TATE PAPERS

ISSN 1753-9854

TATE'S ONLINE RESEARCH JOURNAL

The Materials Used by British Oil Painters in the Nineteenth Century

Joyce H. Townsend

Introduction

A comprehensive study of artists' oil painting instruction manuals and handbooks published in Britain 1800–1900 has recently been published by Carlyle[1], entitled *The Artist's Assistant*. This reviews virtually all the surviving literature on painting processes and materials which was aimed at professional artists and art teachers, and includes references to some of the more ephemeral literature aimed at amateur artists, decorators and tradesmen who used paint. The literature is covered very comprehensively and gives an excellent insight into what artists could have found out about their materials, had they cared to seek it out. Less is known, of course, about how much information each artist actually did seek out: inventories of studio contents at the artist's death often give the best clues, for example, Turner's includes his library contents.[2]

Another rich source is the archives of artists' colourmen, many of which survive from the earlier nineteenth century. The most notable and the largest of these is the Roberson archive, researched and described by Woodcock,[3] which covers almost the whole century, and includes ledgers of materials bought and sold, accounts with individual artists, correspondence, and some working recipes for manufacture of paint mediums and varnishes. The Winsor & Newton archive has been discussed in terms of pigment history to mid-century by Harley,[4] and in terms of pigments, canvas supports, oils, vehicles, and varnishes on sale from 1835 onwards by Carlyle.[5] The less well-researched Reeves archive is discussed from *c*.1856 by Carlyle,[6] and their watercolour materials as well as a paper archive are awaiting further study at the Museum of London. The colourman Berger has also been studied,[7] and there are apparently no surviving archives for other nineteenth-century colourmen, some of whom were absorbed by the 'big names' mentioned above, when the fate of their archives became linked with the fate of the takeover company.

Artists' correspondence, diaries and unpublished papers offer tantalising glimpses of materials used, but unless they have been both published and critically assessed by a materials historian, the information is often hard to interpret. Such material is more of a primary resource for future research than literature which can be assimilated into general knowledge as yet. It is also hard to locate, especially when it belongs to family papers. In the future, such resources may be available in a form which can be searched on the World Wide Web, for example the Whistler archive at the University of Glasgow, which includes correspondence to and from the artist, accounts and notes.[8] Woodcock has published a comprehensive list of artists' (auto)biographies from 1820 into the twentieth century, though many of the books themselves are out of print or difficult to locate.[9]

Information is available on a few artists. The wife of G.F. Watts published a good deal of information on him,[10] and Millais' son published Millais' life and letters.[11] Turner's very meagre references to varnishing in his correspondence have been assessed and found to say very little about his preferences.[12] In contrast, the diary of Ford Madox Brown is peppered with mentions of 'Roberson' and 'copal' which refer indiscriminately (and thus unhelpfully) both to unnamed paintings then being worked on, and to the artist's thoughts generally on the subject.[13]

Another obvious resource is the surviving materials, which includes artists' palettes as well as colourmen's archives. Most are known only through publications which include their analysis, for example,

two of Constable's,[14] one of Sargent's,[15] several of Turner's (figs.1–5),[16] and those in the Whistler archive mentioned above.[17] All but the first of these publications include a colour illustration of each palette. There is no published database on the whereabouts of such materials, though researchers sometimes mention a palette in unpublished dissertations. In the UK, the Royal Academy of Arts, London, has the most extensive collection of palettes, since Academicians were encouraged to donate one apiece. National and private museums – especially those devoted to a single artist – public libraries, university museums, and conservation training programmes often house small amounts of well-provenanced artists' materials.

Fig.1
Turner's 'Chelsea' palette, used at the end of his life.
Tate Archive 7315.5

Fig.2
Turner's paintbox, found in his studio after his death in 1851.
Tate Archive 7315.6

Fig.3
Small travelling chest, used by Turner to carry both paint mediums and medicine. The few remaining drops were analysed.[168]
Tate Archive 7315.8

Fig.4
Large travelling chest, used by Turner to store large supplies of dry pigment. The contents have been analysed.[168]
Tate Archive 7315.7

Fig.5
A selection of the sixty and more dry pigments found in Turner's studio after his death. The contents have been analysed.
Tate Conservation Archive Q04047

The largest number of unpublished dissertations on the materials of British art can be found in the Conservation and Technology Department of the Courtauld Institute of Art, University of London, and the Straus Centre for Conservation, Harvard University, Boston, USA. They can be consulted by appointment, and in some cases represent the only significant study of a particular artist's materials and techniques.

Supports and primings

Canvas was the support chosen for a definite majority of nineteenth-century paintings in the national collection for British art at Tate. Plain weave was mostly used. A significant proportion of works in this collection, perhaps 5-20%, have a panel support, or a more complex one involving paper or canvas on an auxiliary panel support, but the publications on the subject virtually exclusively cover canvas supports. Stretcher types and fibre type for British canvases are little discussed, but French ones have been described by Callen, whose monograph on French Impressionism includes one-to-one colour details of unprimed and primed canvases.[18] They greatly resemble their British counterparts.

Canvas stamps have received considerable attention. When their style is correlated with the detailed history of the artists' colourmen who supplied them, date ranges for the purchase of the canvas may be obtainable. Cobbe has produced the most comprehensive listing in print, for Winsor & Newton 1838-1920,[19] and Butlin has covered Brown of High Holborn's stamps as used by Turner *c.*1830–1850,[20] while others are in course of publication as a series of papers.[21] An unpublished and growing database of canvas stamps for British colourmen, which was built on the work of Cobbe, exists at Tate.[22] Later in the century, artists who travelled to Europe or the USA could have used local sources for canvas, and did, from anecdotal evidence. Some publications that document non-British colourmans' products discuss French stamps[23] and weave and fibre types,[24] and another discusses supports from American colourmen.[25] Stamps on individual paintings are occasionally mentioned, for example Roberson stamps,[26] discussed in connection

with textured primings. Some standard nineteenth-century canvas dimensions are tabulated by Carlyle[27] and by Townsend.[28] Studies of British artists' materials exported to other countries give insights into trends in use: eg thread counts of 15 per centimetre, and canvas stamps occurring on only about 10 per cent of canvases, have been found on canvases painted in Japan with British materials,[29] and their priming types have been studied.[30] No comparable published studies exist for British paintings in the UK – though unpublished dissertations probably tabulate at least some of the information that could be used to clarify trends in the use of supports.

The literature on panels as supports all tends to concentrate on those from earlier centuries, when all panels were well crafted for their purpose. Anecdotal evidence suggests that nineteenth-century ones vary from well-crafted purpose-made ones to recycled rubbish. Terms for board supports have been discussed,[31] as has the nineteenth-century use of academy and canvas boards, and millboards, in the UK,[32] France[33] and the USA.[34]

Supports and primings used by individual British artists have rarely been discussed in isolation, with the exception of Brett's supports[35] and Turner's primings.[36] As well as the composition of the priming, its absorbancy is a key feature of some artists' technique, but it is discussed less often than its colour, which profoundly influences the appearance of a painting. Callen illustrates unpainted areas of canvas on a number of French Impressionist paintings, and discusses artists' selection of canvas properties such as absorbency, texture, and the colour of the priming.[37] Most information on primings is to be found in papers on the materials of a given artist, to be discussed in a later section.

