Titian’s Painting Technique before 1540

National Gallery Company
London

Distributed by
Yale University Press
This edition of the Technical Bulletin has been supported by the American Friends of the National Gallery, London with a generous donation from Mrs Charles Wrightsman.

Series editor: Ashok Roy

© National Gallery Company Limited 2013
All rights reserved. No part of this publication may be transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any storage and retrieval system, without prior permission in writing from the publisher.

Articles published online on the National Gallery website may be downloaded for private study only.

First published in Great Britain in 2013 by National Gallery Company Limited
St Vincent House, 30 Orange Street
London WC2H 7HH

www.nationalgallery.co.uk

British Library Cataloguing-in-Publication Data.
A catalogue record is available from the British Library.

ISBN: 978 1 85709 552 4
ISSN: 0140 7430
1013916

Publisher: Jan Green
Project Manager: Claire Young
Editor: Lise Connellan
Design: Libanus Press
Picture Research: Rosalind McKever
Production: Jane Hyne and Penny Le Tissier
Repro by Alta Image
Printed in the United Kingdom by Butler, Tanner and Dennis

FRONT COVER
Titian, Bacchus and Ariadne (NG 35), 1520–3 (detail).

TITLE PAGE
TOP LEFT: Titian, The Holy Family with a Shepherd (NG 4), c.1510 (detail).
TOP RIGHT: Titian, The Music Lesson (NG 3), c.1535 (detail).
BOTTOM LEFT: Titian, Portrait of Gerolamo (?) Barbarigo (‘The Man with a Quilted Sleeve’) (NG 1944), c.1510 (detail).

Photographic credits
All photographs reproduced in this Bulletin are © The National Gallery, London unless credited otherwise below.

ANTWERP

BERGAMO
Comune di Bergamo - Accademia Carrara: fig. 9, p. 9.

EDINBURGH
© National Galleries of Scotland: fig. 158, p. 82. Photo: © The National Gallery, London, Courtesy of the Owner: fig. 157, p. 82.

FRANKFURT

GLASGOW
Glasgow Museums © CSG CIC Glasgow Museums Collection: figs 68, 70, p. 39; figs 71, 72, p. 40; figs 73, 74, p. 41; fig. 82, p. 43. Photo: © The National Gallery, London, Courtesy of the Owner: fig. 43, p. 24; fig. 69, p. 39; figs 75, 76, p. 41; figs 77, 78, 79, p. 42; figs 80, 81, p. 43.

KINGSTON LACY
The Banke Collection, Kingston Lacy © National Trust Photographic Library/Derrick E. Witty/The Bridgeman Art Library: fig. 16, p. 12.

OXFORD
Ashmolean Museum, University of Oxford. Photo: © The National Gallery, London, Courtesy of the Owner: fig. 32, p. 18; figs 37, 38, p. 20; fig. 191, p. 100; fig. 192, p. 101; figs 193, 194, 195, p. 102; figs 196, 197, 198; 199, p. 103; figs 200, 201, 202, 203, 204; p. 104; figs 205, 206, 207, 208, 209, p. 110; fig. 211, p. 107; figs 229, 230, 231, p. 117; figs 232, 233, 234, p. 118; figs 235, 236, 237, 238, 239, p. 119; figs 240, 241, p. 120; fig. 243, p. 121.

PADUA

PRAGUE

PRIVATE COLLECTION
Courtesy of Bonhams: fig. 234, p. 118.

ST PETERSBURG
© The State Hermitage Museum; fig. 51, p. 32. © The State Hermitage Museum/Vladimir Terebenin: fig. 52, p. 33; fig. 53, p. 34; fig. 55, p. 35; fig. 57, p. 37. Photo: © The National Gallery, London, Courtesy of the Owner: figs 54, 55, 56, p. 34; figs 58, 59, p. 35; figs 60, 61, 62, 63, 64, p. 36; figs 65, 66, p. 37.

VENICE
Gallerie dell’Accademia, Venice © Courtesy of the Ministero per i Beni e le Attività Culturali, Soprintendenza Speciale per il Polo Museale Veneto; figs 41, 42, p. 23. Photo: © The National Gallery, London, Courtesy of the Owner: fig. 29, p. 17.

WARMINSTER
Reproduced by permission of the Marquess of Bath, Longleat House, Warminster, Wiltshire, Great Britain; fig. 83, p. 44; fig. 84, p. 45.

WASHINGTON DC
Notes

Titan's Painting Technique before 1540

1 For example, the hoax in late eighteenth-century London known as the 'Venetian secret'; see M. Aronson, H.A. Cooper and A. Trumble, 'Benjamin West and the Venetian Secret' in Spring 2011, pp. 209–12.
5 One of the National Gallery paintings, 'The Aldobrandini Madonna' (cat. 11, p. 86), was instead examined in 2005 using a Hamamatsu vidicon. Only small areas of particular interest were recorded. The Triumph of Love (cat. 11) was examined using the SIRIS rather than OSIRIS camera.
9 In the funeral oration for his brother Francesco, who died in 1560, it was stated that both boys went to Venice when Francesco was twelve, but since it is disputed as to who was the elder this is not particularly helpful; see C. Hope in Manca 1993, p. 193, note 79, and Tagliferro and Aikema 2009, pp. 35–6.
10 Hale 2012, p. 45.
11 Reproduced in colour in Joannides 2001, p. 11. It is described as 'tempera on panel' but the assumption that a minor painter working in the 1490s would still be working in tempera is not necessarily correct. The landscape, in particular, suggests knowledge of Giovanni Bellini's work, Bellini, and Venetian painters of Zuccato's generation, such as Cima, had been working in oil for most of the last quarter of the fifteenth century; see J. Dunkerton, 'Bellini's Technique' in Humfrey 2004, pp. 198–201, and J. Dunkerton in Conegliano 2010, p. 75.
12 For the importance of mosaic in Venice and its effects on the young Titian see Hills 1999, esp. pp. 207–8.
13 Joannides 2001, p. 10, and Tagliferro and Aikema 2009, pp. 282–5. The Zuccato brothers were long-standing friends of Titian and his family.
14 Titian's signing of the documents associated with the frescoes of the Scuola del Santo in 1511 as 'Titian depentor' indicates that he was by then a master in the guild. The Venetian painters' guild or Arte dei Depentori included painters of all categories, who worked on all types of object. Painters of figures (depentori di figure) were of the same status within the guild as painters involved in other crafts, which suggests that when a young painter qualified to practise, the emphasis was mainly on practical aspects of painting. See Rosand 1982, pp. 9–14, and Humfrey 1995, p. 109.
15 For the most recent discussion of the Fondaco murals, extensively illustrated, see Joannides 2001, pp. 51–71.
16 Colalucci 1991. Titian's fresco technique was very traditional in terms of materials and process, having much in common with trecento frescoes in Padua, such as those of Giusto de' Menabuoi, but the handling is striking for its 'immediatezza ed estemporaneità'. There are no indications of any transfer process for cartoons and instead the first placement of the figures was brushed in with monochrome colours. Some finishing touches 'a secco' survive.
17 Colalucci 1991, p. 22. One of the six giornate was dedicated just to the raised arm of the woman. The Miracle of the Speaking Babe is equally remarkable, with the entire upper part painted in a single day; and the remaining twelve giornate given to the figures, either individually or in small groups.
18 The fresco of Saint Christopher in the Palazzo Ducale, Venice, has only three giornate, although the largest of these seems to have been painted over two days. The design was incised directly into the wet plaster, but was not always followed in the painting. See G. Nepti Scire, 'Recent Conservation of Titian's Paintings in Venice' in Venice and Washington 1990, pp. 110–11.
21 The 'Gypsy Madonna' (Kunsthistorisches Museum, Vienna) is the work by Titian most commonly cited as evidence of his debt to Giovanni Bellini, especially as X-radiography and infrared reflectography have demonstrated that it was originally even closer in design to Bellini's Virgin and Child in the Detroit Institute of Arts (see E. Oberthaler and E. Walmsley, 'Technical Studies of Painting Methods' in Washington and Vienna 2006, pp. 296–8). Since the painting by Bellini is dated 1509, Titian's work is likely to be later — that is, long after any putative apprenticeship in Bellini's workshop.
22 For the Vecellio family see Hale 2012, pp. 9–11.
23 It is sometimes assumed that Giorgione's golden yellow draperies are based on orpiment and realgar (see, for example, Washington and Vienna 2006, p. 26), but this is not supported by scientific analysis. While it is possible that small amounts of either pigment might have been used on areas of yellow, these are not the deep orange blues to be seen, for example, on the figure of Saint Peter in Cima's The Incredulity of Saint Thomas (NG 816), completed in 1504, and Giovanni Bellini's San Zaccaria Altarpiece of 1505 (Dunkerton and Roy 1986, p. 17, and Lazzarini 1983, p. 139).
25 In 1507 he received a commission for a painting for the Doge's Palace but nothing is known of its subject, size or location. For this and the inaccessibility and confusion about Giorgione's work by the time of Vasari's visits to Venice in the middle of the century see Joannides 2001, pp. 19–25.
26 As with so many early works by Titian there are widely divergent opinions on the date of this panel, ranging from 1508 (for example, C. Hope, 'The Early Biographies of Titian' in Manca 1993, pp. 180–2; A. Mazzotta in London 2012, pp. 74–6) to as late as 1514 (for example, Joannides 2001, pp. 166–70; M. Lucco in Rome 2013, p. 57).
27 The use of over-heated and heavy irons to attach the new canvas in traditional lining techniques can result in the flattening of the original surface texture and any impasto.
29 An entry made in 1600 in the account book of the Verona painter Paolo Farinati (Puppi 1968, p. 167) records the purchase of canvas for a banner with the price per braccio and an extra sum for the sewing. This was drawn to our attention by Roland Krischel who has generously shared with us his notes on artists' purchases of canvas in Venice and the Veneto, made, but not used, in connection with his publication of the inventory of the Venetian colour merchant Jacopo de' Benedetti (Krischel 2002 and R. Krischel, 'The Inventory of the Venetian "Vendecolori" Jacopo de' Benedetti: The Non-Pigment Materials' in Kirby, Nash and Cannon 2010, pp. 253–66).
30 In their account books, Lorenzo Lotto (Zampetti 1969) and Paolo Farinati (Puppi 1968) regularly record expenses for strainers and tacks together with canvas.
31 For other examples and discussion see Dunkerton, Foister and Penny 1999, pp. 266–8.
32 Dunkerton and Spring 1998.
33 For examples of white layers that could be either a priming or local underpainting in paintings by Bellini see Lazzarini 1983, plate XII; S. Caglio, F. Frezzato and G. Poli, 'Pigmenti, leganti, strati: osservazioni analitiche sulla tecnica pittorica del"Donna di NOLA"' in Aragivina and Villa 2007, pp. 75–90, for painting materials and layer structure.


