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Notes

**Titian after 1540: Technique and Style in his Later Works**


2. For a detailed biography see Hale 2012 and for briefer accounts of Titian’s life see, for example, C. Hope, ‘Titian’s Life and Times’ in London 2003, pp. 11–28, and Penny 2008, pp. 201–5.


4. The very damaged panel of the Mater Dolorosa belonging to the Roman Catholic Diocese of Brooklyn, New York, is clearly related to the paintings for Charles V and must have been painted at around the same time. Her mantle now appears red but this colour seems likely to have been an underpainting for a blue pigment, now almost completely lost.


6. The surface texture of *The Martyrdom of Saint Lawrence* (fig. 11) now in the Church of the Gesuati, Venice, suggests a twill weave. Although the paint film was transferred from canvas to canvas in 1881–2, the texture of the original canvas seems to be that which is now visible. See A. Roso and N. Pisano, ‘Un Restauro Difficile’ in Alba 2012, p. 17. Another twill weave appears on the *Porttrait of Doga Andrea Gritti* painted probably posthumously in the late 1540s (National Gallery of Art, Washington DC). Here the surface texture of the painting has survived intact since the canvas has never been lined.


8. The distinctive canvas weave is clearly visible, especially in the clouds above the Saint, in the high-resolution image available on the National Gallery of Art website: http://www.nga.gov/content/ngaweb/Collection/art-object-page.43725.html.


11. The face and pointing hand of Christ are the only parts easily distinguished in the confusion of the X-radiograph. Initially it was thought that the *Saint Sebastian* was first conceived as a half-length figure and subsequently extended (Vienna and Venice 2007–8, pp. 304–7 [English edition], pp. 350–3 [German edition]).

12. FTIR analysis is needed to identify the type of calcium sulphate present, and a suitable sample was only available for a few of the works in this study, so it is not necessarily the case that CAT 3 and 8 are alone in having anhydrite as the main component of the gesso. In addition, a mixture of gypsum and anhydrite would be difficult to detect by FTIR and may have been missed.

13. Very few of the cross-sections included the gesso ground layer so it was not always possible in the other paintings to confirm by SEM–EDX analysis whether these impurities were present. In *CAT* 3 some celestine (strontium sulphate) was also identified.

14. For example, on the canvases for the portraits of Charles V on Horseback (fig. 1) and Charles V Seated (Alte Pinakothek, Munich); see C. Garrido, ‘“El emperador Carlos V a caballo en Mühlberg”: studio técnico’ in Madrid 2001, p. 127, and von Sonnenburg 1999, p. 103. Two portraits associated with Titian’s time in Augsburg (but not always accepted as autograph) – Johann Friedrich von Sachsen (Kunsthistorisches Museum, Vienna) and Antoine Perrenet (de Granvelle (Nelson-Atkins Museum of Art, Kansas City) – appear to have been prepared with oil prnings alone, without any chalk or gesso ground; see Wald 1999.


16. In some paint cross-sections from Titian’s later works (including some presented in this study) thin layers of brownish paint have been observed over the initial gesso layer. They have sometimes been described as *imprimiture*, but since they generally vary considerably in composition and colour from sample to sample when taken from the same work, they are perhaps more likely to represent a first lay-in or underpainting – indeed not unlike the process described by Marco Boschini: see Boschini 1660 (Pallucchini ed. 1966), pp. 711–12. Examples include the Escorial *Martyrdom of Saint Lawrence* (see Checa and Muñoz 2003) and the *Portrait of Jacopo Strada* (see Vienna and Venice 2007–8, pp. 169–72 [English edition], pp. 199–202 [German edition]).


18. Dunkerton and Spring, forthcoming.

19. The figure of Saint Theodore in the drawing of a *Landscape with Saint Theodore overcoming the Dragon* in the Morgan Library and Museum, New York, clearly derives from that of Actaeon in *Diana and Actaeon* since it repeats his pose in the final position, although he carries a spear or lance, as did Actaeon in the first version of this figure. The drawing was most likely made for the etching while *Diana and Actaeon* was still on the easel.

20. See Wethey 1987, pp. 29–31, for discussion of later drawings that may have been connected with the preparation of paintings. More studies survive for the works made before 1530.