Pigments

There is vast literature on artists' pigments, which can only be summarised here. The best short summary is that of Gettens and Stout.[38] The first third of the century has been well covered by Harley[39] and the first edition of the much-edited Field's *Chromatography*[40] covers exactly the same period, from the viewpoint of a conscientious colourman. The manufacture, patenting and subsequent availability of the many pigments developed in the other two thirds of the century have not been clarified in such detail. Carlyle[41] summarises information on pigments and colours found in artists' manuals and handbooks, and lists colours sold by the colourmen Reeves, Roberson, Rowney and Winsor & Newton throughout the century, wherever these records survive: this gives potential availability, and an insight into the problems of colour change and incompatibility discussed at the time, but it is not yet matched by published experimental findings.

The assumption that every artist was keen to try out each newly-available material may not be justified. Turner did use new pigments soon after they became available,[42] but where a first attempt has been made to relate earliest date of manufacture and earliest analytical finding of a given pigment[43] there can be intervals of several decades. Further analysis may narrow these gaps, but it remains the case that some artists were wary of using untested pigments in important works. This has implications for dating within an *oeuvre*, and the detection of forgery, which have not been explored. Current methods of pigment analysis are well summarised within the conservation literature, though some papers do not include the keywords 'paintings' or 'artists' materials' in the title.[44]

Distrust of the quality of nineteenth-century materials[45] led to nineteenth-century experimental work on the stability of pigments. The Russell and Abney report[46] *The Action of Light on Watercolours* and the oft-reprinted book by Church,[47] *The Chemistry of Paints and Painting*, both published at the end of the century, echo modern texts on conservation science to a startling degree. More recent work has concentrated much more on the details of this vast subject than on such overviews.

The manufacture of pigments with poor lightfastness and/or inconsistent performance have been studied the most, for example madder[48] whose manufacture and quality were developed and improved by Field the colourman,[49] and Prussian blue.[50] The *Artists' Pigments* series covers the introduction, manufacture and detection of a number of nineteenth-century introductions in authoritative detail: cobalt, cadmium and chrome yellows,[51] synthetic ultramarine,[52] alizarin, emerald and Scheele's greens, and chromium oxide greens.[53] Many pigments are not yet covered in any depth, an exception being mummy,[54] though some have been the subject of more popular books, such as Perkin's mauve in the book of that name.[55] There are very

few studies that specifically cover instability or colour changes in pigments used in the nineteenth century, or by British artists. One exception is a study on the darkening of lead white by hydrogen sulphide.[56]

Paint, mediums and vehicles

Once again, Carlyle provides by far the most comprehensive source of information on paint formulation and use.[57] Her study indicates that innovation, a desire to improve new materials, a wish to emulate historic ones, and frequent dissatisfaction with paint on the market were the norm: the manufactured painting materials of the nineteenth century were complex and ever-changing, and do not show any clear lines of development towards improved stability. A good but brief summary of the changing means of storing paint,[58] from awkward bladders, through primitive syringes to easy-to-use tube paint, is also available. There are thorough studies (with short English summaries) of some specific materials: petroleum-based paints,[59] asphalt,[60] paint driers,[61] and crack patterns attributable to materials.[62]

There are no published summaries of the types of oil found to have been used throughout the century. A summary of the findings from the sources listed below under 'individual artists' would indicate that predominantly linseed oil, but sometimes either walnut or poppyseed oil, was was used in the first half of the century; poppyseed oil was found in increasing preference to linseed oil when paint which came from tubes has been analysed.[63] Paint which includes lead-based driers, or which has a more complex formulation, has generally been found to be linseed-based, when the oil type could be determined at all. Constable used fewer driers, and his oils have been found to be mainly poppyseed. Extensive tabulated analytical results for French paintings[64] imply that poppyseed oil was very commonly used in French tube paints by the last decades of the century, and there is also supporting documentary evidence.[65]

Problems with interpretation of the literature: adulteration and poor quality control

Any artist who used tube paints – and nearly all of them would have used some from the 1860s, on account of their convenience and easy obtainability – could no longer choose which oil to paint with. It came provided, with driers to mitigate the slower drying of poppyseed and walnut oils compared to linseed, and of some pigments, and must also have been provided with other additives designed to stop the paint drying up hopelessly fast in the tube once it had been opened. Wax has been found, and attributed to the last reason – improved shelf life of the paint in tubes – in the materials of Whistler[66] and the French-supplied materials of Puvis de Chavannes[67] and the French Impressionists.[68] Neither could the artist be sure that he/she was obtaining the pigments as stated on the tube, and artists' manuals and books about paint from this period include much information for artists on how to test for adulteration of pigments in the studio, and which (normally cheaper and more susceptible to colour change) adulterants to expect.[69]

Hunt is the artist best known for complaining to his colourmen, at length and over decades, about the quality of their products.[70] Townsend *et. al.*[71] listed pigments which were substituted with others, colour names which had multiple identities, those which were often supplied with additives, and colours of the same name but different formulation in oil and watercolour media. Oils, resins, media, solvents, varnishes were also affected, according to the literature of the day.[72] The problem was not confined to Britain: adulteration of materials was also perceived as a problem in Germany in the last decades of the nineteenth century.[73]

Varnishing practices

The most comprehensive source of varnish formulations and practice is Carlyle's monograph.[74] The same author has described the background to nineteenth-century varnishing practices.[75] The use of a varnish-like material as an interlayer applied before later paint has been discussed briefly.[76] Since the literature is so sparse for varnishes actually used by British artists, it is worth noting that the varnishing preferences of French artists,[77] and Van Gogh's use of eggwhite varnishes[78] have both been discussed in terms of their concerns over the glossiness or mattness of the varnished painting. G.F. Watts was unusual in his concern over the gloss of varnishes.[79]

White and Kirby[80] have analysed the varnishes used on paintings in the National Gallery, London,

during the nineteenth century. They note that mastic was the most popular varnish at mid-century, while dammar was scarcely used by 1850, a point also made by Carlyle[81] and Mayer and Myers,[82] though dammar was widely discussed just after that date. It was also first mentioned in Dutch sources in 1855, with mastic and volatile oil varnishes being mentioned most frequently at that time.[83] White and Kirby's analyses confirm the common occurrence of mastic, often as a spirit varnish and sometimes with (generally linseed) oil incorporated as a plasticiser. Mixed mastic and dammar varnishes, which may have been a consequence of adulteration, and mastic/copal varnishes were also found in that collection in the later nineteenth century; it could be seen that particular restorers used by the gallery favoured certain varnish types. Varnishes can only rarely be associated with a given artist, since there is evidence that other artists, or a restorer chosen by the purchaser, would often have been asked to varnish a painting for the first time, or to improve its appearance only a decade or two after painting.[84] Nineteenth-century paintings were often varnished in the frame in the earlier part of their lives, as surface examination makes clear – a practice which makes sampling for the original varnish, or one which might match documentary evidence, more open to interpretation.