35 L. Lazzarini, “Lo studio stratigrafico della Pala di Castelfranco e di altre opere contemporanee” in Lazzarini et al. 1978, p. 47. The lead white layer occurs in all the samples from the upper part of the painting. The Laura (Kunsthistorisches Museum, Vienna) also has gesso and no imprimitura. We are grateful to Elke Oberthaler for confirming this point.


37 Lazzarini 1981, plate XIII.

38 Dunkerton and Hirst 1986, p. 282.

39 Gennini 1960, pp. 19–23. Cennini describes the preparation of lead white and also notes that it is often mixed with other pigments. The use of lead white is common in early sixteenth-century Venetian paintings, and has been used alone, and where it has therefore been possible to confirm the presence of lead white. Berrie and Matthew have also re-analysed the imprimitura on this painting since the 1990 study, but interpreted the dolomite as a separate addition. See B. Berrie and L. Matthew, “Lead white from Venice: a whiter shade of pale?” in Spring 2011, pp. 295–301. A similar priming also features on Bellini’s Lady with a Mirror (Kunsthistorisches Museum, Vienna, information supplied by Elke Oberthaler).

40 Dunkerton and Spring 1998.


42 Dunkerton and Spring 1998.

43 Spring and Dunkerton 2003.

44 EDX analysis indicated that the zinc was associated with only sulphur in some places, and with both sulphur and potassium in others. The zinc sulphate is perhaps therefore present in two different forms since where potassium was detected the FTIR spectrum was slightly different. In the cross-section from the Portrait of Girolamo Barbarigo (cat. 5), where associated potassium was detected by EDX analysis, ATR–FTIR micro-spectroscopic imaging gave a sulphate spectrum with a single broad band at c. 1066 cm⁻¹. In the sample from La Schiavona (cat. 6), spectra from a zinc inclusion where no potassium was present gave a more complex sulphate band with a maximum at c. 1040 cm⁻¹ and additional sharp bands at c. 1157 and 966 cm⁻¹. Zinc soaps were detected in both cases and the spectra suggested that soaps of both the saturated fatty acids and the di-acids may be present. In the sample from La Schiavona, some zinc oxalate was also visible.

45 Among them Sacred and Profane Love (Galleria Borghese, Rome), probably painted in 1514 (L. Lazzarini, “Indagini scientifiche sui materiali e la tecnica pittorica dell “Amor Sacro e Profano” di Tiziano” in Lucchesi Ragni and Agosti 1991, pp. 381–3). In the Frari, Venice (1519–26), but not on the Pesaro Altarpiece of 1520, where similar layers are also present on the Pesaro Altarpiece. The zinc sulphate is perhaps therefore present in two different forms since where potassium was detected the FTIR spectrum was slightly different. In the cross-section from the Portrait of Girolamo Barbarigo (cat. 5), where associated potassium was detected by EDX analysis, ATR–FTIR micro-spectroscopic imaging gave a sulphate spectrum with a single broad band at c. 1066 cm⁻¹. In the sample from La Schiavona (cat. 6), spectra from a zinc inclusion where no potassium was present gave a more complex sulphate band with a maximum at c. 1040 cm⁻¹ and additional sharp bands at c. 1157 and 966 cm⁻¹. Zinc soaps were detected in both cases and the spectra suggested that soaps of both the saturated fatty acids and the di-acids may be present. In the sample from La Schiavona, some zinc oxalate was also visible.

46 Among them Sacred and Profane Love (Galleria Borghese, Rome), probably painted in 1514 (L. Lazzarini, “Indagini scientifiche sui materiali e la tecnica pittorica dell “Amor Sacro e Profano” di Tiziano” in Lucchesi Ragni and Agosti 1991, pp. 381–3). In the Frari, Venice (1519–26), but not on the Pesaro Altarpiece of 1520, where similar layers are also present on the Pesaro Altarpiece. The zinc sulphate is perhaps therefore present in two different forms since where potassium was detected the FTIR spectrum was slightly different. In the cross-section from the Portrait of Girolamo Barbarigo (cat. 5), where associated potassium was detected by EDX analysis, ATR–FTIR micro-spectroscopic imaging gave a sulphate spectrum with a single broad band at c. 1066 cm⁻¹. In the sample from La Schiavona (cat. 6), spectra from a zinc inclusion where no potassium was present gave a more complex sulphate band with a maximum at c. 1040 cm⁻¹ and additional sharp bands at c. 1157 and 966 cm⁻¹. Zinc soaps were detected in both cases and the spectra suggested that soaps of both the saturated fatty acids and the di-acids may be present. In the sample from La Schiavona, some zinc oxalate was also visible.

47 For the Assunta see note 43. For other examples where the only preparation on the canvas is a layer of gesso see Lazzarini 1983; Dunkerton and Spring 1998.

48 Dunkerton and Spring 1998. For further discussion of transfer techniques for underdrawing in Titian’s workshop see I. Artemieva and C. Kalinina, “Sulla storia e sul restauro del dipinto” in Ancona 1998, pp. 39–47. The first recorded discovery of an underdrawing by Titian is surely that of the Madonna with the Choirs (Kunsthistorisches Museum, Vienna), revealed during transfer in 1851 and recorded by a painted copy on the back of the original paint stilllithograph and Oberthaler and Walmesley, “Technical Studies of Painting Methods” in Washington and Vienna 2006) and Jacopo Pesaro being presented by Pope Alexander VI to Saint Peter (Dubois and Wallert 2003), as well as various other paintings by Titian in R. Bellucci and C. Fosinetti, ‘Considerazioni sul disegno e “underdrawing” nella pittura veneta e titiana’ in Florence 2011, pp. 51–62.

49 For further discussion of transfer techniques for underdrawing in Titian’s workshop see I. Artemieva and C. Kalinina, “Sulla storia e sul restauro del dipinto” in Ancona 1998, pp. 39–47. The first recorded discovery of an underdrawing by Titian is surely that of the Madonna with the Choirs (Kunsthistorisches Museum, Vienna), revealed during transfer in 1851 and recorded by a painted copy on the back of the original paint stilllithograph and Oberthaler and Walmesley, “Technical Studies of Painting Methods” in Washington and Vienna 2006) and Jacopo Pesaro being presented by Pope Alexander VI to Saint Peter (Dubois and Wallert 2003), as well as various other paintings by Titian in R. Bellucci and C. Fosinetti, ‘Considerazioni sul disegno e “underdrawing” nella pittura veneta e titiana’ in Florence 2011, pp. 51–62.


52 One of the more radical changes of drapery colour in Titian’s paintings seems to have been that to the pale lilac (now almost grey) dress of the woman on the left in Sacred and Profane Love (Galleria Borghese, Rome). Cross-sections reveal that originally this was a deep red colour, apparently completed with glazes of red lake before the change was made. See I. Lazzarini, ‘Indagini scientifiche sui materiali e la tecnica pittorica dell’Amor Sacro e Profano’ in Venice and Washington 1990, pp. 151–5.

53 R. Krischel, ‘The Inventory of the Venetian “Vendecolori” Jacopo
124 | NATIONAL GALLERY TECHNICAL BULLETIN VOLUME 34

Titian’s Painting Technique before 1540


58 For earlier workshops, and especially for Titian’s brother Francesco, see Tagliaferro and Aikema 2009, pp. 27–131.

59 For example, the series of young women with mirrors from the first decade of the century, probably painted mostly by Titian himself; the different versions of The Virgin and Child with Saint John, Jeanne and Maurice (W. Deiters, “Titian’s “Sacre Conversazioni” im Kunsthistorischen Museum, im Chiswick House und im Musée du Louvre” in Venice and Vienna 2008, pp. 141–7); the variations on ‘La Bella’ (W. Deiters and N. Gustavson, ‘Beispiele der Replizierung von Tizians früheren Bilderverbindungen’ in Vienna and Venice 2008, pp. 133–40; and also H. Glanzvill, F. Riitano and C. Seccaroni, “‘La Bella’ e le Fanciulle di Venezia e Sant Pietroburgo: spunti per una lettura tecnica integrata’ in Florence 2011, pp. 63–73). For ‘The Albrecht Dürer Madonna’ derivations see cat. 11.


61 Linseed oil was identified in one sample of white paint from Bacchus and Ariadne and two samples of brown paint and flesh paint in Venus and Adonis. The binder in the later Vindranum Family was characterised as walnut oil in six samples from different areas. In addition some GC analysis was carried out in the 1980s on a few samples which showed that the oil was heat-bodied oil but none of the results obtained gave ratios in the range expected for non heat-bodied oil. This result might also be accounted for by the use of a mixture of heat-bodied and non heat-bodied oils; for example, if the pigments were first ground in a non heat-bodied oil (as might be practical since it can be quite difficult to grind them with a rather thick oil), with a proportion of heat-bodied oil then being added on the palette.