22. The legs of this figure in the painting, especially his left thigh, have been badly affected by the large losses in the
lower part of the picture and were extensively reconstruct-
ed in the recent restoration. See A. Roso and N. Pisano, ‘Un

Vienna and Venice 2007–8, pp. 238–41 (German edition
only). The question as to whether Titian’s workshop made
painted replicas, perhaps as ricordi, has been much debat-
ed. Occasionally candidates for such a type of painting
have been proposed, but they can usually be shown to be
later copies. This is certainly the case with the small-scale
version of Titian’s The Trinity (‘La Gloria’) in the National
Gallery (NG 4222), which is clearly derived from Cornelis
Cort’s engraving published in 1566 but appears subse-
quently to have been corrected with some knowledge of
the original painting (see Penny 2008, pp. 304–11).
This and the fact that the National Gallery painting has a
red-brown ground, similar to the grounds often seen on
paintings by El Greco, suggest that it may have been pro-
duced in Spain in the late sixteenth or early seventeenth
centuries. It is therefore not included in this study.

The overlying of traced outlines of the various versions
demonstrates the likely use of cartoons based on tracings
of the first versions in the case of the ‘Venus with a music-
ian’ series, and also the two versions of The Entombment
(see M. Falomir, ‘Titian’s Replicas and Variants’ in London
For a similar study of the versions and replicas of
Titian’s Danaé composition see R. Wald, ‘Titian’s Vienna
“Danae”. Observations on execution and replication in
Titian’s studio’ in Vienna and Venice 2007–8, pp. 124–33

Falomir, Joannides and Mora 2014, pp. 16–51 (in
Spanish) and 60–74 (in English).

Reproduced (although on a rather small scale) in Falomir,
Joannides and Mora 2014, pp. 27 and 44.

For examples of works attributed to Orazio, Marco and
Cesare, see Tagliaferro and Alkema 2009, pp. 193–221
and 275–304.

Girolamo Dente had been recommended to García
Hernández, Philip II’s Venetian representative, as capable
of making a copy of Titian’s The Martyrdom of Saint
Lawrence (now in the Gesuiti), Tagliaferro and Alkema

For examples of works that can be attributed to Girolamo
Dente, see Tagliaferro and Alkema 2009, pp. 89–106 and
154–61.

Hale 2012, p. 611.

Philip II was prepared to accept a copy of The Martyrdom
of Saint Lawrence (see note 28) if necessary, although in
the end Titian himself (almost certainly with some work-
shop assistance) produced the version that is in El Escorial.
On the other hand, in 1564 the councillors of Brescia
were not pleased to have been sent three canvases for
the ceiling of the Palazzo Pubblico, which they believed to
have been painted by the workshop instead of by Titian as
stipulated in the contract; see Wethey 1969–75, vol. III,
pp. 89 and 225.

See, for example, Madrid 2003, pp. 247 and 394.

See Kirschel 2002: Matthew 2002; R. Kirschel, ‘The
Inventory of the Venetian “Vendecolori” Jacopo de’
Benedetti: The Non-Pigment Materials’ in Kirby, Nash and
Berrie, “Memoria de colori che bisogno torre a vinetta”:
Venice as a Centre for the Purchase of Painters’ Colours’

Titian porträtiert seinen Farbenhändler Alvise “daicolori” dalla Scala’ in Dresden 2010, p. 59, note 49.

T. Weddigen and G.J.M. Weber, Alchemie der Farben:
Titian porträtiert seinen Farbenhändler Alvise “daicolori” dalla Scala’ in Dresden 2010, pp. 52–3.


The quantitative SEM–EDX analyses suggest that this is an
ordinary vitrum blanchem rather than the higher quality
cristallo. See Spring 2012 for further information on this
point.

For other examples of copper pigments used as a drier for
black paint in sixteenth-century Italian works see Spring,

Mills and White 1977, p. 58.

No medium analysis was carried out for An Allegory of
Prudence (cat. 2) due to the difficulty in finding an appro-
priate area for sampling.

In a few samples the ratio of azelate to suberate diacids
was a little higher than expected for heat-bodied oil, most
notably in the sample from the dark background in The
Virgin suckling the Infant Christ (cat. 7), but none of
the results obtained gave ratios in the range expected for
non-bodied oil.

The medium analysis result from the dark green-brown
paint of the foreground was harder to interpret due to the
presence of beeswax but on balance seems to suggest the
use of linseed oil.

