the Detection of Arsenic and Mercury in Natural History Collections: A Case Study. *Collection Forum*. 11(1):6–15.

Glastrup, Jens. 1987. Insecticide Analysis by Gas Chromatography in the Stores of the Danish National Museum's Ethnographic Collection. *Studies in Conservation*. 32(2):59–64.

Hawks, Catharine and Deborah Bell. 1999. Removal of Stains Caused by Mercuric Chloride Treatments of Herbarium Sheet Labels. *ICOM-CC Preprints, 12th Triennial Meeting, Lyon 29 August–3 September 1999*. Paris: ICOM-CC. pp. 723–727.

Landry, Linda. 1988. Case Study: Nineteen Objects Tested for Arsenic Residue. *ICOM-CC Ethnographic Conservation Newsletter*. 18:3–4.

Lundbaek, Torben. 1995. Temporary Storage: A Challenge to the National Museum of Denmark. *Museum International*. 47(4):23–27. The author describes the problem of removing old pesticide residues (DDT) in preparing collections for a move.

Moye, H. Anson (ed.). 1981. *Analysis of Pesticide Residues*. Vol. 58 in Chemical Analysis Series. New York: John Wiley & Sons.

Muir, D., M. Lovell, and C.P. Pearce. 1981. Health Hazards in Natural History Museum Work. *Museum Journal*. 80(4):205–206. This article reports the results of tests conducted on collections in the late 1970s at the City of Bristol Museum and Art Gallery.

Nason, James D. 2001. Poisoned Heritage: Curatorial Assessment and Implications of Pesticide Residues in Anthropological Collections. In *Contaminated Collections: Preservation, Access and Use. Proceedings of A Symposium held at the National Conservation Training Center, Shepherdstown, West Virginia, April 6–9, 2001*. Collection Forum. Volume 17. pp. 67–81. The author describes the historical research and analytical testing protocols using XRF spectrometry in a study of pesticide residues on some of the collections at the Thomas Burke Memorial Washington State Museum in Seattle.

Odegaard, Nancy, Scott Carroll, and W.S. Zimmt. 2000. *Material Characterization Tests for Objects of Art and Archaeology*. London: Archetype Publications, Ltd. Among the material characterization tests in this manual, there are several excellent spot-tests for chemicals that are found in some persistent pesticide formulations, such as arsenic, mercury, and lead.

Odegaard, Nancy. 2001. Methods to Mitigate Risks from Use of Contaminated Objects, Including Methods to Decontaminate Affected Objects. In *Contaminated Collections: Preservation, Access and Use. Proceedings of A Symposium held at the National Conservation Training Center, Shepherdstown, West Virginia, April 6–9, 2001*. Collection Forum. Volume 17. pp. 117–121.

Purewal, Victoria. 2001. The Identification of Four Persistent and Hazardous Residues Present on Historic Plant Collections Housed within the National Museum and Galleries of Wales. In *The Contamination of Museum Materials and the Repatriation Process for Native California: Proceedings of a Working Conference at the San Francisco State University, 29 September to 1 October 2000*. Collection Forum. Volume 16. pp. 77–86.

Sirois, P. Jane and Genevieve Sansoucy. 2001. Analysis of Museum Objects for Hazardous Pesticide Residues: A Guide to Techniques. In *Contaminated Collections: Preservation, Access and Use. Proceedings of A Symposium held at the National Conservation Training Center, Shepherdstown, West Virginia, April 6–9, 2001*. Collection Forum. Volume 17. pp. 49–66.

Sirois, P. Jane. 2001. The Analysis of Museum Objects for the Presence of Arsenic and Mercury: Non-Destructive Analysis and Sample Analysis. In *The Contamination of Museum Materials and the Repatriation Process for Native California: Proceedings of a Working Conference at the San Francisco State University, 29 September to 1 October 2000*. Collection Forum. Volume 16. pp. 65–75.

Spittler, Terry D., John B. Bourke, Paul B. Baker, and George W. Helfman. 1985. Inhalation Exposure of Museum Personnel to Ethylene Dichloride–Carbon Tetrachloride Fumigant. *Dermal Exposure Related to Pesticide Use: Discussion of Risk Assessment: Based on a Symposium Sponsored by the Division of Pesticide Chemistry at the 187th Meeting of the American Chemical Society, St. Louis, Missouri, April 8–13, 1984*. Washington, DC: American Chemical Society. pp. 243–251. This article reviews a study conducted of staff at the Smithsonian Institution, National Museum of Natural History, who were involved in fumigation treatments of some of the natural history collections.