62 Zinc was also found together with orange and yellow arsenic sulphide in Jacopo Pesaro being presented by Pope Alexander VI to Saint Peter (cat. 27). Dubois and W a l l e r t 2003 (analysis carried out at the National Gallery).

63 In Dunkerton and Spring 2003. The inclinations in the priming were analysed by SEM–EDX and so it was not appreciated at that time that the zinc was present as zinc sulphate, as it has now been possible to show by ATR–FTIR imaging. It was concluded in the earlier study that the zinc was present as part of an earth pigment, as in the sample analysed there was a large proportion of an earth pigment, as in the sample analysed there was a large proportion of an earth pigment. Although again a zinc-rich earth is postulated, it is recognised that it might be present in some other form.

64 The detection of zinc by XRF analysis has been reported in a significant number of Italian paintings. With this technique, however, it is not possible to determine the form in which the zinc is present. In some analyses a constant iron to zinc ratio was found and it was postulated on this basis that a zinc-rich earth pigment was present. In other cases the correlation with iron was not so certain; it is possible therefore that at least some of these cases represent other examples of zinc sulphate. See Molto and Seccaroni 2002. See also Borghese, Carini, Olivari and Scatarrati 2008, where zinc was reported in The Adoration of the Kings by Palma Vecchio, in red areas and those painted with arsenic sulphide pigments; and Amadori et al. 2012, where zinc was found by XRF in paint containing arsenic sulphide pigments. Although again a zinc-rich earth is postulated, it is recognised that it might be present in some other form.

65 Similar results were obtained by ATR–FTIR analysis to those for the prunings of the Portrait of Geronimo (? Barbarigo) (cat. 5) and La Schiavona (cat. 6, see note 42). Agglomerates containing zinc and sulphur only gave spectra with a maximum at c.1040 cm⁻¹ and two additional sharp bands at c.1157 and 966 cm⁻¹. Agglomerates that contained potassium in addition gave a more simple sulphate spectrum with a band at c.1070 cm⁻¹ and a weak band at c.980 cm⁻¹. Zinc soaps, perhaps formed with both saturated fatty acids and di-acids, were also detected by ATR–FTIR.


67 In the fifteenth-century Strasbourg manuscript (Borradaile and Borradaile 1966), for example, ‘glicem stein’ is an ingredient in a recipe for preparation of an oil that will make it ‘much clearer and paler’ as well as ‘very quick drying’, and it is also suggested that a small quantity ‘as much as a bean’ can be mixed with colours on the grinding slab ‘in order to make the colour dry well’ (Borradaile and Borradaile 1966, pp. 54–5). Charles Lock Eastlake discussed zinc vitriol as a drier at length and believed it was the favourite siccative of the Northern European painters of the fifteenth century; see Eastlake 1847 (1960), pp. 130–1. He interpreted ‘glicem stein’ as zinc vitriol, white copperas, and it is certainly a zinc compound. Zinc ‘steins’ are a so-called secondary drier. They increase the effectiveness of the final layer (the National Gallery analysis showed the drying of the paint surface) and encourage through drying of the paint film below the surface; see Tumosa and Mecklenburg 2005, and Erich 2006, pp. 10–12, for a summary of the action of dryers.

68 The recipe (no. 319) is entitled ‘Mordant for gilding glass, which has been tried by a Venetian Friar’ (Merrifield 1889, vol. 1, p. 620). Mary Philadelphia Merrifield in her English translation lists ‘coperoza, which must be line and white and not grey’ as one of the ingredients in this oil-based mordant or adhesive. As it is described as white this is clearly zinc vitriol (zinc sulphate) rather than another type. A recent Italian annotated edition of the Marciana manuscript dates it to the second half of the sixteenth century and transcribes this material as ‘coperoza che sia bella et bianca’: see Frezziato and Seccaroni 2010, p. 155 (entry 339).

69 Zinc sulphate has been found in Stephen Lochner’s Saint Matthew, Catherine of Alexandria and John the Evangelist (NG 705), about 1450, and in the Master of Liesborn’s The Adoration of the Kings (NG 258). In these works, however, it is always in paint composed of red lake, and since recipes for this pigment exist that include zinc vitriol it may be that here it is not associated with the medium, and is not a separate additive. Two other examples are Jan van Eyck’s Portrait of Margareta van Eyck (Groeningemuseum, Bruges). For more details on these paintings and on the recipes see Spring et al. 2012: Spring and Morrison, forthcoming. The presence of zinc (but not confirmed as zinc sulphate) has also been reported in a number of other paintings by Lochner and other Cologne painters; see Stege et al. 2012.

70 An example in red lake paint in what is probably an early work by Garofalo from around 1500 is published in Kirby, Spring and Higgitt 2005. It has also been detected in red paint in a large altarpiece by Lorenzo Costa and Gianfrancesco Mainieri, from around 1500 (NG 1119), and in two works by Giovanni Battista da Faenza from 1500–15 (NG 282 and NG 1051). In the second of these it was possible to show that the zinc is present as zinc sulphate by ATR–FTIR imaging, in a pale pink underlayer for a red lake layer. It was also found in this work together with arsenic sulphide pigments in orange paint. Other examples of zinc in orange and yellow areas painted with pigment or reagenta (revealed by XRF) have been reported in paintings by Palma Vecchio (see Borghese, Carini, Olivari and Scatarrati 2008).

71 See the examples in note 72, many of which are earlier in date than the paintings by Titian and are from elsewhere in Italy.


The red lake from HPLC analysis identified kermes from the scale insect Kirby, Saunders and Spring 2006. It seems likely, however, based on the dates, that New World cochineal from Dactylipous coccus Costa was used both here and in The Verdramin Family (see note 94). See also note 97.

J. Pesters and L. Lazzarini, 'I Materiali e la Tecnica dei Tintoretto della Scuola di San Rocco' in Rossi and Puppi 1996, pp. 275–80. Kirby and White 1996, p. 71. The red lake in Veronese's The Adoration of the Kings (NG 268), previously published as Polish cochineal, has been reanalysed and it now seems more likely that this pigment is cochineal of the New World type. Therefore it would be worth reconsidering the result from Veronese's The Consecration of Saint Nicholas (NG 26), which was published as probably Polish cochineal. One painting by Tintoretto, The Origin of the Milky Way (NG 1311), was found to contain lac. But overwhelmedly the existing red lake analyses from Venetian pictures in the later sixteenth century have identified carcinic acid.

The identification of Polish cochineal from Porphyrhophora palonica Linnaeus and similar species is based on the detection of carcinic acid with up to 15% kermesic acid and flavokermesic acid in addition. This can therefore be difficult to distinguish if a mixture of kermes and a carcinic acid-containing dye are present. However, the significant absence of kermesic or flavokermesic acid generally indicates that the dyestuff is not of the Polish cochineal type. The distinction between the Old World Armenian variety from Porphyrhophora hamelii Brandt and related species, and the New World cochineal from Dactylipous coccus Costa, is even more difficult to make. These two dyestuffs differ only in the proportions of the minor components, particularly that known as dclII. However, in practice dclII is rarely detected by HPLC analysis in samples of red lake paint, so it is generally not possible to specify analytically whether the source of the carcinic acid is the New World or Old World Armenian variety. See Cardon 2007, chapter 12.

This could be due to the relative expense of the Old World cochineal dyestuffs which were reserved for dyeing only the most expensive types of cloth, perhaps making shearings from these textiles less available to the pigment industry (see Molá 2000, pp. 107–31). One example of a pigment of this type is the red lake from the robe of the kneeling figure in Titian's Painting Technique before 1540 attributed to the workshop of Giovanni Bellini (NG 1098), dated to about 1475–80. HPLC analysis identified carcinic acid with some kermesic acid and the source of the dyestuff is likely to be Polish cochineal. Kirby, Spring and Higgitt 2003, p. 86.

For a discussion of names used for yellow lead-containing pigments see Kirk 1991 and Seccaroni 2006.

This will depend on whether yellow lead oxide (litharge, PbO) or red lead is used as the starting material. Both of these compounds react more readily with the binding medium to form lead soaps than lead-tin oxide, which might explain why this has happened so extensively in Titian's paintings, but since these oxides have been converted to soaps it is no longer possible to determine the starting material in this case, and whether the lead-tin yellow was originally more golden, as would be the case if unreacted red lead was present, or a rather pale variety, as it would be if unreacted litharge was present. Litharge associated with lead-tin yellow has been found by Raman analysis in paintings by Lotto, where it was, as here, interpreted as resulting from the preparation procedure of the lead-tin yellow; see Amadori et al. 2012, p. 19. Experiments making yellow lead-containing pigments to different recipes can be found in a discussion of names used for yellow lead-containing pigments 101. Fitzhugh 1997, pp. 49–50. Hills 1999, pp. 146–50.

Fitzhugh 1997, pp. 49–50. Garofalo also used orpiment and realgar sparingly in this way: see Dunkerton, Penny and Spring 2002.

We are grateful to Janet Ambers at the British Museum for the use of mineral samples see Kühn 1993 and Seccaroni 2006.


Fitzhugh 1997, pp. 49–50. Garofalo also used orpiment and realgar sparingly in this way: see Dunkerton, Penny and Spring 2002.

We are grateful to Janet Ambers at the British Museum for the use of mineral samples see Kühn 1993 and Seccaroni 2006.


Fitzhugh 1997, pp. 49–50. Garofalo also used orpiment and realgar sparingly in this way: see Dunkerton, Penny and Spring 2002.