The lighter areas in particular are noticeably lilac in
colour, and are composed of red lake, black and lead white.
See cat. 1, fig. 84.

Kirby 2000, p. 23.

See Kirby 2000, p. 35, for a table showing relative costs
of ultramarine, azurite and smalt in Venice during the
sixteenth century.


A similar effect was perhaps the motive behind the use
of a pink underpaint beneath ultramarine seen in some
of Titian’s earlier works. See vol. 34 of this Bulletin, p. 27.


G. Bortolaso, ‘A study of various works from the period

For a review of early examples of the use of smalt see Stege

Lazzarini 1987, p. 126, note 17. Lorenzo Lazzarini also
reports that there is a small amount of smalt in Titian’s
Pala Pesaro of 1519–26, but states that it is mixed with
ultramarine only as a siccative for the oil medium. See
Valconera 1979, p. 71.

Parra 1999.

C. Garrido, “El emperador Carlos V a caballo en Mühl-

For a review of the early history of smalt (before 1550),
including the Italian recipes, see Stege 2004 and Dela-
mare 2013, pp. 37–98.

The recipe is quoted in Stege 2004.

The larger potassium ion is able to more effectively stabili-
sing the tetraehedral coordination around the cobalt ion
in the glass that is responsible for the blue colour; see
Terczyńska-Madej, Cholewa-Kowalska and Laczka 2010
and Robinet et al. 2011.

Merrillfield 1849, vol. 2, p. 649, and Lomazzo 1585,
p. 191.

The ore was sometimes roasted to extract instead the
bismuth metal, which was a valuable commodity used in
alloys – for type metal, for instance. The slag that remained

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contained the cobalt that could then be used to colour glass. See Delamarre 2013 and Stege 2004.

59 See Spring et al. 2012 for the methodology employed for quantitative analysis, a full account of the elements present in small, and their origin and relationship with the ingredients, as well as a preliminary assessment of the results from around 40 paintings, including a discussion of variations in cobalt and arsenic content. See also Robinet et al. 2013, which reports some preliminary attempts to understand the role of arsenic in the glass.

60 Spring et al. 2005.

61 See Kirby 2015 and Monnas 2012, p. 23.

62 No suitable samples were available for HPLC analysis of the red lake pigments in An Allegory of Prudence and Diana and Actaeon.

63 The majority of these existing results from HPLC analysis of red lake pigment were produced by Jo Kirby and a full assessment of them in the context of the dyestuff industry across the whole of the sixteenth century in Venice can be found in Kirby 2015.

64 See cat. 1. Although dyed textile sheenings were often used as the source of the dyestuff for making lake pigments, which could have resulted in a mixture of dyestuffs in a single pigment, both the ATR–FTIR imaging results and SEM–EDX analysis gave evidence that lake pigment particles with different substrates were present, suggesting that more than one type had been used.

65 Molà 2000, pp. 120–37, and Kirby 2015.

66 See Kirby 2015 for the result from the painting by Lotto. The result from The Vendramin Family is also discussed in this article but, based on the proposal that had been made in Penny 2008 that the painting was begun in the 1540s but then finished in the 1550s, it was assumed that the cochineal dyestuff detected was from this later stage. Here (see cat. 1) it is proposed that all the work may well have been painted in the 1540s, and indeed the cross-section of a sample from the same red drapery that was sampled for dyestuff analysis does not show any clear evidence of more than one stage of painting, or of a cochineal-based lake used only at the surface.

67 See McAndrew et al. 1985, pp. 512–15, where these early HPLC results from analyses carried out by Raymond White are published.

68 Kirby and White 1996, p. 71. Analysis was originally carried out by thin layer chromatography (TLC) but the result was confirmed by HPLC analysis in 1994. See also Kirby 2015.

69 Indeed, the use of lac for dyeing was less common in Italy in this period and in 1466 was prohibited by the Genoese dyers’ guild for the dyeing of silk. See Monnas 2012, p. 23.


71 These analyses have been published in various separate articles, but have been brought together and discussed as a group in Kirby 2015. See also vol. 34 of this Bulletin, p. 29.

72 Cardon 2007, p. 613.


74 Some other examples of Titian’s use of arsenic sulphide pigments in his later work can be found in Vienna and Venice 2007–8, p. 109.