Framing practices

It is only in the 1990s that there has been much published on original frames, with illustrations. The choice of frame has always been important to presentation, but more importantly it reflects the later nineteenth-century artist's intention. The context and development of portrait frames are well set out by Mitchell and Roberts[85] who illustrate frames made by Brown for Rossetti, and selected by Rossetti, Whistler, Burne-Jones, Hunt, and Sargent, and in a catalogue by Simon.[86] Some other frames have been illustrated in publications on the technical examination of individual works by Brett,[87] Burne-Jones,[88] Watts[89] and Whistler.[90] Nineteenth-century European and British frames including those for Alma-Tadema, Brown, Burne-Jones, Collins, Hughes, Hunt, Leighton, Moore, Rossetti and Whistler are illustrated by Mendgen,[91] for the Pre-Raphaelites (Brown, Collins, Hughes, Hunt, Rossetti and Sandys) by Roberts,[92] for later Victorian artists (Alma-Tadema, Burne-Jones, Drummond, Hunt, Leighton, Rossetti and Spencer Stanhope) by Roberts,[93] and for Poynter by Sawicki.[94] There is a good selection of drawings of frame mouldings used throughout the century by Mitchell and Roberts, in another publication.[95] Photographic archives of frames exist in several British national galleries, and can be consulted.[96]

Studies on the properties and deterioration of nineteenth-century materials

Values have been published for the glass transition[97] of the most common natural resin varnishes, a property that relates to their ability to retain dirt which has landed on the surface. This property, which would not have been understood in the nineteenth century, has been used to account for the excessive dirt retention of some oil-modified paint mediums.[98]

The melting points of various painting materials have been measured,[99] and can be related to probable damaging effects of lining at too high a temperature, namely loss of impasto, running of one layer into another and darkening.[100] Changes in appearance of Turner's paintings, arising both from his choice of materials and from conservation treatments, have been summarised.[101] Townsend[102] has compiled published values for the refractive index of paint media and varnishes, a property which influences the transparency of the paint film.

It is only since the early 1990s that researchers have tried to make accurate reconstructions of nineteenth-century materials, to age them both artificially and naturally, to use the resulting material to further the understanding of deterioration in real paintings, and to develop techniques of analysis that are well-targeted towards aged and much-altered materials. Paint mediums[103] modified by the addition of natural resins to form megilps,[104] and copal-based mediums,[105] as well as oil paints and mediums,[106] have been reconstructed, aged and studied with a view to improving their detection in real paintings, and better understanding their optical properties. Measurements of their response to solvent cleaning,[107] and their optical properties,[108] have begun. More publications can be expected in these areas in the coming decade.

Studies of the chemical deterioration processes of oil-based paints must begin with studies of the

chemistry of their drying: significant work has been published on the latter by Mills and White,[109] and very recently by Sutherland,[110] van den Berg,[111] van der Brink[112] and Languri *et. al.* [113] Recent studies[114] have focussed as well on the chemistry of aged and discoloured natural resin varnishes.

Literature which discusses the materials of individual artists

The two most-studied artists of the earlier nineteenth century are Turner and Constable. For Turner, his studio materials have been described, then[115] revisited by Eastaugh[116] for the red organic pigments, and by Townsend with a comprehensive summary of his use of supports and primings,[117] as well as a summary of the pigments he used in oil and watercolour media throughout his life.[118] Also described is his use of modified oil media, both in summary[119] and in considerable analytical detail.[120] The materials of some individual paintings have been discussed by a number of researchers.[121] Cove has described a good cross-section of Constable's materials, both pigments and media in paintings done over his lifetime,[122] his media and the contents of a palette,[123] and some individual paintings.[124] His practice of retaining some paint from an earlier composition into a later one has also been described,[125] as well as his sometime habit of modifying an earlier composition on the same support, wherein his materials were also analysed.[126] Some further analyses of his media[127] and techniques[128] are available.

Far less published analytical information is available for other artists of the first half of the century: Cotman and Crome[129] have been studied in some detail. The terms of reference of this paper exclude William Blake, who did not paint in oil medium. This author does not know of any published studies on the materials used by Callcott, Etty, Lawrence, Martin, Mulready, Leslie, Stansfield or Wilkie, to name some serious omissions.

At mid-century, the literature on individual artists seems sparse – until one realises how much less there is for later decades. Redgrave's writings and a small number of his paintings have been studied.[130] The Pre-Raphaelites[131] have been researched far more than their conventional contemporaries, though predominantly in terms of what they wrote,[132] rather than the materials they used in practice. (They were uniquely prolific diarists, among artists, and in any case far more documentary material seems to have survived after *c*.1850 than before, which partly accounts for this.) Technical examinations of individual paintings by Hunt,[133] Millais[134] and Rossetti are available,[135] as well as findings for Brown, Collins and Hughes.[136]

Rather little has been published on British artists active after *c*.1860 in Britain. Exceptions include studies on Leighton,[137] Sargent,[138] Watts,[139] and Whistler.[140] There appear to be no technical studies of Alma-Tadema or Burne-Jones, to name but two establishment figures.

Very few exhibition catalogues published in the twentieth century include a sizeable technical entry based on analysis of materials. Cove on Constable is a notable exception.[141] The recent trend towards the inclusion of such information in collections catalogues, such as that for the Huntington Library and Art Gallery,[142] is very welcome. It seems likely that such information will be published on the World Wide Web in the future, under the web sites of individual museums, and possibly under the guise of a nineteenth-century artist's web site.

Table 1

British artists for whom published technical examinations are available.

Artist	Lifespan
Brett, John	1831–1902
Brown, Ford Madox	1821–1893
Collins, Charles Allston	1828–1873
Constable, John	1776–1837
Cotman, John Sell	1782–1842

Crome, John	1768–1821
Hughes, Arthur	1832–1915
Hunt, William Holman	1827–1910
Leighton, Lord Frederic	1830–1896
Millais, John Everett	1829–1896
Redgrave, Richard	1804–1888
Rossetti, Gabriel Dante	1828–1882
Sargent, John Singer	1856–1925
Watts, George Frederic	1817–1904
Turner, Joseph, Mallord William	1775–1851
Whistler, James Abbott McNeill	1834–1903

Literature on artists' studios and painting practices

A recent exhibition focussed on the commercial activities of artists in London, and the districts they chose to live in. Its catalogue[143] illustrates in colour many of the extant watercolours, paintings and photographs of artists' studios in the nineteenth century, and some artists' self-portraits with palette in hand. All are interesting but frustrating to the materials historian, for most of the studios were rather clearly tidied of the most fascinating clues to daily practice, or even moved bodily into the best-furnished room in the artist's possession, before being recorded for posterity. Even the photographs lack sufficient resolution for suppliers' names to be recognised on materials, or for studio props to be identified with those illustrated in colourmen's catalogues. The best evidence is still documentary, for example McGrath,[144] and derives from dairies, correspondence, and the catalogues mentioned above, which were more profusely illustrated as the century progressed, and black-and-white printing processes became more affordable. Painting materials[145] and outdoor sketching materials as advertised[146] have been discussed and illustrated recently.