We are grateful to Janet Ambers at the British Museum for the use of mineral samples see Kühn 1993 and Seccaroni 2006.

and C. Haisch. *The rediscovery of sublimed arsenic sulphide pigments in painting and polychromy: applications of Raman microspectroscopy* in *Spring 2011*, pp. 269–76. Burnt umber, which was orange, is also mentioned in documentary sources as a pigment.

105 Although it is possible that dolomite (calcium magnesium carbonate) has been added as a colourless extender, it is consistently present together with yellow iron oxide; so it seems most likely to be associated with the earth pigment. Some dolomite was also found with anurite in blue layers; it is common to find it associated with this particular blue mineral. Lazarinini mentions that, in Venice, earth pigments might have been obtained from the mainland: for example, *terra giulia di Verona*, which he says is from the area between the Avesa and the Valpantena valleys (although he states that it has a high limonite content of 50–60%, which does not match that found in the Titian paintings). See Lazarinini 1987, p. 118.


**Cat. 1 The Flight into Egypt**

1 The painting was cleaned and restored at the National Gallery; an account of the treatment appears in *Ruhemann 1955*, pp. 278–82. His description of the technique (characteristic in its emphasis on the apparent use of monochrome undermodelling) is not supported by the evidence of the paints cross-sections. The painting was sampled by Joyce Plesters at the time of the cleaning and then again by Joyce Plesters and Ashok Roy in 1980 when both fragments were exhibited at Wildenstein’s. The painting is badly abraded from past cleaning, notably in the foreground, in the background above Christ, the torso of the old man next to Christ, the area between the young man and the Adulteress and the robes of the figure behind her. There has been flaking along the join, particularly across Christ and the soldier to the left. Other areas are affected by drying cracks that have developed as a result of defective technique and the numerous pentimenti.

2 For a full account of the history of attribution and discussion of the subject of the painting see Humfrey 2012, pp. 90–6.

3 Humfrey 2012, pp. 95–6.

4 The choice of a canvas of this width would also have saved wastage with a painting of these dimensions. If a wider loom width had been used a strip would need to be trimmed off or alternatively two pieces joined with the warp perpendicular to the main piece, a technique often seen in Venetian canvases.

5 In Humfrey 2012, pp. 94–5. They were made by Giovanni C.F. Villa when the painting was on display in Edinburgh.

6 The painting was X-rayed at the National Gallery during the cleaning in 1951–3. Unfortunately the individual X-ray plates did not overlap and so it is not possible to assemble them into a full mosaic. An attempt was made for Humfrey 2012, fig. 3, p. 94, but it appears that the positive films (used to make prints from the original X-rays) were used and so the image is inverted, with areas that absorb X-rays appearing dark instead of light. The images reproduced here are from a set of prints from the positives held in the Photographic Library at the National Gallery.

7 Humfrey 2012, p. 93.

8 SEM–EDX analysis and ATR–FTIR microspectroscopic imaging on the cross-section identified zinc sulphate and zinc soaps. The FTIR spectra suggest that a combination of soaps of both the saturated fatty acids, palmitate and stearate, and the diacids, such as azelate, may be present. Some of the inclusions were found by SEM–EDX analysis to also contain a small amount of potassium and gave a slightly different FTIR spectrum. See essay, pp. 24–5, for a more detailed discussion and for other paintings in this study where zinc sulphate and zinc soaps were found. The only pigment in the red layer is vermilion. The brown layer contains earth pigments, including some with a manganese content, as well as some calcium carbonate which may be a component of the earth pigment, a little lead-tin yellow, lead white and black.

9 HPLC analysis identified the dyestuff as kermes from the scale insect *Kermes vernalis Planchnon. Kermes has also been found to be the major dyestuff in samples of red lake from *The Holy Family* (cat. 4), *La Schiavona* (cat. 6), *Noli me Tangere* (cat. 7) and *The Music Lesson* (cat. 12). A small peak for alizarin was also detected but the other components expected for madder were not observed and it seems likely that it represents a modern retouching. This would be consistent with the appearance of the cross-section sample under ultraviolet light, as there seems to be a thin additional layer at the surface that is separated by a fluorescent varnish layer.

10 See essay on Bacchus and Ariadne (cat. 8, p. 73).

11 Confirmed by SEM–EDX analysis.

12 The dress of Profane Love, on the left in *Sacred and Profane Love* (Galleria Borghese, Rome), now appears almost white, shaded with grey, but paint samples indicate that a small amount of red lake was included in the paint mixture. See L. Lazarinini, *Indagini scientifiche sui materiali e la tecnica pittorica dell’Amor Sacro e Profano* di Titian in *Rome 1995*, p. 347.

13 See Dunkerton and Roy 1986, pp. 15–16, and note 14, p. 26. They have also been observed in samples from Venetian works by Sebastiano del Piombo; see Lazarinini et al. 1978, p. 54.

The samples are still kept at the National Gallery and were re-analysed by SEM–EDX, showing that the orange areas are a mixture of lead-tin yellow, red earth and a little vermilion, while the yellow highlights contain only lead-tin yellow.

Cat. 3 **Rest on the Flight into Egypt**


2. Infrared reflectography was carried out at the National Gallery on 13 March 2012 with the same equipment used to examine the National Gallery’s own paintings.

3. Presented by Troels Fihlenborg at a seminar held at the Statens Museum for Kunst, 6 March 2012. See also Wivel and Fihlenborg, forthcoming; we are grateful to the authors for sharing their results before publication.

4. Reproduced in Joannides 2001, fig. 142, p. 161. The painting was auctioned in Milan in 1995 as a work by Titian. If so, it is likely to have been heavily repainted and it may well be a later production, perhaps of the seventeenth century (private communication from Antonio Mazza). 

Cat. 4 **The Holy Family with a Shepherd**

1. The painting is generally well preserved. There are scattered losses, mainly from the sky and Saint Joseph’s cloak, and some of the more thinly painted areas are slightly abraded, showing the tops of the canvas threads. The worst affected area is the landscape between the Christ Child and Joseph. The varnish layers applied in the last restoration are now slightly discoloured and have lost some transparency, particularly over the ultramarine blue of the Virgin’s mantle.


4. In the X-ray images of the bottom left corner of the picture the bottom edge of the original canvas looks as though it is a selvedge. This is supported by the presence of an orange layer consisting of a mixture of lead-tin yellow, lead white and red earth (identified by EDX), in one of the cross-sections taken in 1953. Beneath the layers that make up the orange cloak as finally painted.

5. These paint samples were first published and discussed in Dunkerton and Spring 2003, pp. 16–21.

6. These particles have the appearance of charcoal, but this has not necessarily been used in the form of a dry drawing medium, since the appearance of the lines in infrared images suggests that the drawing medium was wet. In cross-sections the medium around the particles is not visible, but this is not unusual even where the underdrawing is wet, and could also be a consequence of drawing with a very dry brush.

7. The pigment can be seen in a cross-section to still have a strong blue colour while, as is often observed in blanched ultramarine-containing paint, the matrix around it appears cloudy and there is a greyish crust on the surface. The problem might also be exacerbated by the deterioration of the varnish layers applied in 1953.

8. Lazzerini 1983. Apart from the occurrences on Titian’s Assumption of the Virgin of 1518 and the Pesaro Altarpiece of 1519–26, where in both cases the indigo is mixed with lead white as a first lay-in for areas of blue (see p. 142 – the term imprimitura is here used in the sense of a local underpainting), the only other painting with indigo listed in Lazzerini’s extensive table is by Tintoretto. See discussion in the essay, p. 27.

9. HPLC analysis identified kermes from the scale insect Kermes vermilio Planchon. Smaller quantities of methylated pseudo-purpurin and purpurin were also present, indicating the presence of a pseudopurpurin-rich madder, presumably from Rubia tinctorum L. No alizarin was detected but this is often only a minor component of madder lake at this date. EDX analysis of the substrate of the red lake in the upper layers, the kermes lake, found some alum (potassium aluminium sulphate) dispersed in the layers, and spot spectra of individual large lake particles indicated that some potassium was incorporated in the hydrated alumina substrate. Alum is a starting material used in lake making, but usually an alkali is added to the dye solution so that alumina, which has formed a salt with the dyestuff, precipitates from the solution. In this case it appears that the precipitation has not gone to completion. The madder lake substrate appeared to be slightly different, with almost no potassium incorporated in the alumina substrate.

10. Realgar and pararealgar were identified by Raman microscopy. We are grateful to Janet Ambers at the British Museum for this analysis. The pararealgar, which is yellow, is likely to be a degradation product (see essay, p. 10). Zinc was detected by EDX analysis on a cross-section from Joseph’s orange mantle in the realgar layer. It does not appear to be associated with iron, and is probably not therefore present as a zinc-rich earth pigment. Although in ‘La Schiavona’ (cat. 6, p. 61) and Portrait of Gerolamo (? Barbarigo (cat. 5, p. 54) it was confirmed that the zinc is present as zinc oxide and zinc sulphate, this was not possible in these samples as too little was present.

11. For the emergence of orange colours as distinct from yellow, and especially in Cima’s paintings, see Hills 1999, pp. 146–50. Arsenic-based pigments have recently been found on Cima’s earliest altarpieces dating from the late 1480s and early 1490s, including the Olera, Vicenza and Conegliano altarpieces; see G. Poldi, ‘L’arancio e altri gialli. Sigillature sui pigmenti di Cima a fronte di trentuno opera esaminate’ in Spiazzi and Villa 2011, pp. 43–55. For the layer structure of Saint Peter’s orange robe in The Incredibility of Saint Thomas (NG 816) see Dunkerton and Boy 1986, p. 13.

12. The actual execution of this altarpiece is often dated to late in the decade, but for the argument that it may have been painted as early as 1505 see Conegliano 2010, p. 204.