75 See Seccaroni 2006 for Borghini and other historic documentary sources relating to lead-containing yellow pigments, and esp. p. 110 for the Escorial documents.

76 See Penny, Roy and Spring 1996, for example.

77 Fischer et al. 1999.

78 For La Bella, see Boselli et al. 2011, p. 85. For the Berlin painting see Fischer et al. 1999, and also the unpublished experimental report on the results of autoradiography available at https://www. helmholz-berlin.de/media/all_9690471/ae/862e00a3-a0a2-450a-875a-d3a00cf0a1e6.pdf. See also the review of early examples of Naples yellow in Seccaroni 2006, with references.

79 For occurrences of malachite in paintings by Titian, Veronese and Tintoretto, see Lazzarini 1987; Penny, Roy and Spring 1996; and Plesters 1980.

80 For these much quoted and discussed letters, see, for example, Sohm 1991, pp. 11 and 16–18; London 2003, p. 140; Vienna and Venice 2007–8, pp. 146–8 (English edition), pp. 162–4 (German edition). As is the case with some of the last works, it is difficult to imagine how Titian might have made the draperies appear more highly finished. The paint that we see now is clearly not an underpainting.

81 For the qualities of prestenza in painting (and its counterpart diligenza) as discussed in sixteenth-century sources see Cerasulo 2014.

82 Richardson 1980, p. 9. Francis Richardson also points out that Aretino, as a Tuscan, may have been conditioned to feel uncomfortable about the lack of finish in Schiavone’s (and, by extension, Titian’s) works. He also stresses that Schiavone varied levels of finish according to function and destination (p. 29).

83 For the paint handling in Tintoretto’s works of the late 1540s and early 1550s see J. Dunkerton, ‘Tintoretto’s Painting Technique’ in Madrid 2007, pp. 143–7.


85 Quoted in Cerasulo 2014, pp. 79–80.

86 In the letter accompanying a portrait by Titian that Philip sent from Augsburg to his aunt Mary of Hungary in May 1551, he actually complained that ‘you can see very well the haste with which he has painted my armour and if there had been more time I would have had him work on it again’. There is disagreement as to whether the painting referred to in the letter is the magnificent full-length portrait of Philip in armour (Museo Nacional del Prado, Madrid), which is in fact relatively highly finished and full of detail, and may have been painted slightly earlier in Milan in late 1548. For a summary of the discussion see Humfrey 2007, p. 248.

87 Hale 2012, p. 540.

88 The painting is much damaged in some areas but this does not account for the lack of conventional finish in some parts of the composition. For the recent restoration and detail photographs see Alba 2012.

89 For the relationship between Titian, Nicolò Stoppio and Jacopo Strada, see Hale 2012, pp. 644–8, esp. p. 644 for quotes from the letter. The date given here, when Strada is known to have been in Venice, is given to the portrait in almost all publications. However, in the catalogue entry on the painting in Vienna and Venice 2007–8 (pp. 169–72 [English edition], pp. 199–202 [German edition]) it is dated 1566.

90 For the technique of the Portrait of Jacopo Strada, see E. Oberthaler, ‘Cat. 37, Titian, Jacopo Strada’ in Vienna 1996, pp. 175–80.

91 See Sohm 2007, pp. 77–81. Interestingly, this does not seem to have been an issue for Giovanni Bellini, who may have been just as old when producing his last works (like Titian, his date of birth is uncertain).
for the likenesses in the painting to be based on drawn studies made at the beginning of the project. Therefore some of the boys could be depicted as looking a little younger than their actual age when their heads were painted.