Earlier in the nineteenth century, artists had sometimes practised drawing from the dead, or even from the *ecorché* figure,[147] as they had since the later seventeenth century. The practice declined, as it became harder to obtain bodies legally, and drawing from the plaster cast became more normal, as the first stage of training for aspiring artists. Live models were used throughout the century[148] for both male and female subjects. In the latter half of the century, many individual female models and/or mistresses and/or wives within the artist's circle can be identified in paintings by Rossetti, Whistler, Brown and other artists associated with the Aesthetic and Arts and Crafts movements,[149] while the male models are less frequently known. Lay-figures played an increasingly important role later in the nineteenth century, even with artists who also used live models and sitters for portraits, as has been documented by Woodcock.[150]

Materials use in a broader context

The focus of interest for technical studies is on French artists, not British ones, in the last decades of the nineteenth century. This is completely understandable, in terms of the international importance of French art. Notable examples include monographs on the French Impressionists[151] and the Barbizon school.[152] These publications offer the best examples of the intelligent synthesis of information painstakingly compiled from numbers of paintings and numbers of artists, then inter-compared and sometimes contrasted with documentary evidence. Artists studied in some depth include Gauguin[153] (who chose primings for absorbency) and Van Gogh. The latter's use of experimental primings as well as commercial ones,[154] fugitive red lakes,[155] egg white varnishes,[156] as well as wider aspects of his technique[157] have been discussed. American tonalists and impressionists have also been studied,[158] with particular emphasis on

Bierstadt,[159] and a directory of American colourmen has been published.[160]

Studies on British art are not yet ripe for such a synthesis: some of the more major artists have not been published on at all, (see above for examples, and Table 1 which lists the few whose works have been analysed,) and the lack of obvious national schools makes it less logical to compare other than all of them. What has been published represents work in progress, and attempts to document actual use of materials, as distinct from their first known date of invention, manufacture or publication. Summaries of what is known include the durability of modified oil mediums from the early- to mid-nineteenth century,[161] and the earliest uses of new pigments noted in the national collection of British paintings.[162]

Publications on non-British nineteenth-century materials are mentioned here because the trade in artists' tube paints and other materials was international by the end of the periods they cover, and thus their findings on pigments and media are comparable to British materials. For example, Zucker[163] states that by 1830-1840 American colourmen were selling imported materials from Europe with their own labels attached. They may not have been manufacturing equivalent materials in the USA by then, though by the end of the century they were.[164]

At the beginning of the century, British artists must have used predominantly materials from their own country. At mid-century, the limited evidence suggests that they still did. Turner for example used canvasses and boards supplied exclusively by London-based colourmen,[165] so did Constable to judge from the publications on his materials cited already, and Puvis de Chavannes used exclusively French materials in the earlier 1850s.[166] Studies on Whistler and Sargent,[167] both American-born artists who lived and worked in London and Paris more than in their native country, have shown that they used materials from British and French suppliers at least from the 1880s, and that in Whistler's case, he could buy German tube paints with attached labels from French and English colourmen.[168] There would have been a healthy export trade of British artists' materials, and doubtless other countries', to India and Japan as well as to the USA by then, and technical examination of western-style paintings in any of these countries could well reflect British practice, with a short time lag. Indeed, watercolour materials had been exported to the farthest corners of the British empire throughout the nineteenth century, for the use of tourists and amateur artists as well as surveyors, the military, botanists and other 'professional' users.

Fig.6
A further selection of Turner's studio pigments. The contents have been analysed.[168]
Tate Conservation Archive Q04047

Notes

1. L. Carlyle, *The Artist's Assistant: Oil Painting Instruction Manuals and Handbooks in Britain 1800–1900 with Reference to Selected Eighteenth-century Sources*, London 2001, pp.277–80, 337–543.
2. A. Wilton, *Turner in his Time*, London 1988, pp.248–9.
3. S. Woodcock, 'The Roberson Archive: A Colourful Past', *The Picture Restorer*, no.12, 1997, pp.14–7. S. A. Woodcock, 'The Roberson Archive: Content and Significance', in A. Roy and P. Smith (eds.), *Painting Techniques: History, Materials and Studio Practice*, London 1998, pp.30–7. S. A. Woodcock, *Index to Account Holders in the Roberson Archive 1820–1939*, Cambridge 1997.
4. R. D. Harley, *Artists' Pigments: A Study in English Documentary Sources*, 2nd ed., London 2001.
5. Carlyle 2001, pp.277–80, 337–543.
6. Carlyle 2001.
7. S. Carew-Reid, *Lewis Berger & Sons (1766-1960): An English Colour Manufactory*, unpublished