Vingelsgaard, V. and A.L. Schmidt. 1986. Removal of Insecticides from Furs and Skins: Registration of Conservation Condition. *ICOM Symposium of Ethnographic and Water-Logged Leather, 9-11.6. 86/Amsterdam*. ICOM: Amsterdam. pp. 51–60. This paper reviews the techniques used to analyze and mitigate the presence of pesticide residues such as DDT and lindane from Arctic ethnographic collections at the Danish National Museum.

### Section III: Botanical and Synthetic Pyrethroid Pesticides

Elliot, Michael. 1989. The Pyrethroids: Early Discovery, Recent Advances and the Future. *Pesticide Science*. 27:337–351.

Florian, Mary-Lou E. 1998. “Natural Products”: For Insect and Fungal Control? *ICOM-CC Ethnographic Conservation Newsletter*. 18:4–8.

### Halogenated Hydrocarbon Pesticides

Bell, Jan R. and Arthur H. Wolf. 1976. Rolling Your Own—A New System of Textile Storage. *Curator*. 19(3):246–249. The author discusses the use of paradichlorobenzene with roll mounts for textile storage.

Raphael, Toby. 1985. Use of Paradichlorobenzene in Museum Collections. *Conserv-O-Gram*. 3/12. National Park Service. Washington, D.C.

Raphael, Toby. 1985. Effects of Paradichlorobenzene on Museum Objects. *Conserv-O-Gram*. 3/13 National Park Service. Washington, D.C.

Raphael, Toby. 1985. Paradichlorobenzene Health and Safety Update. *Conserv-O-Gram*. 3/14 National Park Service. Washington, D.C. These now outdated and out of print Conserv-o-grams from the National Park Service are useful for understanding how PDB was employed in museums in the past.

Schantz, Viola S. 1949. A War-Time Fumigant Successful. *Journal of Mammology*. 30(1):82–83. The author describes the use of the fumigant mixture of carbon tetrachloride and ethylene dichloride for biological survey collections in 1943/1944 to replace the use of carbon disulfide.

### Inorganic Pesticides

Anon. 1984. Arsenic in taxidermy specimens. *Rocky Mountain Regional Conservation Center News*. 1(4):1.

Bloomcamp, Lee. 1987. Pest Control and Pesticide Usage in Museums and Systematics Collections. *ACS Newsletter*. 15(4). This article discusses the use of Vikane and Phostoxin, inorganic fumigants, and methyl bromide, a halogenated hydrocarbon pesticide, as well as other pesticides for use with natural history and anthropological collections.

Briggs, D., P.D. Sell, M. Block, and R.D. I'ons. 1983. Mercury Vapour: A Health Hazard in Herbaria. *The New Phytologist*. 1983(94):453–457. These authors present the results of studies conducted at the Cambridge University Herbarium where it was found that metallic mercury vapors were being released from specimens formerly treated with mercuric chloride.

Carter, David & Annette K. Walker (eds.). 1999. *Care and Conservation of Natural History Collections*. Oxford: Butterworth-Heinemann. This book includes a review of preservatives historically used on natural history collections, including arsenic, mercury, borax, and potassium aluminum sulfate. There is also discussion of chemicals used in tanning solutions as well as moth-proofing agents.

Derrick, Michele R., Helen D. Burgess, Mary T. Baker and Nancy E. Binnie. 1990. Sulfuryl Fluoride (Vikane): A Review of its Use as a Fumigant. *Journal of the American Institute for Conservation*. 29(1): 77–90.

Fenn, Julia. 1988. Fumigation with Hydrogen Phosphide “Phostoxin” at the Royal Ontario Museum. *Proceedings of the 14th Annual IIC-CG Conference May 27–30, 1988, Toronto*. Toronto: IIC-CG. pp. 115–123. The author discusses the use of Phostoxin as a pesticide fumigant on artifact collections at the Royal Ontario Museum in the late 1980s and its effects on artifact materials.

Hawks, Catharine A. and Stephen L. Williams. 1986. Arsenic in Natural History Collections. *Leather Conservation News*. 2(2):1–4. This article is a comprehensive review of the historic use of arsenic as well as mercuric chloride in natural history collections.

Hawks, Catharine A. and David W. Von Endt. 1990. Mercury and Mercury Compounds in Natural History Collections: An Annotated Bibliography. *Natural History Conservation*. 5:4–19.

Knapp, Anthony M. 2000. Arsenic Health and Safety Update. *Conserv O Gram*. 2/3. National Park Service, Washington, D.C.

Purewal, Victoria. 1999. The identification of hazardous pesticide and fungicide residues present on herbarium material. *SSCR Journal*. 10(4):5–9.

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