# The Organic Chemistry of Museum Objects

# John S. Mills Raymond White

**Butterworths** 

The organic chemistry of museum objects

### Butterworths Series in Conservation and Museology

Series Editors:	Arts and Archaeology		
	Stephen G Rees-Jones Courtauld Institute of Art, University of London		
	Architecture		
	<b>Derek Linstrum</b> Institute of Advanced Architectural Studies, University of York		
US Executive Editor:	Norbert Baer Conservation Center of the Institute of Fine Arts, New York University		
<b>Consultants:</b>	Norman Brommelle		
	<b>W T Chase</b> Freer Gallery of Art, Smithsonian Institution		
	Sir Bernard Feilden		
	<b>Elizabeth Pye</b> Institute of Archaeology, University of London		
	David Bomford National Gallery, London		
Published titles:	Artists' Pigments c. 1600–1835, 2nd Edition (Harley) Conservation of Historic Buildings (Feilden) Conservation of Library and Archive Materials and the Graphic Arts (Petherbridge) Conservation of Manuscripts and Paintings of South-east Asia (Agrawal) Conservation of Wall Paintings (Mora, Mora, Philippot) The Museum Environment, 2nd Edition (Thomson) Manual of Curatorship (Thompson)* Museum Documentation Systems (Light, Roberts, Stewart)* The Textile Conservator's Manual (Landi) Conservation and Exhibitions (Stolow) Conservation and Restoration of Works of Art and Antiquities (Kühn)		
Forthcoming titles:	Ancient Metals: A Microstructural Atlas Conservation of Glass Conservation of Internal and External Rendered Surfaces Conservation of Soil Constructed Buildings Conservation of Structural and Decorative Stone Conservation of Structural Timber Conservation of Marine Archaeological Objects Effective Museum Management* Materials for Conservation* * Related titles (not in series)		

## The Organic Chemistry of Museum Objects

John S. Mills Scientific Adviser

and

#### Raymond White Principal Scientific Officer

Scientific Department, The National Gallery, London

Butterworths London . Boston . Durban . Singapore . Sydney . Toronto . Wellington All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, including photocopying and recording, without the written permission of the copyright holder, application for which should be addressed to the publishers. Such written permission must also be obtained before any part of this publication is stored in a retrieval system of any nature.

This book is sold subject to the Standard Conditions of Sale of Net Books and may not be resold in the UK below the net price given by the Publishers in their current price list.

First published 1987

C Butterworth & Co (Publishers) Ltd. 1987

British Library Cataloguing in Publication Data Mills, John S.
The organic chemistry of museum objects.
1. Museum conservation methods
2. Chemistry, Organic
I. White, Raymond
069.5'3 AM145
ISBN 0-408-11810-5

Library of Congress Cataloging-in-Publication Data Mills, John S. (John Stuart) The organic chemistry of museum objects. Bibliography: p. Includes index. 1. Museum conservation methods. 2. Artists' materials. 3. Chemistry, Organic. I. White, Raymond. II. Title. AM145.M55 1986 069.5'3 86-12942

ISBN 0-408-11810-5

### Preface

The aim of this book is to provide an account of the composition, chemistry and analysis of the organic materials which enter into the structures of objects in museum collections. This project was embarked upon in the belief that there is a need for such a compendium, both on the museum side and on that of the academic chemist, and in the hope that it may bring the two closer together. The literature of conservation and that of chemistry overlap only to a small extent, and while most conservators and other technical museum personnel are at least aware (through the medium of the Art and Archaeolog y Technical Abstracts) of the existence of the relevant chemical literature, staff in the universities often know rather little of the more practical or ad hoc research scattered through the conservation journals.

A book intended for both chemists and nonchemists must involve some compromise, and only part of the text will be of interest to both parties. The chemists will not need the introductory chemistry of Chapter 1 while conservators and curators, perhaps even students, may not feel the need to inform themselves fully on, say, the chemistry of shellac. However, the book is intended to be read: it has not been compiled as a reference handbook of materials though it may partly serve this function for the natural products.