diploma dissertation, Courtauld Institute of Art, University of London 1997.
8. www.special.lib.gla.ac.uk/collections/whistler. [Note: 2004 address; see now http://www.whistler.arts.gla.ac.uk/].
9. S. Woodcock, '*The Life of a Painter*: Technical information in painters' biographies and autobiographies published in Britain 1820–1940', in Roy and Smith 1998, pp.240–5.
10. M. S. Watts, George Frederic Watts: The Annals of an Artist's Life, London 1912.
11. J. G. Millais, The Life and Letters of Sir John Everett Millais, Methuen & Co., London 1899.
12. J. H. Townsend, 'Turner's use of materials, and implications for conservation', in J. H. Townsend ed., *Turner's Painting Techniques in Context*, London 1995a, pp.5–11.
13. V. Surtees, *The Diary of Ford Maddox Brown*, New Haven and London 1981.
14. S. Cove, **'**Constable's oil painting materials and techniques: with 2 case studies', in L. Parris and I. Fleming-Williams (eds.), *Constable*, exhibition catalogue, Tate Gallery, London 1991, pp.493–529. S. Cove, 'Mixing and Mingling: John Constable's oil paint medium *c*.1802–1837, including the analysis of the "Manton" paint box', in Roy and Smith 1998, pp.211–6.
15. J. Ridge, and J. H. Townsend, 'John Singer Sargent's Later Portraits: Their Technique and Materials', *Apollo*, no.148, 1998, pp.23–30.
16. J. H. Townsend, 'The Materials of J.M.W. Turner: Pigments', *Studies in Conservation (SinC)*, no.38, 1993a, pp.231–54.
17. J. H. Townsend, 'Whistler's oil painting materials', *The Burlington Magazine*, no.CXXXVI, 1994a, pp.690–5. x
18. A. Callen, *The Art of Impressionism: Painting Technique and the Making of Modernity*, New Haven and London 2000, pp.27-9, 30-44, 50-61, 62-85, 100.
19. A. Cobbe 'Colourmen's canvas stamps as an aid to dating paintings: a classification of Winsor and Newton's canvas stamps from 1838-1920', *SinC*, no.21, 1976, pp.85–94.
20. M. Butlin, 'Turner's unfinished oils: some new evidence for their late date', *Turner Studies*, no.1(2), 1981, pp.43–5.
21. C. Proudlove, 'London artists' colourmen. Part I: A to D' *The Picture Restorer*, no.10, 1996, pp.10–12.
22. It can be viewed by appointment at Tate Conservation Department.
23. S. Constantin, 'The Barbizon painters: a guide to their suppliers', *SinC*, no.46, 2001, pp.49–67.
24. Callen 2000. K. Vanderlip de Carbonnel, 'A study of French painting canvases', *Journal of the American Institute for Conservation (JAIC,)* no.20, 1981, pp.3–20.
25. A. W. Katlan, *American Artists' Materials Vol.2: A Guide to Stretchers, Panels, Millboards and Stencil Marks*, Connecticut, USA 1992.
26. C. Holden, 'Luke Fildes R.A. 1844–1927: "The Doctor" 1890–91', in *Completing the Picture*, London 1982, pp.65–8.
27. Carlyle 2001, pp.447–9.
28. J. H. Townsend, 'The materials of J.M.W. Turner: Primings and supports', *SinC*, no.39, 1994b, pp.145–53.
29. N. Kamba, '19th-century canvas manufacturers in England', *Kokoritsu Rekishi Minzoku Hakubutsukan kenkyu hokoku* no.40, 1992, pp.121–35.
30. N. Kamba, 'The ground of oil paintings in early Meiji period', *Bulletin of the National Museum of Japanese History* no.19, 1989, pp.357–91.
31. S. Jaques, 'A brief survey of paper board and some of the literature describing it with some definitions of marketing terms for mount boards used in conservation', *The Paper Conservator*, no.23, 1999, pp.1–12.
32. P. Bower, *Turner's Later Papers: A Study of the Manufacture, Selection and Use of his Drawing Papers 1820–1851*, exhibition catalogue, Tate Gallery, London and Delaware 1999 pp.114–6. P. Bower, 'The vivid surface: Blake's use of paper and board', in J.H. Townsend (ed.), *William Blake the Painter at Work*, London, 2003, pp.54–60.
33. Callan 2000.
34. A. Katlan, 'The American artist's tools and materials for on-site oil sketching', *JAIC*, no.38, 1999,

pp.21-32.

35. K. Lowry, 'A technical note on Brett's paintings', in *John Brett: A Pre-Raphaelite on the Shores of Wales*, exhibition catalogue, National Museum and Gallery of Wales, Cardiff 2001, pp.38–43, 116–20.

36. Townsend 1994b.

37. Callan 2000.

38. R. J. Gettens and G. L. Stout, *Painting Materials: A Short Encyclopaedia,* New York 1966.

39. Harley 2001.

40. G. Field, *Chromatography*: *or, A Treatise on Colours and Pigments, and of their Powers in Painting, &c*., London 1835.

41. Carlyle 2001, pp.465–543.

42. Townsend 1993a. J.H. Townsend, 'Painting techniques and materials of Turner and other British artists 1775–1875', in A.Wallert, E. Hermens, and M. Peek (eds.), *Historical Painting Techniques, Materials and Studio Practice*, Los Angeles, USA 1995b, pp.176–86.

43. J.H. Townsend, 'Painting techniques and materials of Turner and other British artists 1775–1875', in A. Wallert, E. Hermens, and M. Peek, (eds.), *Historical Painting Techniques, Materials and Studio Practice*, Los Angeles, USA 1995b, pp.176–86.

44. J.H. Townsend, 'Analysis of pastel and chalk materials', *The Paper Conservator*, no.22, 1998, pp.21–8. A. Burnstock, 'Introduction to methods for the analysis of pigments and plasters – an overview', in *The Analysis of Pigments and Plasters*, London 1998 pp.5–8. M. Clarke, 'The analysis of medieval European manuscripts', *Reviews in Conservation*, no.2, 2001, pp.3–17.

45. Carlyle 2001.

46. W.J. Russell, and W. de W. Abney, *Action of Light on Watercolours*, London 1888.

47. A.H. Church, *The Chemistry of Paints and Painting*, London 1890. R. Bubb, '*George Field: A study of the manuscript notebooks concerning pigment manufacture, with particular reference to madder, its history and cultivation, including some biographical notes,* unpublished dissertation, Courtauld Institute of Art, University of London (1983).

48. R. Bubb, 'The life and work of George Field, colourmaker (1777–1854)' in H. Althöfer (ed.), *Das 19. Jahrhundert und die Restaurierung. Beiträge zur Malerei, Maltechnik und Konservierung*, München 1987, pp.238–47.

49. R. D. Harley, 'Field's manuscripts: early nineteenth-century colour samples and fading tests', *SinC*, no.24, 1979, pp.75–84.

50. J. Kirby, 'Fading and colour change of Prussian blue: occurrences and early reports', *National Gallery Technical Bulletin*, no.14, 1993, pp.62–71. R. H. Feller (ed.), *Artists' Pigments: A Handbook of their History, Characteristics and Use*, vol.1, Washington D.C. 1986.

51. A. Roy (ed.), *Artists' Pigments: A Handbook of their History, Characteristics and Use*, vol.2, Washington and Oxford 1993.

52. Ibid.

53. E. E. Fitzhugh (ed.), *Artists' Pigments: A Handbook of their History, Characteristics and Use*, vol.3, Washington and Oxford 1997.

54. S. Woodcock, 'Body colour: the misuse of mummy', *The Conservator*, no.20, 1996, pp.87–94.

55. S. Garfield, *Mauve: How One Man Invented a Colour that Changed the World*, London 2001.

56. L. Carlyle, and J. H. Townsend, 'An investigation of lead sulphide darkening of nineteenth-century painting materials', in S. Hackney, J. H. Townsend, N. Eastaugh and V. Todd (eds.), *Dirt and Pictures Separated*, London 1990, pp.40–3.

57. Carlyle 2001. L. Carlyle, 'From dead-colouring to finishing: British eighteenth- and nineteenth-century oil paint application as discussed in contemporary oil painting instruction books', in S. Wallace, J. MacNaughtan, and J. Parvey (eds.), *The Articulate Surface: Dialogues on paintings between conservators, curators and art historians*, Canberra, Australia 1996, pp.103–16.

58. Anon., 'The collapsible tube', in L. Fairbairn (ed.), *Paint and Painting*, exhibition catalogue, Tate Gallery, London 1982, pp.67–9.