11 A survey of paintings with lozenge-twill canvas as a support is given in Seccaroni 2012.
12 Another advantage of this type of canvas could have been its strength and durability, useful for artists like Titian who were working for patrons from afar, enabling the pictures to be successfully rolled for transport. This relatively intricately woven fabric would have been more expensive than plain weave canvas since more skill and time was needed to set up the loom for weaving. See Seccaroni 2012, p. 60.
13 The Portrait of Isabella d’Este (Kunsthistorisches Museum, Vienna), usually thought to date from around 1536, is also painted on a canvas with a very similar weave. We are grateful to Elke Oberthaler for this information.
14 Reproduced in Penny 2008, p. 211.
15 See The Triumph of Love, see vol. 34 of this Bulletin, Cat. 13.
17 Penny 2008, pp. 211 and 226.
18 Penny 2008, p. 223.
19 The switch between the two main figures revealed by the infrared images makes it more likely that the long-bearded figure really is Andrea; it makes less plausible the suggestion made by Stefanie Lew that the figure by the altar is a representation of the first Andrea Vendramin, founder of the family fortunes, and that Andrea and Lunardo, who both died in 1547, are also represented in the painting as deceased; see Penny 2008, pp. 223–4.
21 The Triumph of Love (see vol. 34 of this Bulletin, Cat. 13).
22 If in the original design the space between Lunardo and Gabriel was to be filled with sky, a layer of indigo and white as the lowest layer in these samples might be expected. Although the gesso is not present in the sample, the samples seem generally to have sheered between the gesso and the paint layers. It is possible that it was always intended for one of the boys to occupy this area.
23 The copper pigment may have been introduced on the palette or during preparation of the oil.
24 For the clothes in the painting, see Penny 2008, p. 215.
25 In one sample from the deep red drapery a single large particle of smalt is present but it is not clear if it is an intentional inclusion in the mixture and this pigment was not found in any other samples.
26 J. Dunkerton and M. Spring in vol. 34 of this Bulletin, p. 27.
pigment to that containing kermes and may well relate to the trace amounts of cochineal present. Lac-derived lake is usually prepared directly from sticklac through alkaline extraction of the dyestuff, rather than from cloth shearings, so it seems possible that three separate lake pigments are present.

Although here it was not possible to confirm this layer structure through a sample, a dark grey underpaint for a verdigris green has been found in The Music Lesson (NG 3): see vol. 34 of this Bulletin, CAT. 12.

Cat. 2 An Allegory of Prudence

No selvedges are included in the canvas, so although vertical threads are presumed to be warp and horizontal ones weft, this is not certain.

The painting has only a few losses, which are from around the edges, but it has suffered some abrasion and increased transparency of the thin paint, especially in the old man and the three animal heads. As a result, distracting pentimenti have become visible.

For the history of the interpretation of the painting, see Penny 2008, pp. 238–42.

Panofsky and Saxl 1926.


Nicholas Penny points out that Titian depicts himself as having grey eyes in his self-portraits. The eye of the old man in the Allegory appears dark but even when viewed under magnification it is so shadowed, smudgy and affected by small losses that it is difficult to argue whether any particular eye colour was intended. It can also be pointed out that in the X-radiograph (e.g. 97) the profile of the first version – repeated approximately in the final version – bears even less resemblance to that of Titian as it appears in the Prado Self Portrait (Museo Nacional del Prado, inv. PO0407), dated to around 1562. The nose visible in the X-radiograph has a more marked bump and is somewhat shorter, as indeed is the whole face. Titian frequently assigned hooked and somewhat pendulous noses to mature and elderly figures, including, for example several of the Mantua Emperors.

Detection of Ca, S and O by EDX analysis indicates that the gesso consists of calcium sulphate, but the form in which it is present has not been established. As in some of the other paintings, there are also small amounts of dolomite (calcium magnesium carbonate) and siliceous minerals as impurities. In one cross-section some black pigment is present, but this is not evident in another, so is probably not a deliberate addition.


The dark horizontal patch that could be read as a mouth in the image published in Penny 2008, p. 239, was caused by a void in the central stretcher joint that was not eliminated when the presence of the stretcher was digitally reduced in the X-ray image published then; this has been remedied in the X-radiograph reproduced here.

Penny 2008, p. 236.

There are many painted copies of the lost canvases but the best record of their poses and costume is likely to be the well-known, early seventeenth-century engravings made by Aegidius Sadeler II, of which a detail is illustrated here.


A tentative association between An Allegory of Prudence and these ‘timpani around painted by the hand of Master Titian’ was made by Nicholas Penny (Penny 2008, p. 238). The compilers of the inventory: Vincenzo Mantovano and Tommaso da Lugano, were presumably told by the family that they were painted by Titian, who was, of course, still living. See Whistler 2009, pp. 539–40, and Penny 2008, p. 225.

Penny 2008, p. 238, in suggesting that the painting could date from as early as about 1550, also pointed out the similarity between the profile head of the youth and the group of portraits on the left in The Vendramin Family (CAT. 1), which he attributes to workshop intervention in both instances.