A word should be said regarding our policy both on coverage and on referencing. Both of these are generally more comprehensive on topics for which there exist no adequate books or review articles—resins and lacquers are a case in point—and in consequence there is no particular correlation between length of a chapter and the practical importance of its subject. A correlation between length and chemical complexity is more likely but even in the larger chapters no attempt is made at completeness.

Despite their practical importance, the major structural materials such as wood or skin products, are relatively simple chemically. These materials are included so as to be seen in their chemical context but they really need the individual treatment which, it is hoped, they will receive in due course in this Series. With regard to references, the later ones are always preferred to those of earlier years; prior to 1960 references are mainly confined to those of historical interest.

We thank our colleagues in the Scientific Department of The National Gallery for their help with our enquiries and their patience when practical investigations have sometimes been delayed by our preoccupation with this book. Our thanks are also due to the Consultant Editor, Professor Norbert S. Baer, and Mr. Stephen G. Rees-Jones, the Series Editor, for reading the manuscript and making many suggestions for improvements.

> John Mills Raymond White

This page intentionally left blank

## Table of contents

#### Preface

Intr	odu	icti	on
	vu u		•

1	Basic organic chemistry	
	<ul><li>1.1 Hydrocarbons</li><li>1.2 Compounds with functional groups</li></ul>	1 8
2	Analytical methods	
	<ul><li>2.1 Separation methods—chromatography</li><li>2.2 Spectrometric methods</li></ul>	13 17
3	Oils and fats	26
	<ul> <li>3.1 Composition</li> <li>3.2 Chemical properties of fats</li> <li>3.3 Changes in buried fats</li> <li>3.4 Drying oils and drying</li> <li>3.5 Minor components of oils and fats</li> <li>3.6 Products containing, or derived from, fats and fatty acids</li> </ul>	26 28 29 30 35 36
4	Natural waxes	41
	<ul> <li>4.1 Insect and animal waxes</li> <li>4.2 Plant waxes</li> <li>4.3 Fossil and earth waxes</li> <li>4.4 Detection and identification of waxes</li> </ul>	41 43 44 45
5	Bituminous materials	48
	<ul><li>5.1 Asphalt and bitumen</li><li>5.2 Tars and pitches</li><li>5.3 Elementary carbon</li></ul>	48 54 57
6	Carbohydrates: sugars and polysaccharides	60
	<ul> <li>6.1 Monosaccharides</li> <li>6.2 Oligosaccharides</li> <li>6.3 Polysaccharides</li> <li>6.4 Cellulose</li> </ul>	60 63 64 64

#### viii Table of contents

	6.5	Starch	66
	6.6	Plant gums and mucilages	66
	6.7	Identification of polysaccharides	68
	6.8	Lignin	69
	6.9	Lignans	70
7	Prot	eins	73
	7.1	Kinds of protein	74
	7.2	Properties and durability	78
	7.3	Analysis of proteins	78
	7.4	Amino acid dating of proteinaceous materials	79
8	Natural resins and lacquers		83
	8.1	The monoterpenoids	83
	8.2	Diterpenoid resins	85
	8.3	Triterpenoid resins	92
	8.4	Fossil resins	96
	8.5	Polyisoprenoids—rubber	99
	8.6	Insect resins—shellac	101
	8.7	Japanese lacquer	104
9	Synthetic materials		111
	9.1	Kinds of polymer	111
	9.2	Vinyl polymers	112
	9.3	Condensation polymers	115
10	Dye	stuffs and other coloured materials	121
	10.1	Colour and dyeing	121
	10.2	Natural dyestuffs	122
	10.3	Synthetic dyestuffs	129
	10.4	Fading of dyes	130
11	Fun	damental aspects of deterioration	134
	11.1	Radical reactions	134
	11.2	Other agents of deterioration	139
12	Ana	lysis in practice	141
	12.1	Paint	141
	12.2	Varnishes and lacquers	149
	12.3	Resinous objects	152
	12.4	Wax objects and coatings	152
	12.5	Bituminous adhesives and coatings	152
	Inde	ex	161