59. M. Barro, 'Die Petroleummalerei im 19. Jahrhundert', in Althöfer 1987, pp.248–251. P. Wyer, 'Die Ludwigschen Petroleumfarben', *Zeitschrift für Konservierung and Kunsttechnologie (ZKK)*, no.7, 1993, pp.343–58.
60. C. Bothe, 'Über Asphalt und seine Verwendung in der Malerei', *ZKK*, no.12, 1998, pp.351–86.
61. L. Carlyle, 'Paint driers discussed in nineteenth-century British oil painting manuals', *JAIC*, no.38, 1999, pp.69–82.
62. G. Theurer, '"Englisches Craquelée": Frühschwundrisse bei Ölgemälden', *ZKK*, no.12, 1998, pp.33–98.
63. R. White, J. Pilc, and J. Kirby, 'Analyses of paint media', *National Gallery Technical Bulletin (NGTB)*, no.19, 1998, pp.74–95.
64. Cove 1998.
65. Callan 2000, p.100.
66. Townsend 1994a.
67. T. Hensick, K. Olivier, and G. Pocobene, 'Puvis de Chavannes' allegorical murals in the Boston Public Library: history, technique and conservation', *JAIC*, no.36, 1997, pp.59–81.
68. Callan 2000.
69. L. Carlyle, 'Authenticity and adulteration: what materials were 19th-century artists really using?', *The Conservator*, no.17, 1993, pp.56–60.
70. Carlyle 2001, pp.461–2. M. R. Katz, 'Holman Hunt on himself: textual evidence in aid of technical analysis', in E. Hermens (ed.), *Looking Through Paintings,* Baarn, The Netherlands and London 1998 pp.415–44.
71. J. H. Townsend, L. Carlyle, N. Khandekar, and S. Woodcock, 'Later nineteenth-century pigments: evidence for additions and substitutions', *The Conservator*, no.19, 1995, pp.65–78.
72. Carlyle 2001.
73. B. Miller, 'Paintings materials research in Munich from 1825 to 1937', in Roy and Smith 1998, pp.246-8.
74. Carlyle 2001, pp.347–81.
75. L. Carlyle, 'Varnish preparation and practice 1750–1850', in Townsend 1995a, pp.21–8.
76. A. Southall, 'Turner's contemporaries: their materials, practices and opinions', in Townsend 1995a, pp.12–20.
77. M. Swicklik, 'French painting and the use of varnish', *Conservation Research*, Washington D.C. 1993, pp.157–76.
78. C. Peres, 'Matte Oberflächen und Eiweiβfirnisse bei Van Gogh und seinen Zeitgenossen', in A. Harmssen (ed.), *Firnis: Material – Ästhetik – Geschichte,* AdR-Schriftenreihe zur Restaurierung und Grabungstechnik, Braunschweig 1999, pp.183–7.
79. Woodcock 1998.
80. R. White, and J. Kirby, 'A survey of nineteenth- and early twentieth-century varnish compositions found on a selection of paintings in the National Gallery Collection', *NGTB*, no. 22, 2001, pp.64–84.
81. Carlyle 2001, pp.84–7.
82. L. Mayer, and G. Myers, 'A note on the early use of dammar varnish', *SinC*, no.47, 2002, pp.134–8.
83. M. Stols-Witlox, 'Final varnishes for oil paintings in Holland, 1600–1900. Evidence in written sources', *ZKK*, no.15, 2001, pp.241–55.
84. Carlyle 2001.
85. P. Mitchell, and L. Robert, *Frameworks: Form, Function and Ornament in European Portrait Frames*, London 1996, pp.353–402.
86. J. Simon, *The Art of the Picture Frame*, exhibition catalogue, National Portrait Gallery, London 1997.
87. Lowry 2001.
88. P. Mitchell, and L. Roberts, 'Burne-Jones's picture frames', *The Burlington Magazine,* no.CXVII, 2000, pp.362–70.
89. J. Ridge, 'G. F. Watts: "Sic transit"', in S. Hackney, R. Jones and J. H. Townsend (eds.), *Paint and Purpose: A Study of Technique in British Art*, London 1999, pp.90–5.
90. J. H. Stoner, 'Whistler's views on the restoration and display of his paintings', *SinC*, no.42, 1997,

pp.107–14. Hackney *et al.* 1999, pp.152–7.

91. E. Mendgen, *In Perfect Harmony: Picture + Frame 1850–1920*, exhibition catalogue, Van Gogh Museum and Kunstforum Wien, n.d.

92. L. Roberts, 'Nineteenth-century English picture frames. I. The Pre-Raphaelites', *The International Journal of Museum Management and Curatorship (IJMMC)*, no.4, 1985, pp.155–72.

93. L. Roberts, 'Nineteenth-century English picture frames II: the Victorian High Renaissance', *IJMMC*, no.5, 1986, pp.273–93.

94. M. Sawicki, "The Visit of the Queen of Sheba to King Solomon by Edward Poynter", 1884–1890. The Frame Revisited', *Australian Institute for the Conservation of Cultural Material Bulletin*, no.25, 2000, pp.21–32.

95. P. Mitchell, and L. Roberts, *A History of European Picture Frames*, London 1996, pp.67–74.

96. The National Gallery, the National Portrait Gallery, and Tate.

97. M. Schilling, 'The glass transition of materials used in conservation', *SinC*, no.34, 1989, pp.110–16.

98. Townsend 1995a.

99. J. H. Townsend, 'Thermomicroscopy applied to painting materials from the late eighteenth and nineteenth centuries', *Thermochimica Acta*, no.365, 2000, pp.79–84.

100. Townsend 1995a.

101. J. H. Townsend, 'Turner's oil paintings: changes in appearance', in V. Todd (ed.), *Appearance, Opinion, Change: Evaluating the Look of Paintings*, London 1990, pp.53–61.

102. J. H. Townsend, 'The refractive index of nineteenth-century paint media: a preliminary study', in J. Bridgland (ed.), *International Council for Museums Committee for Conservation (ICOM-CC) 10th triennial meeting*, London 1993b, pp.586–91.

103. The author has used the convention that 'paint media' is the term for broad and chemically distinct classes of materials, such as oil, watercolour, while variations within a class are described as 'mediums'. Thus, paints based on wax or copal, say, combined with oil, have oil-modified mediums.

104. J. H. Townsend, L. Carlyle, A. Burnstock, M. Odlyha, and J. J. Boon, 'Nineteenth-century paint media part I: The formulation and properties of megilps', in Roy and Smith 1998, pp.205-10. M. Odlyha, 'The role of thermoanalytical techniques in the characterisation of samples from Turner's "The Opening of the Wallhalla, 1843"', in Townsend 1995a, pp.29–34.

105. L. Carlyle, N. Binnie, G. Van der Doelen, J. Boon, B. McLean, A. Ruggles, 'Traditional painting varnishes project: preliminary report on natural and artificial aging and a note on the preparation of cross-sections', in Harmmsen 1999, pp.110–127. K. J. Van den Berg, J. van der Horst, and J. J. Boon, 'Recognition of copals in aged resin/oil paints and varnishes', in J. Bridgland (ed.), *ICOM-CC 12th triennial meeting* Lyon, London 1999, pp.855-61. S. Hackney, J. Ridge, J. H. Townsend, L. Carlyle, and K. J. van den Berg, 'Visual deterioration in Pre-Raphaelite paintings', in A. Phenix, *Deterioration of Artists' Paints: Effects and Analysis*, London 2001, pp.54–6. S. Hackney, J. Ridge and J. H. Townsend, 'Pre-Raphaelite technique, and its consequences', in R. Vontobel (ed.), *ICOM-CC 13th triennial meeting,* London 2002, pp.426–31. J. H. Townsend, J. Ridge and S. Hackney, *Pre-Raphaelite Painting Techniques 1848-56,* London 2004.