13. Only a small amount of chloride was detected by EDX analysis, suggesting that it is a secondary product from a traditional method of manufacture of verdigris, in which copper plates coated in honey and common salt are exposed to acetic acid vapour; see Kühl 1990, where examples of copper chloride-containing verdigris in paintings are reported, together with a discussion of relevant recipes in treatises.

14. The identification of these glazes demands a refined means of analysis and thus few other examples have been reported to date. However, at the National Gallery they have now been found on a number of fifteenth- and sixteenth-century paintings by, among others, Uccello, Raphael, Garofalo and, perhaps most significantly for Titian, Cima da Conegliano.

15. These medium analysis results were reported in Dunkerton and Spring 2003. It was suggested that in the red lake glaze of the Virgin’s drapery the heat-bodied linseed oil was combined with a little pine resin. Pine resin may have been added to increase the transparency and gloss of this glaze but it should be noted that this result could also be due to a small amount of varnish contamination. In the subsequent analyses of other paintings undertaken in this study, traces of resin including pine resin have been detected but these have normally been linked to the materials in the varnish layers and no definite evidence of resins added to Titian’s media has been found.

Cat. 5 **Portrait of Gerolamo (?) Barbarigo (The Man with a Quilted Sleeve)**

1. The varnish layers applied in the restoration are now slightly discoloured and opaque and some retouches have altered. The condition of much of the paint surface is reasonably good, although there is evidence of abrasion in the black cloak and on the face, particularly at the junction of cheek and beard. In the lower corners there are extensive losses from flaking, now much retouched. On the right side the area affected extends into the lower sleeve and hand. The old, but non-original, inscription ‘TITIANUS’ was retained but has been touched out.


4. Medium analysis was carried out by GC–MS.
5 SEM–EDX analysis confirmed the presence of zinc and sulphur in the inclusions, with some potassium in addition in some areas. Analysis by ATR–FTIR microscopy and microspectroscopic imaging showed that the zinc was present in the form of sulphates and soaps. The FTIR spectra suggest that a mixture of zinc soaps may be present including those of the saturated fatty acids, palmitate and stearate, and the diacids, such as azelate.

6 Medium analysis was carried out by GC–MS on samples taken from the edges. It is worth noting that no samples were taken for medium analysis from the lighter passages of paint: the flesh or the white camicia, for example.

7 The deepest blue areas, on his chest, where the paint contains rather little lead white are also slightly blanched, a deterioration most probably associated with the ultramarine pigment.


9 During the cleaning of 1949, overpainting of the beard and hairline, including coarsely painted strokes of hair, was removed. This repaint (well documented by photography) dissolved off with the varnish and was clearly relatively recent. See National Gallery Conservation Record, p. 12.

Cat. 6 Portrait of a Lady (La Schiavona)

1 There are many small losses from the paint and ground that appear to have been the result of rolling of the canvas for transport in the past. There are also filled losses on the woman’s face that appear to be related to wide drying cracks. The paint of the background is much abraded and has been extensively retouched. The occlus to be seen in fig. 130 was retouched, together with the rest of the painting, before photography on 8 September 1960. The occlus was then painted out and the painting re–photographed on 3 March 1961.

2 See N. Penny in London 2003, p. 80, for discussion of the identity of the woman.

3 See Gould 1961, pp. 334–40, for an account of the discoveries made during cleaning.

4 In Gould 1961 some doubt is expressed as to the sequence of these changes in the background. Re–examination of the 1961 samples confirmed that immediately below the lower edge of the rectangle there is grey paint directly on the priming, beneath the paint associated with the sky and landscape seen through the circular porthole, confirming that the rectangle was the first idea and that the grey background had already been blocked in around it.

5 Joyce Plesters stated in her 1960 report on examination of samples that this dark grey paint showed ‘a remarkable resemblance to the original dark grey paint on the rest of the background’ based on the observation that they both contained a similar fine–grained black pigment mixed with lead white, some particles of the latter being quite large. She concluded that it was ‘very likely but not certain’ that the roundel window was covered up by the artist himself. New SEM–EDX analyses on the surviving 1960 cross–sections have shown that the dark grey paint contains in addition the same dolomite–containing earth pigment as the rest of the background. It would seem to be almost impossible that a later restorer would use this same mixture and we can therefore now be more certain that it was indeed Titian who painted out the roundel.


7 Summarised by N. Penny in London 2003, p. 80.

8 For the possible meaning of the initials see N. Penny in London 2003, p. 80.

9 Identified by SEM–EDX analysis and ATR–FTIR microspectroscopic imaging on a cross–section. As in Cat. 2 and 5 (pp. 41 and 54) a small amount of potassium was detected in addition suggesting more than one type of sulphate might be present. Zinc oxalate, probably a degradation product, was also identified.

10 Medium analysis was performed on samples from the edges of the painting. A portion of each was first analysed by GC–MS, but in several of the samples interpretation of the analysis was complicated by the presence of beeswax as a contaminant, probably from conservation treatment. The remainder of the sample was rinsed with xylene then methanol to remove the beeswax contamination and again analysed by GC–MS, which gave more secure results.

11 Previously described by Dunkerton and Spring 2003, pp. 18–19. The samples were re–examined and analysed further during the present study, as when examined during the 1961 restoration, most of which still survive in reasonably good condition.

12 This probably represents overlapping strokes from the same undermodelling rather than a separate stage. Some indigotin was detected by HPLC when a sample was taken from the upper purple and red layers for identification of the dyestuff in the red lake pigment (see note 14). It is unlikely to be in these upper layers. Instead, the sample probably included a little of the blue undermodelling. Although indigo was not initially observed by optical microscopy in cross–sections, in one sample where the layer is a darker blue, the lead white matrix (between easily visible particles of ultramarine) does appear ‘stained’ blue, as it might be if it contained indigo, which is of extremely small particle size.

13 The same method described in note 10 was used, since again the samples were contaminated with beeswax. The light pink underlayer was exposed at the left edge where the painting is usually covered by the frame so that it was possible to sample it separately. No samples could be taken from either the white passages of drapery or the flesh paint.

14 The sample was from the purple paint at the left edge. The major dyestuff was identified as kermes, from the scale insect Kermes vermilio Planchon. Minor amounts of methylated pseudopurpurin and purpurin (but no alizarin) were detected, indicating a very small quantity of a pseudopurpurin–rich madder, presumably from Rubia tinctorum L. A trace of ellagic acid was also detected, indicating that at least one of the lakes has been prepared by extracting the dye from the shearings of a silk textile.

15 See N. Penny in London 2003, p. 80, for discussion of this costume.

16 Some fading has certainly taken place, as can be seen from a more intensely red band of paint along the left edge where it has in the past been protected by a frame.

Cat. 7 Noli me tangere

1 During the cleaning a small branch that had been added to the right side of the tree over the sky, in the position of Titian’s larger suppressed branch, and alterations made by a restorer to the Magdalen’s waistline and bulky draperies were removed. There are no large losses but the paint film is somewhat worn, especially in the sky. The suppressed branch had become obtrusively visible and was touched out again. The varnish applied in 1938 is now slightly discoloured.

2 N. Penny in London 2003, p. 86, and A. Bradley and D. Jaffe in London 2003, pp. 92–4, for the date of Sacred and Profane Love. See also M.G. Bernardini, L’Amor Sacro e Profano Love, See also Dubois and Wallert 2003, pp. 179–84.


4 Although there is a great deal of old putty and restoration around the edges, remnants of tack holes can be seen around all four sides.

5 Confirmed by SEM–EDX and ATR–FTIR microspectroscopic imaging. Although translucent colourless dolomite (calcium magnesium carbonate) is spread throughout the layer, only the one or two larger particles are easily seen, such as that at the far right of the cross–section that has the characteristic right–angled shape. Gypsum (calcium sulphate dihydrate) was confirmed in the gesso ground by FTIR microscopy in transmission mode.

6 In earlier reflectograms – published as details in J. Dunkerton, Titian’s Painting Technique’ in London 2003, pp. 51–2, and Dunkerton and Spring 2003, p. 15 – the underdrawing for Christ’s features could not be seen.

7 For evidence of the use of a palette knife to scrape off excess cima on the canvas of Jacopo Pesaro being presented by Pope Alexander VI to Saint Peter see Dubois and Wallert 2003,
p. 24. Marks in the gesso on the Portrait of Girolamo Fracastoro (see essay, fig. 1.3) indicate that it too was applied with a knife.

8 The X-ray and infrared images and leggings in The Holy Family with a Shepherd (cat. 4) show similar rugged dark shapes where the paint may have pulled up while worked vigorously with the brush and perhaps also a knife.

9 Gould 1958, p. 44. This interpretation was first questioned, before the underdrawing was revealed by infrared reflectography, by J. Dunkerton and N. Penny in Rome 1995, pp. 364–7, and then, with infrared reflectography, by J. Dunkerton, ‘Titian’s Painting Technique’ in London 2003, pp. 51–2, and Dunkerton and Spring 2003, p. 15. There remains, however, a lingering attachment to the legend; see Washington and Vienna 2006, p. 130, and Rome 2013 p. 59.

10 No pure white passages of drapery were sampled, so the binding medium of the white paint has not been identified. However, in both The Holy Family with a Shepherd (cat. 4), and The Music Lesson (cat. 12), GC–MS analysis of samples from white drapery paint identified heat-boiled walnut oil. It may be that, in this picture also, a heat-bodied walnut oil medium was used for the white despite the use of heat-bodied linseed oil in other colours (see also essay, p. 24).

11 HPLC analysis identified the major dyestuff as kermes from the scale insect Kermes vermilio Planchon. Minor amounts of methylated pseudopurpurin and purpurin were also present, indicating a very small quantity of a pseudopurpurin-rich madder, presumably from Rubia tinctorum L. No alizarin was detected, but in any case it is only often a minor component in madder lakes at this date. An alumina-based substrate was confirmed by EDX analysis for the kermes lake.