See Penny 2008, pp. 240–1, for discussion and illustration of some of the possible sources including ‘grillois’ cameos, showing conjoined full-face and profile heads. Gabriel Vendramin may well have owned such a cameo.

Cat. 3 Venus and Adonis

This assumes that the warp threads are horizontal.

The painting has suffered from large paint losses in the trees, especially the part above Adonis’ outstretched arm, and from the bottom right corner. Old fillings (some of which contain lead and show as white in the X-radiograph) and retouchings in these areas were not removed during the last treatment. The paint is also slightly abraded, most disturbingly in the lower body of Venus and parts of the sky, the effect of the damage now reduced by retouching.

Penny 2008, p. 280; Falomir, Joannides and Mora 2014, p. 38 (in Spanish) and p. 68 (in English).

Falomir, Joannides and Mora 2014, pp. 18–31 (in Spanish) and pp. 61–6 (in English).

Falomir, Joannides and Mora 2014, pp. 31–4 (in Spanish) and pp. 66–7 (in English); see also Joannides and Dunkerton 2007.

Discussed and illustrated in Falomir, Joannides and Mora 2014, pp. 31–51 (in Spanish) and pp. 66–71 (in English); Joannides and Dunkerton 2007; Penny 2008, pp. 280–4.


Falomir, Joannides and Mora 2014, p. 48 (in Spanish) and p. 70 (in English).

Reproductions of the Prado version have often included a later extension at the left edge (now covered by the frame, following recent conservation; see Falomir, Joannides and Mora 2014, p. 55 [in Spanish] and p. 75 [in English]).

Interestingly, when Philip received his painting of Venus and Adonis he complained that there was a fold caused in packing. It is very likely that this was actually the seam, which is quite prominent. Penny 2008, p. 280, and Crowe and Cavalcaselle 1877, vol. II, p. 509.


The painting was sampled during the cleaning in 1973 by Joyce Pesters. Some new cross-sections were prepared from the remaining unmounted fragments by Jilleen Nadolny during preparation of the catalogue of the Venetian School after 1540 (Penny 2008). All existing cross-sections have been re-examined and further analysis carried out for this study.
Identified by HPLC analysis of a sample from Adonis’ red drapery. Given the date of this painting this is most likely to be New World cochineal.

The smalt particles are small and as they are degraded and are depleted in potassium the level of cobalt measured by SEM–EDX is not fully reliable, but nevertheless gives some idea of the original intensity and composition of the pigment. The content of cobalt oxide is in the range of 4.6–6.0 wt % and the As/Co atomic % ratio is 1.2–1.7, making it a high arsenic smalt as seen in the other paintings in this study.

The identification of linseed oil in two paint samples (including the brown paint of the bow) was published in Mills and White 1977, p. 58, and an additional two samples were analysed by GC–MS in 2015. The interpretation of these new results was hampered by the inclusion of wax from previous lining treatments; however, it does appear (after careful sample preparation and critical interpretation) that walnut oil was indeed used as the binder in blue-green paint from the landscape. Both analytical campaigns (in 1977 and 2015) included a sample from the flesh of Adonis’ thigh. However, due to difficulties in interpretation neither result has been included here.

See also Penny 2008, p. 276.

Cat. 4 Diana and Actaeon

1 For an account of the recent conservation history of this painting see final essay in this volume. The painting is in good condition. There are slight losses from the edges of the canvas, in particular at the bottom right corner. A small tear crosses the little dog on the right and there is another short vertical damage to the left of Diana’s right foot. Where the paint is thick because of an accumulation of layers as a result of changes to the composition it has developed drying cracks (for example, around the upraised hand of Actaeon). Thinner passages of paint may be slightly worn and some have become more transparent allowing underlayers to show more than would have been intended. In some areas the appearance of the painting has been affected by discoloration of smalt pigment and the fading of red lakes.

2 Wethey 1969–75, vol. III, pp. 72 and 170. Giovanni Benavides is also known as Juan de Benavides.

3 Lank 1982.

4 For a summary of the documentation, see Wethey 1969–75, vol. III, p. 139.


6 See also Edinburgh 2004, p. 157.

7 It is not known whether there was a specific intended location for the poëie. Philip first received the two ‘Diana’ paintings at the Alcazar in Toledo in August 1560. The following year, when he moved to Madrid, he must have taken the canvases with him. See Wethey 1969–75, vol. III, pp. 78–80.