106. L. Carlyle, *MOLArt Fellowship. Historical Reconstructions of Artists' Oil Paint: an investigation of oil processing methods and the use of medium-modifiers*, Report No.72894, Canadian Conservation Institute, Ottawa 2000, revised 2001. L. Carlyle, 'Historical reconstructions of artists' oil paint: an investigation of oil processing methods and the use of selected artists' mediums', in Phenix 2001, pp.6–7. L. Carlyle, N. Binnie, A. Ruggles, and E. Kaminska, 'The yellowing/bleaching of oil paintings and oil paint samples, including the effect of oil processing, driers and mediums on the colour of lead white paint', in Vontobel 2002.

107. M. Kokkori, A. Phenix, and J. J. Boon, 'Solvent extraction of organic compounds from oleo-resinous "megilp" paint media', in Bridgland 1999, pp.318–24. K. Sutherland, *Solvent Extractable Components of Oil Films*, doctoral dissertation, University of Amsterdam, 2001.

108. Townsend 1993b. Hackney *et al.* 2002.

109. J. S. Mills, and R. White, *The Organic Chemistry of Museum Objects*, 2nd ed., Butterworth-

Heinemann, Oxford 1994.
110. Sutherland 2001.
111. J. D. van den Berg, *Analytical Chemical Studies on Traditional Oil Paint*, doctoral dissertation, University of Amsterdam, 2002.
112. O. van der Brink, *Molecular Changes in Tempera Paint Dosimeters*, doctoral dissertation, University of Amsterdam, 2001.
113. G. Languri, J. van den Berg, and J. Boon, 'Effects of additions of mastic copaiba balsam, asphalt or earth pigments on the chemical drying of oil and oil paint', in Phenix 2001, pp.25–6. G. Kanguri, *Molecular studies of Asphalt, Mummy and Kassel Earth Pigments*, doctoral dissertation, University of Amsterdam, 2004.
114. J. Boon, and G. van der Doelen 'Advances in the current understanding of aged dammar and mastic triterpenoid varnishes on the molecular level', in Harmssen 1999, pp.92–104. G. A. van der Doelen, K. J. van den Berg, and J. J. Boon, Comparative chromatographic and mass-spectrometric studies of triterpenoid varnishes: fresh material and aged samples from paintings', *Studies in Conservation*, no.43, 1998, pp.249–64. G. A. van der Doelen, *Molecular Studies of Fresh and Aged Triterpenoid Varnishes*, doctoral dissertation, University of Amsterdam, 1998.
115. N. W. Hanson, 'Some painting materials of J.M.W. Turner', *SinC*, no.1, pp.1954, pp.162–73.
116. N. Eastaugh, 'Some dyes and dye-based pigments in Turner's palette', in Townsend 1995a, pp.46–9.
117. Townsend 1994b.
118. Townsend 1993a. J. H. Townsend, *Turner's Painting Techniques*, exhibition catalogue, Tate Gallery, London 1993c. (Reprinted London 1996, 1999, 2005.)
119. Townsend 1995a.
120. Odlyha 1995. J.J. Boon, J. Pureveen, D. Rainford and J. H.Townsend, '"The Opening of the Wallhalla, 1842": the molecular signature of Turner's paint as revealed by temperature-resolved in-source pyrolysis mass spectrometry', in Townsend 1995a, pp.35-45.
121. Townsend 1995a. M. Wyld, and A. Roy, 'The making of "The Fighting Temeraire"', in *Turner: The Fighting Temeraire*, exhibition catalogue, National Gallery Publications, London 1995, pp.121–3. R. White and J. Pilc, 'Analyses of paint media', *NGTB*, no.17, 1996, pp.91–103. R. White and J. Pilc, 'Analyses of paint media', *NGTB*, no.16, 1995, pp.86–95.
122. Cove 1991.
123. Cove 1998.
124.S. Cove, 'The Constable project: current research into materials and techniques', *Conservation Today: the UKIC 30th Anniversary Conference*, London 1988, pp.59–63. S. Cove, 'An experimental painting by John Constable R.A.', *The Conservator*, no.12, 1988, pp.52–6.
125. M. Swicklik, 'Interpreting artist's intent in the treatment of John Constable's "The White Horse" sketch, *JAIC*, no.37, 1998, pp.362-72. A. Kirsh, and R. S. Levenson, 'Determining the status of Constable's "White Horse" sketch', in *Seeing Through Paintings*, New Haven and London 2000, pp.200–2.
126. A. Southall, 'John Constable 1776–1837: "Flatford Mill (Scene on a Navigable River)" 1816-dated 1817', in *Completing the Picture*, exhibition catalogue, Tate Gallery, London 1982, pp.34–8.
127. R. White, J. Pilc, and J. Kirby, 'Analyses of paint media', *NGTB*, no.19, 1998, pp.74–95.
128. S. Cove 'Constable's oil sketches on paper and millboard', in *The Institute of Paper Conservation: conference papers Manchester 1992*, London 1992, pp.123–8.
129. C. Proudlove, 'The early Norwich artists: their technique and the Dutch example', in A. W. Moore, *Dutch and Flemish Painting in Norfolk*, London 1988, pp.151–6.
130. H. Eastwood, *Richard Redgrave (1804–1888): a study of his paintings and work, in the context of the Victoria and Albert Museum, including the technical examination of four paintings*, unpublished dissertation, Royal College of Art/V&A Conservation Course, 1997.
131. Katz in Hermans 1998. S. Sheldon, 'Methods and materials of the Pre-Raphaelite circle in the 1850s', in Roy and Smith 1998, pp.229–35. M.R. Katz, 'William Holman Hunt and the "Pre-Raphaelite Technique"', in Wallert *et al.* 1995, pp.158–65. Townsend *et al.* 2004.