12 GC–MS analysis of the grey paint of the cloudy sky, the green and opaque brown foliage of the tree, as well as the more translucent yellow-brown foliage, identified heat-boiled linseed oil as the binding medium.

13 Gould 1958, pp. 47–8. ‘Copper resinate’ is a term that has generally been used in the past for copper-containing glazes, whether browned or still green, and whether or not the full composition has been confirmed by analysis. Indeed, in 1958 this type of analysis was not possible. It was a prevailing belief at the time, which still persists to some extent, that a copper pigment such as verdigris was boiled together with an oil resin varnish to make ‘copper resinate’ which was either applied while still runny or ground to be used as a pigment after it had cooled. See Ekema Hommes 2004 for the historical origins of this belief and a review of documentary sources on green glazes. It is now known that these translucent paints are generally composed of verdigris, which has often reacted with the oil medium. A little oil-resin varnish is sometimes added, which can result in small amounts of copper-resin acid compounds (‘copper resinate’) being formed over time.

14 FTIR microscopy in transmission mode identified dolomitic yellow earth and silicates associated with the earth, as well as a little verdigris.

15 FTIR microscopy in transmission mode on scriptures of the paint of the opaque brown leaves, and ATR–FTIR imaging and SEM–EDX analysis of the cross-section in fig. 126, from an adjacent area, confirmed a dolomitic yellow earth, red earth, indigo and verdigris. The verdigris particles appear rather brownish and may have discoloured. In addition EDX mapping indicated copper was spread throughout the layer, perhaps in the form of the copper soaps seen by transmission FTIR, a result of reaction of the pigment with the oil.

16 Confirmed by FTIR microscopy in transmission mode and SEM–EDX on scriptures of green paint. FTIR showed unreacted particles of verdigris, as well as some sign of reaction with the oil in the form of some copper soaps. GC–MS analysis of the green leaves showed a higher than normal level of oleic acid, as is often seen in paint films containing verdigris that has reacted to form copper soaps. There was no indication of copper resinate.

17 Although a translucent brown layer is visible at the surface of the cross-section in fig. 126, FTIR and EDX analysis confirmed that directly on the paint is a calcium oxalate-type crust, on top of which is a layer which fluoresces under ultraviolet light, does not contain copper, and is probably the remains of a very degraded varnish not removed during the last cleaning, confirmed by the traces of mastic and pine resin that were just detectable by GC–MS analysis. Photomicrographs confirm that in some places on the tree tiny fragments of a discoloured yellow-brown varnish remain lodged in the interstices of the canvas weave.

Cat. 8 Bacchus and Ariadne

1 An account of the treatment and condition is given in Lucas and Plesters 1978, pp. 25–37.


4 In Bull and Plesters 1990 The Feast of the Gods was described as having a lead underpaint and this study it was possible to re-examine a sample stored in the Scientific Department and under the better microscope now available it could be seen that in addition to lead white the priming layer contains lamp black and a little yellow earth. SEM–EDX analysis confirmed the latter and also showed that the small translucent particles that were present were dolomitic (calcium magnesium carbonate) associated with the yellow earth.

5 Illustrated in Lucas and Plesters 1978, p. 34. Drawings made by workshop members are often found on the backs of panels, including some by Titian, the best examples being those on the Palazzo Gozzi in Ancona; M. Cordaro, C. Gianantoniasi and D. Zari, ‘Il restauro del dipinto’ in Ancona 1988, pp. 72–3. There are also sketches on the back of the canvas of the Annunciation (Scuola Grande di San Rocco, Venice); see Venice and Washington 1990, p. 214.

6 This has resulted in dark areas in the X-radiograph that have the appearance of paint losses but are actually the result of flaking of the lead white on the reverse; see Lucas and Plesters 1978, pp. 35–6. Elsewhere the presence of this layer reduces the contrast between areas where paint containing lead white had been thickly applied and those that are more thinly painted or contain X-ray transparent pigments. In addition, the overlaps between X-ray plates were insufficient for a completely accurate mosaic to be assembled. Unfortunately, it is not possible to X-ray the painting again as the composite panel to which it is attached includes a honeycomb core which would disrupt the image even more than the lead white layer.

7 The pigment mixtures for this figure contain so little lead white that he barely registers in the X-radiograph. The only strong highlights are those on the snakes that entwine him.

8 In October 1522 Titian told Giacomo Tebaldi, Alfonso’s agent, that he barely registers in the X-radiograph. The other woman may be the girl with the tambourine, whose drapery he barely registers in the X-radiograph. The only strong highlights are those on the snakes that entwine him.

9 In October 1522 Titian told Giacomo Tebaldi, Alfonso’s agent, who was putting pressure on him to finish the work, that he just had to change two women and the painting would be ready; see Gould 1975, p. 270. Perhaps he was still adjusting Ariadne. The other woman may be the girl with the tambourine, whose drapery was reduced.

10 See Lucas and Plesters 1978.


12 Lucas and Plesters evidently already considered that the azurite was present beneath ultramarine in Ariadne’s blue drapery since no sample was taken, but Titian generally seems to have used other pigments in the underpaint for blue draperies.

13 The d’Este family seems to have had an obsession with obtaining the highest quality ultramarine for use in their commissions. This

NATIONAL GALLERY TECHNICAL BULLETIN VOLUME 34 | 129
Titian’s Painting Technique before 1540

goes back at least to the Muses for Lionello and Borso d’Este’s Belbifo Studio; see Dunkerton, Roy and Smith 1987, p. 34, note 31.

The sample was from the top of her thigh, very close to where the two sides of her skirt part on either side of her leg, and the infrared image does show shifts in contours in this area that could explain these overlapping paint layers. The pigments were analysed by SEM–EDX on the cross-section.

This cross-section is reproduced in Plate 6c in Lucas and Plesters 1978. The second of the pink layers was described as white in this article, but with the better microscope now available it is clear that it is pink, SEM–EDX detected Al in the red lake pigment.

Confirmed by SEM–EDX analysis. The high quality of the pigment is evident in the small proportion of associated colourless minerals relative to blue lanarite. A little potassium feldspar was detected, as well as a silicate containing Si, Al, Mg and K, which may be phlogopite, and one particle of pyrite (FeS2). The lanarite particles are around 10 µm in size on average.

These include works produced in Rome by Sebastiano del Piombo; see Dunkerton and Howard 2009, pp. 16–7.

Arsenic and sulphur were confirmed to be present in the bright orange-yellow particles by SEM–EDX. Ramian microscopy identified mainly pararang, which is yellow, with some realgar. We compared the sample with a pigment from the British Museum for this analysis. For further discussion see essay, p. 30.

SEM–EDX confirmed a dolomitic yellow earth, a very small amount of arsenic sulphide and lead white in the underpaint in a light tone of the drapery. In a darker tone there seems to be red earth in addition in the underpaint, as well as one or two black particles that were confirmed by SEM–EDX to be coal black. The upper orange paint layer in the darker tone was composed of arsenic sulphide pigment mixed again with dolomitic yellow earth and red earth, as well as one particle of limonite (Fe2TiO7) which may be associated with the red earth, as it was found to be in The Flight into Egypt (Cat. 1, note 13).

This sample is also illustrated in Lucas and Plesters 1978. The uppermost layer was said to contain malachite, and the lower dark green layer green earth. Analyses with SEM–EDX and ATR–FTIR imaging on this same cross-section have now, however, made it possible to confirm the new pigment identifications. The lead-tin yellow is inhomogeneous, with tin-rich zones that are probably unreacted white tin oxide, as found in other paintings in this study (see also note 22).

Identified by X-ray diffraction as lead-tin yellow of the ‘type I’ form. In a cross-section it can be seen that there is extensive lead soap formation, and SEM–EDX analysis indicated that the pigment was inhomogeneous, with tin-rich zones of white unreacted tin oxide, perhaps accounting for the rather pale tone of the yellow (see also note 21).

Cat. 9 Portrait of Girolamo Fracastoro

1 For the identification of the sitter and the date of the portrait see Dunkerton, Fletcher and Joannides 2013.

2 Identified by EDX analysis. Some dolomite (calcium magnesium carbonate), calcium carbonate and a significant amount of celestite (strontium sulphate) are also present.

3 EDX analysis detected a significant amount of sulphur (in addition to carbon) in this pigment, which is characteristic of coal black, as is its appearance under the microscope. Although coal black was a relatively common pigment in the sixteenth century (see Spring, Grout and White 2003, esp. pp. 97–100), this does make it more likely that the doorway is an original feature.

4 Identified by GC–MS analysis. The azelate/suberate ratio obtained from the paint of the cloak was of an intermediate level; not as low as that expected for a heat-bodied oil but not as high as that expected for a non heat-bodied oil. The ratio obtained from the sample within the archway was slightly closer to that expected for a heat-bodied oil, but was again a little high.

5 Identified by GC–MS analysis, although some caution is required in the interpretation of the results due to a little beeswax contamination from the lining process. The sample from the ledge appears to be a heat-bodied oil, but the azelate/suberate ratio obtained from the sample from the architectural feature lies between that expected for a heat-bodied and a non heat-bodied oil.

Cat. 10 A Boy with a Bird

For a detailed account of the condition, technique and discussion of the connections between this painting and the Venus and Adonis paintings see Joannides and Dunkerton 2007, pp. 36–57. Joannides favours an earlier date of around 1516 to that suggested here.


5 Usually identified as the canvas now in the Museo Nacional del Prado, Madrid.

4 The complex argument is presented, with extensive illustration by Joannides, in Joannides and Dunkerton 2007, pp. 36–41; see also Joannides 2008, p. 46, and Joannides 2006, pp. 141–5.