132. M. Aronson, *Trial and Error: Further Notes on the Materials and Techniques of the Pre-Raphaelite Painters*, unpublished dissertation, Straus Conservation Center, Harvard University, Boston, 1986. C. Thomas, 'Notes on the materials and techniques of "Chaucer Reading at the Court of Edward III..." by Ford Madox Brown, *Australian Institute for Conservation of Cultural Material Bulletin*, no.19, 1993, pp.1–6.
133. S. Hackney, 'William Holman Hunt: "The Awakening Conscience"', in Hackney *et al.* 1999, pp. 80–85. Townsend *et al.* 2004.
134. S. Hackney, 'John Everett Millais: "Ophelia"', in Hackney *et al.* 1999, pp.74–9. Townsend *et al.* 2004.
135. T. Byington, *A Technical Study of Five Oil Paintings by Dante Gabriel Rossetti in the Collection of the Fogg Art Museum*, unpublished dissertation, Straus Conservation Center, Harvard University, Boston, 1987. Townsend *et al.* 2004.
136. Hackney *et al.* 2001.
137. N. Wyllie, *Lord Leighton: his methods and materials*, unpublished diploma dissertation, Courtauld Instituite of Art, University of London, 1991.
138. Ridge and Townsend 1998. J. Ridge and J. H.Townsend, 'John Singer Sargent' in Hackney *et al.* 1999, pp.96–101.
139. Mitchell and Roberts 2000. C. Willoughby, 'Search for permanence: the materials and methods of G.F. Watts (1817–1904)', in Althöfer 1987, pp.203–16. J. Ridge, and J. H. Townsend, 'G F Watts in context: his choice of materials and techniques', Roy and Smith 1998, pp.223–8.
140. Townsend 1993a. Townsend 1994a. Stoner 1997. S. Hackney, 'Colour and tone in Whistler's nocturnes and harmonies', *The Burlington Magazine*, no.CXXXVI, 1994, pp.695–9. S. Hackney, 'Art for art's sake: the materials and techniques of J. A. M. Whistler', in Wallert *et al.* 1995, pp.186–90. S. Hackney, 'J. A. M. Whistler: "Nocturne in Blue and Silver: Cremorne Lights 1872"', in Hackney *et al.* 1999, pp.86-9.
141. Cove 1991.
142. R. Asleson, and S. Bennett, *British Paintings at the Huntington*, New Haven and London 2001.
143. K. Wedd, L. Peltz, and C. Ross, *Creative Quarters: the art world in London 1700–2000*, exhibition catalogue, Museum of London, London 2001.
144. M. McGrath, *A catalogue of some 18th and 19th-century patents dealing with artists' instruments',* unpublished diploma dissertation, Courtauld Institute of Art, University of London, 1973.
145. Carlyle 2001.
146. Katlan 1999.
147. I. Bignamini, 'The artist's model: from Lely to Hogarth', in I. Bignamini, and M. Postle, *The Artist's Model: Its Role in British Art from Lely to Etty*, exhibition catalogue, Nottingham University Art Gallery, Nottingham, 1991, pp.8-15.
148. M. Postle, 'The artist's model: from Reynolds to Etty', in Bignamini and Postle 1991, pp.16–24.
149. J. Marsh, and P. J. Nunn, *Women Artists and the Pre-Raphaelite Movement*, London 1989.
150. S. Woodcock, 'Posing, reposing, decomposing: life-size lay figures, living models and artists' colourmen in nineteenth-century London', in Hermens 1998, pp.445–64.
151. D. Bomford, J. Kirby, J. Leighton, and A. Roy, *Art in the Making: Impressionism*, exhibition catalogue, National Gallery, London 1990.
152. A. Burmester, C. Heilmann, and M. Zimmermann, *Barbizon. Malerei der Natur – Natur der Malerei*, München, Germany 1999.
153. V. Jirat-Wasiutyenski, and H. T. Newton Jr., *Technique and Meaning in the Paintings of Paul Gauguin*, Cambridge 2000.
154. K. Hoermann Lister, C. Peres, and I. Fiedler, 'Tracing an interaction: supporting evidence, experimental grounds', appendix in *Van Gogh and Gauguin: the studio of the south*, D. W. Druick, and P. K. Zegers (eds.), London 2001, pp.354–69.
155. C. Peres, M. Hoyle, and L. van Tilborgh (eds.), *A Closer Look*: *Technical and Art-Historical Studies on Works by Van Gogh and Gauguin*, Zwolle, The Netherlands 1995. J.-P. Rioux, 'Caractérisation de pigments décolorés dans les tableaux de Van Gogh peints à Anvers-sur-Oise', in Bridgland 1999, pp.403–8. E. Hendriks, and L. van Tilborgh, 'Van Gogh's "Garden of the Asylum": genuine or fake?', *The Burlington*

Magazine, no.CXLIII, 2001, pp.145–56.
156. C. M. Peres, 'Vincent Van Gogh's triptych of trees in blossom, Arles (1988). Part II. On egg white varnishes', in J. S. Mills, and P. Smith (eds.), *Cleaning, Retouching and Coatings*, London 1990, pp.131–3.
157. J. Leighton, A. Reeves, A. Roy and R. White, 'Vincent van Gogh's "A Cornfield, with Cypresses"', *NGTB*, no.11, 1987, pp.42–59.
158. L. Mayer and G. Myers, 'Understanding the techniques of American tonalist and Impressionist painters', *JAIC*, no.32, 1993, pp.129–39.
159. Bierstadt's late paintings: methods, materials and madness', *JAIC*, no.38, 1999, pp.33–44. S. M. Hartwell, and H. M. Parkin, 'Corcoran and Cody: the two versions of *The Last of the Buffalo*', *JAIC*, no.38, 1999, pp.45–54. L. Mayer and G. Myers, 'Bierstadt and other 19th-century American painters in context', *JAIC*, no.38, 1999, pp.55–67.
160. A.W. Katlan, *American Artists' Materials Suppliers Directory*, USA, 1992.
161. L. Carlyle, and A. Southall, '"No short mechanic road to fame": the implications of certain artists' materials for the durability of British painting 1770-1840', in R. Hamlyn (ed.), *Robert Vernon's Gift: British Art for the Nation 1847*, exhibition catalogue, Tate Gallery, London 1993, pp.21–6.
162. Townsend 1995b.
163. J. Zucker, 'From the ground up: the ground in 19th-century American pictures', *JAIC*, no.38, 1999, pp.3–20.
164. Katlan 1992.
165. Townsend 1993a.
166. Hensick *et al.* 1997.
167. Townsend 1994a. Townsend and Ridge 1998.
168. Townsend 1994a.

Acknowledgements

The author gratefully acknowledges the discussion, and access to research and/or conservation treatments in progress given by her collaborators and friends, especially Dr Jaap Boon and his group, Dr Leslie Carlyle, Sarah Cove, Dr Ashok Roy and his group, and Sally Woodcock; as well as her colleagues past and present at the Tate, in particular Stephen Hackney, Rica Jones, Jacqueline Ridge, and Anna Southall. All have helped immensely to further our understanding of a complex and varied period of materials history. Dr Aviva Burnstock, James Hamm, Dr Alison Murray, Dr Joyce Hill Stoner and Kate Olivier provided information on recent unpublished student dissertations. Jacqueline Ridge made useful comments on drafts, and suggested some additional references for inclusion.
This paper is based on the article by the same author, first published in *Reviews in Conservation*, vol.3, 2002, pp.46-55. *Reviews in Conservation* is published annually by the International Institute for Conservation of Historic and Artistic Works. Relevant references published between 2002 and October 2004 have been added by the author.
Joyce Townsend is a Senior Conservation Scientist at Tate.