8 Illustrated in Joannides and Dunkerton 2007, p. 45.


7 EDX analysis detected manganese and oxygen in the black particles, identified as pyrolusite. Manganese dioxide, Iron was present in the red and yellow particles in the ground, confirming earth pigments. Associated potassium aluminium silicates and silica were also found, as well as particles containing calcium. X-ray powder diffraction confirmed the presence of iron oxide, calcium carbonate and silica as the major components.

8 In several of the samples this pigment is in the form of large agglomerates, in which EDX analysis detected, in addition to manganese dioxide, some barium sulphate. The latter is a common accessory mineral associated with pyrolusite. For the use of natural mineral form of manganese dioxide in sixteenth- and seventeenth-century painting see Spring, Grout and White 2003, pp. 100–1.


10 In Humfrey 2004, p. 92, it is dated c.1520, but in London 2003, in the caption to fig. 46, p. 94, it is dated c.1530.

11 If so, the canvas must have been recently primed and painted in order for weave distortion to have occurred when the smaller piece was stretched.

12 The possibility that Titian and his workshop were producing landscape paintings closely related to the woodcut is suggested by the inclusion of such a painting as part of the stock of the eighteenth-century Paris dealer (Gernay, in a strip added by an anonymous painter to the top of Watteau’s famous shop sign only a few years after it was first painted; see Joannides and Dunkerton 2007, p. 56, note 47. Of course, this could be an invention based on the print.

13 Identified by FTIR microscopy.

14 Identification of the pigments in these mixtures was made on the basis of SEM–EDX analysis. The suggestion that yellow lake might be present is based on the detection of calcium carbonate in these layers, which could be a substrate for this pigment.

15 Analysis was carried out by GC–MS and the results were reported in Joannides and Dunkerton 2007, p. 52. The presence of a small amount of beeswax contamination in some samples led to a rather cautious interpretation of the detection of walnut oil at this time; see especially note 62. However, after recent reassessment of these results we can state more confidently that walnut oil was used as the binding medium in the pink paint from the boy’s finger and the white paint of his sleeve.

16 There was some small variation in each sample of the ratio of the di-acids azelate and suberate, used as a guide to the degree of heat-bodying. In most cases this fell within the range expected for a heat-bodied oil. However, it was slightly higher for the sample from the sky, although not high enough to indicate a non-bodied oil.

17 GC–MS analysis of this sample gave a slightly lowered azelate level, possibly due to a small amount of beeswax contamination; however, the identification of linseed oil is clear. The azelate/suberate ratio was again a little higher than that expected for a heat-bodied oil, but not high enough to suggest a non-bodied oil.
Cat. 11 The Virgin and Child with the Infant Saint John and a Female Saint or Donor (‘The Aldobrandini Madonna’)

1. The painting is generally in good condition, with damage limited mainly to the edges and to the upper part where it was once turned over onto a smaller stretcher. During restoration the intense blue of the distant mountains was apparently toned down by retouching. Uneven residues of darkened old varnish disrupt the modelling in some places: for example, the Child’s proper left hand. Retouchings on the female saint’s skirt are mismatched or discoloured and the varnish applied in 1955 has become a little blanched. This is especially evident over the deepest folds of the Virgin’s mantle. It is possible that there has also been some degradation of the ultramarine blue glazes.

2. For the provenance see Penny 1999, pp. 111–12.

3. See Gould 1975, p. 278, although he was inclined not to identify this with the National Gallery canvas as he believed that the saint is Saint Catherine. In the National Gallery Catalogue of 1860/1 (Wornum 1860, vol. 1, p. 258) the painting is recorded as inscribed: ‘TICIANUS’ and the date 1533. Although there is no record of any cleaning until that of 1955, there was no inscription by then. It can hardly have been original and may well have been fictitious.


5. R. Bellucci and C. Frosinini, ‘Considerazioni sul disegno e “underdrawing” nella pittura veneta e in Tiziano’ in Florence 2008, pp. 57–60. In the case of the Fort Worth version, the X-radiograph shows that the central group was initially closer to the London painting, with the same pose for the Child and a figure on the left in the same position as the young Baptist. This is very blurred in the X-radiograph and it has been suggested that it might be an angel. The head of the Baptist on the right appears to cross the dense green paint of the landscape, and so he too may be a later introduction. See Christiansen 1987, pp. 190–6. A third, less close, variant is a panel in the Royal Collection. It is smaller but the omission of the Baptist and female saint meant that the traced cartoon from the National Gallery painting could still be used for the Virgin. The figure of the Virgin and the rather tightly painted landscape detail are almost certainly not by Titian, but he may have contributed the wriggling Christ Child and the figures of Tobias and the Angel in the background. See London 2007, pp. 194–7, and Iaat 2006, pp. 43–52.


7. Spot spectra of larger black particles in the imprimitura collected during SEM–EDX analysis gave large peaks for manganese. EDX mapping of the large particle in this layer in r.v. 172 indicated that iron was located in the brown areas and manganese in the black areas.

8. The painting was examined with infrared in 2005 using a Hamamatsu vidicon but only small areas of particular interest were recorded. As a result less can be said about more general features as seen by infrared imaging of the other paintings in this study.

9. See, for example, Penny 1999, p. 109.

10. Careful notes and a coloured drawing of the cross-section by Joyce Plesters in 1955 record the layer structure and paint composition. She also noted that although the priming and gesso ground were not present in the cross-section, other small paint fragments indicated that the rose pink was directly on the imprimitura. Although the cross-section survives and this layer structure can still be recognised, it is not in good enough condition to illustrate here. A further sample taken from this drapery in 1993 included only the uppermost yellow paint. X-ray diffraction confirmed that the lead-tin yellow was of the ‘type I’ form (matching the JCPDS pattern no. 384).

11. The yellow is very pale and as in other paintings in this study this seems to be because some white tin oxide is present in the lead-tin yellow, indicating incomplete roasting during manufacture of the pigment. Extensive lead soap formation is also evident in the cross-section.

12. SEM–EDX analysis showed that the pigment includes only a small proportion of associated colourless minerals relative to blue lazurite, indicating a high-quality pigment. When the sample was taken in 1993 it was noted that the paint might be degraded. The blue pigment itself, averaging 5–10 μm in particle size, is still an intense colour, but in the backscattered electron SEM image the paint as a whole appeared notably porous, which might explain its slightly blanched appearance.

13. In some of the large verdigris particles a small amount of chlorine was detected in addition to copper, probably related to the method of manufacture. The lead-tin yellow includes pale tin-rich zones indicating incomplete roasting of the raw materials, as also seen in some of the other paintings.

14. SEM–EDX mapping detected copper in this layer. ATR–FTIR microspectroscopic imaging confirmed that verdigris was present. A band in the FTIR spectrum at around 1607 cm\(^{-1}\) might also be related to the verdigris pigment, or might indicate the presence of some ‘copper resinate’ as a reaction product, either with varnish on the surface or with resin in the paint medium, although the many overlapping bands in the spectrum from different components make it impossible to be certain about the assignment.
13 HPLC analysis identified kermes from the scale insect *Kermes vermilio* Planchon. Smaller quantities of methylated pseudopurpurin and purpurin were also detected, indicating the presence of a pseudopurpurin-rich madder, presumably from *Rubia tinctorum* L. In addition, traces of an unidentified component, often known as ‘Novik Type C’, reported to be found in samples of soluble redwood from species of *Caesalpinia*, were detected, indicating that some brazilwood or sappanwood may also be present. See Nowik 2001.

14 Confirmed by EDX analysis. In some black particles Mn was the predominant element, confirming manganese black which must be natural pyrolusite. The calcium carbonate could be an extender, or might instead be present as a component of the earth pigment.

15 The ATR–FTIR spectra include bands at c.1580 cm\(^{-1}\) and c.1411 cm\(^{-1}\), characteristic of the acetate ion, presumably copper acetate since copper was confirmed by IDX analysis. An additional band at c.1612 cm\(^{-1}\) was also present which is difficult to assign but seems to be characteristic of the particles with this appearance.

16 The large black particle included with the earth pigment, which IDX analysis indicated consisted of iron-rich yellow particles and associated silicates. The IDX also showed that there is a small amount of bone or ivory black present, but the larger black particles seemed to have the characteristics of coal black.

17 Analysis by GC–MS detected heat-bodied linseed oil as the binding medium of the upper brown layer. Although some peaks for diterpenoid resin acids were observed, these could be connected to traces of varnish; the absence of components such as retene, hydroretene and norabietatelines suggests that no pitch was present in the sample.

18 This is consistent with the observation that a large blackish particle appeared translucent brown when compressed in the diamond cell for FTIR analysis. The spectra from both the large black particles and the smaller brown particles were characterised by a broad peak with a maximum at c.1616 cm\(^{-1}\) which can be related to the aromatic ring stretching. FTIR spectra of this type are also seen more generally in brown or black pigments derived from fossilised or pyrolysed materials, such as lignitic earths or bistre produced from wood soot. However, although the presence of some other organic brown pigment in addition cannot be ruled out, it is most likely that they are smaller particles of coal black since larger particles of this pigment certainly are present.

19 Medium analysis was carried out by GC–MS.

20 Mills and White 1977, p. 58.

Cut. 13 *The Triumph of Love*


2 For a full account of the provenance, function as a portrait cover and sources for the design see Whistler 2009, pp. 536–41.

3 See also Dunkerton 2009, p. 542.


5 Whistler 2009, p. 536.

6 For the date and extended execution of *The Vendramin Family* see Penny 2008, pp. 206–15.

7 A sample from the sky at the left edge, which coincides with a line for the oculus that can be seen in the infrared image, shows that this particular line of drawing lies on top of the first indigo and lead white underpaint of the sky (riv. 233, p. 118).

8 Identified by GC–MS analysis.

9 Indigo was identified by transmission FTIR microscopy on a small fragment of the underlayer from a sample of the distant landscape to the right of Cupid. An underlayer of the same composition is also visible in cross-sections from the sky and the landscape on the left of the painting.

10 Lead-tin yellow was identified by SEM–EDX analysis. It is in the form of large agglomerates, which has perhaps prevented the starting materials from fully reacting when they were roasted, since by EDX mapping it can be seen that these include pale zones rich in tin, which are probably untreated tin oxide. This makes the pigment a rather pale yellow.

11 A similar effect, where the verdigris glaze is well preserved when applied over an opaque green underpaint in the landscape, and discoloured when applied over a lighter layer, can be seen in two other paintings in the National Gallery: Jacopo Bassano’s *The Good Samaritan* (NG 277) and Paolo Veronese’s *Respect* (NG 1325). See Dunkerton and Spring, forthcoming; and Penny, Roy and Spring 1996.

12 The texture must be the result of the lead-tin yellow having formed large agglomerates, as seen in a sample and also discussed in note 10.

### Recovering Titian: The Cleaning and Restoration of Three Overlooked Canvas Paintings


2 For the attribution of the Portrait of Girolamo Fracastoro see Dunkerton, Fletcher and Joannides 2013, p. 4; and for *The Music Lesson* see Penny 2008, pp. 296–301, and Dunkerton, forthcoming.

3 Suida 1931, p. 52 (for the portrait), and Suida 1915, p. 184 (for *The Music Lesson*).

4 Dunkerton, Fletcher and Joannides 2013.

5 For Girolamo Romano and Teodoro Lechi see Penny 2004, pp. 381–2.

6 Unfortunately contamination of a sample with wax from later conservation treatments meant that analysis was not successful.

7 The relining was carried out by David Thomas of the National Gallery Conservation Department.

8 In order to achieve maximum saturation of the damaged dark colours the surface was first varnished with ‘Regalrez 1094’. The losses were retouched with ‘Gamblin Conservation Colours’ and glazed, if necessary, with pigments ground in ‘Regalrez 1094’. The final sprayed varnish is ‘MS2X’.

9 For the frame see Penny 2010, pp. 59–61.

10 For a fuller account of its provenance and reputation see Penny 2008, pp. 296–301, and Dunkerton, forthcoming.

11 Stretchers of this construction have been noted on several English paintings. The stretcher of Joshua Reynolds’s *Portrait of the 4th Duke of Queensbury (Old Q)* as Earl of March in the Wallace Collection, which is likely to have been lined in London in the late eighteenth or early nineteenth century, is very similar. Another example is the stretcher that was present on Wright of Derby’s *Mr and Mrs Thomas Colman* (NG 6496) when it was acquired by the National Gallery. This may date from 1826. See Wyld and Thomas 1986, p. 29. I am grateful to Alexandra Gent for discussion of this point.

12 This observation was made in the entry for the painting in the newly compiled ‘Manuscript Catalogue’.

13 National Gallery Conservation Record, transcribed from the ‘Manuscript Catalogue’.


15 Penny 1997, p. 300. In 2002 it was exhibited in Mantua as ‘Pavodavonio’! See note 16 below.


17 National Gallery Conservation Record for NG 3.

18 During cleaning it was discovered that the same dark grey putty covered the extensions and was smeared over flake losses in the main part of the painting. The solubility of the putty and the retouchings over it indicated that that it was unlikely to be from an earlier restoration. The format of the best of the painted copies of the work, possibly even by Pavodavonio and illustrated in Penny 2008, p. 310, is close to that of the National Gallery canvas without the extensions. Two engravings made when the painting seems to have been in Holland in the later seventeenth and early eighteenth centuries are slightly extended at the right side (or left side in the case of the Gronsveld print which is reversed) in order to include more of the scroll of the violin, but such adaptations are common in reproductive prints and they are not always a good guide to the original dimensions of altered paintings.

19 In Penny 2008 it was still catalogued as ‘Imitator of Titian’ but with the date brought forward to c.1580.

132 | NATIONAL GALLERY TECHNICAL BULLETIN VOLUME 34
20 When acquired for the collection of Charles I, the painting must have been among the consignment of works shipped from Italy to London on The Margaret. Some of these were apparently irretrievably damaged by contact with a leaking cargo of mercury. Several paintings had to be cleaned by Jerome Lanier. Brother of Nicholas, as mercury vapour seems to have blackened the surfaces. It seems that some could be surface cleaned with saliva or warm milk, but with others the varnishes had to be removed and replaced. Lanier stated that he used aqua vita (also known as ‘spirits of wine’), which is distilled alcohol with a high water content, in other words a fairly powerful solvent for varnishes; see J. McClure, ‘The History of Painting Conservation and the Royal Collection’ in Sitwell and Staniforth 1998, pp. 85–96.

21 GC–MS analysis detected norambreniolide, a characteristic component of fir balsam, along with additional diterpenoid resin acids. Fir balsam is mentioned as a varnish ingredient in several nineteenth-century recipes. It has been found on other National Gallery paintings, usually as part of a varnish layer applied prior to acquisition by the National Gallery or during a treatment carried out in the nineteenth century. See White and Kirby 2001.

22 The consolidation and relining were carried out by Paul Ackroyd and Lynne Harrison.

23 Illustrated in Penny 2008, p. 296.

24 This number does not relate to its number in the Gonazaga and Royal Collection inventories of 1626 and 1650.

25 See note 18 of this essay.

26 The filling is a liquid ‘gesso’ made from chalk and polyvinyl alcohol and the ‘imprimitura’ is based on pigments ground in ‘Paraloid B-72’ with some ‘Art Care B72 Retouching Gel’ added to texture the filling and retouching so that the restoration scatters light in a similar way to the cracked original paint surface. The retouching was carried out with ‘Gamblin Conservation Colours’ with some glazes with pigments ground in ‘Regalrez 1094’. The paint film proved easy to saturate following relining and so ‘MS2A’ was used as the preliminary and final varnish. This varnish also has the advantage of not being too brilliant and glossy; which can result in surface sparkle on a painting such as this with slightly elevated edges to the craquelure.

Bibliography


Borghini 1584 R. Borghini, Il Riposo, Florence 1584.
Dubois and Wallert 2003

Dunkerton 2008

Dunkerton, Fletch and Joannides 2013

Dunkerton, Fister and Penny 1999

Dunkerton and Howard 2009

Dunkerton, Penny and Spring 2002

Dunkerton and Roy 1986

Dunkerton, Roy and Smith 1987

Dunkerton and Spring 1998

Dunkerton and Spring 2003

Dunkerton and Spring, forthcoming

Eastlake (1847) 1960
C.L. Eastlake, Methods and materials of painting of the great schools and masters, first published in 1847 under the title Materials for a History of Oil Painting, republished London 1960.

Eikema Hommes 2004

Erich 2008

Favaro et al. 2012

Fitzhugh 1997

Florence 2011

Frezzato and Secaroni 2010

Garnett 2000

Gettens, Kühn and Chase 1993

Gould 1958

Gould 1961

Gould 1969

Gould 1975

Hale 2012

Hills 1999

Humfrey 1995

Humfrey 2004

Humfrey 2007

Humfrey 2012

Izat 2006

Joannides 2001

Joannides 2006

Joannides 2008

Joannides and Dunkerton 2007

Kirby 2000
Kirby, Nash and Cannon 2010
Kirby and Saunders 2004
Kirby, Saunders and Spring 2006
Kirby, Spring and Higgitt 2005
Kirby and White 1996
Krischel 2002
Kühn 1990
Kühn 1993
Laing and Hirst 1986
Lazzarini 1983
Lazzarini 1987
Lazzarini et al. 1978
Lomazzo 1584
G.P. Lomazzo, Trattato dell’arte de la pittura, Milan 1584.
London 1994
London 2002
London 2003
London 2007
London 2012
Lucas and Pesters 1978
Lucchini Ragni and Agosti 1991
Manca 1993
Mantua 2002
Matthew 2002
Mazzotta 2012
Merrifield 1849
M.P. Merrifield, Original Treatises, dating from the Xth to XVIIth Centuries on the Arts of Painting, 2 vols, London 1849.
Mills and White 1977
Mosioli and Seccaroni 2002
Mola 2000
Monnas 2012
Munich 2000
Nowik 2001
Oberthaler and Griesser 2000
Olivato Puppi and Puppi 1977
Paris 1993
Pelosi et al. 2010
Penny 2010
Penny 1999
Penny 2004
Penny 2008
Penny, Roy and Spring 1996

Puppi 1968

Rome 1995

Rome 2013

Rosand 1982

Roskill 1968

Rossi and Puppi 1996

Ruhemann 1955

Seccaroni 2006

Sitwell and Staniforth 1998

Spiazzi and Villa 2011

Spring 2011

Spring 2012

Spring et al. 2012

Spring, Grout and White 2003

Spring and Morrison, forthcoming

Stege et al. 2012

Stols-Witlox, Megens and Carlyle 2012

Suida 1912

Suida 1913
W. Suida, Titian. Zurich 1913.

Suida 1935

Tagliaferro and Aikema 2009

Tumosa and Mecklenburg 2005

Vasari (1568) 1966–87

Venice 2000

Venice and Washington 1990

Vienna and Venice 2008

Washington and Vienna 2006

Wethey 1969–75

Whistler 2009

White and Kirby 1994

White and Kirby 2001

Wivel and Filtenborg, forthcoming

Wormum 1860
R.N. Wormum, Descriptive and Historical Catalogue of the Pictures in the National Gallery, London 1860.

Wyld and Thomas 1986

Zampetti 1969