10 Gypsum was identified by FTIR microscopy in transmission mode performed on an unmounted fragment from the background, using a diamond compression cell. ATR–FTIR microscopy of a cross-section sample confirmed this result, and also identified the large rounded grains visible in this layer as starch. As only one of the cross-sections includes the ground layer, it is not clear whether this is an original component or present only in this sample due to penetration of a lining adhesive applied to the back of the canvas.

11 Wethey 1969–75, vol. III, p. 73, seems to have read these motifs as a stag and dog, but that was before the cleaning of 1998–9.

12 Semi-quantitative SEM–EDX analysis indicates that the small particles are depleted in potassium and therefore deteriorated rather than a grade of pigment that was always pale. The cobalt content is relatively high, measuring between 4 and 6 weight % oxide. The small is also quite high in the arsenic associated with the ore (As/Co atomic % ratio is 1.4–2.4), as found in the other paintings in this study.

13 SEM–EDX and ATR–FTIR microspectroscopic analysis of the cross-section identified a large agglomerate of copper carboxylate in this layer.

14 All the particles analysed by ATR–FTIR microscopy gave similar spectra identifying malachite. EDX confirmed this, and showed that in every particle there was a small amount of zinc in addition to copper.

15 This type of lead-tin yellow has commonly been found in paintings by Titian: see vol. 34 of this Bulletin, pp. 29–30.

Cat. 5 Diana and Callisto

1 This assumes that the seam is in the warp direction. In both canvases there is quite a lot of variation, so an average thread count is given here.

2 For an account of the recent conservation history of this painting see essay, p. 116. The painting is in good condition. There are slight losses from the edges of the canvas and a few small damages in the main part but no major losses. Thinner passages of paint may be worn and some have become more transparent, allowing underlayers to show more than would have been intended. Discoloration of the small pigment and fading of red lake pigments have affected the appearance of the painting in some areas. The thinly painted rocks behind Diana’s head appear indistinct and seem to have been particularly affected by an increase in transparency, and also most probably some abrasion and wear, diminishing the sense of recession in this part of the landscape behind the figures. See also note 4.

3 SEM–EDX analysis of the gesso detected calcium, sulphur and oxygen, indicating that it consists of calcium sulphate, although the type has not been confirmed as there was no sample available for FTIR analysis.

4 Damage and likely pigment alterations to the thinly painted clouds in the sky of the Rape of Europa (Isabella Stewart Gardner Museum, Boston) result in a similar effect and the impression of a red-brown ground. In comparison, Rubens’s copy of the Rape of Europa (Museo Nacional del Prado, Madrid) shows blue and grey clouds. Since the Rape of Europa was in the Orleans Collection along with the ‘Diana’ paintings and the even more damaged Perseus and Andromeda (Wallace Collection, London), it seems likely that they were all victims of French picture restorers of the early eighteenth century.

5 Harold Wethey was especially critical about the
consequences of past conservation treatments (he attributed the damage to cleaning rather than structural treatment) on these parts of the painting. See Wethey 1969–75, vol. III, p. 75. 6 This copy, probably painted largely by the workshop but perhaps with some intervention by Titian, must have been based on a tracing from the original design. Photographs taken of the back of the canvas when it was exposed for relining in 1912 show that at first the figure groups were carefully outlined on the canvas, with the design being exactly as in the original. During painting, the figure on the left was completely redesigned and the nymph seated at the centre was eliminated. The other seated nymph was changed slightly and the crouching dog taken out. The lapdog, however, must be the invention of a restorer, as there appears to be a large loss in this area.

7 HPLC analysis identified cochineal dyestuff as the major component; although from analyses it is very difficult to determine the source with certainty, given the date of the painting this is likely to be from a New World source such as Dactylopius coccus Costa. A smaller amount of kermes dyestuff from the scale insect Kermes vermilio Planchon was also found to be present.

8 Many other instances are known where a purple pigment mixture made with smalt and red lake has become completely brown, with a translucency that can make it indistinguishable from highly discoloured varnish. See Spring, Penny, White and Wyld 2001.

9 Although this second sample was from a paler passage of paint with a proportion of lead white, it probably included some of the underlying dark paint and it contained a mixture of pigments with both smalt and verdigris identified by FTIR microscopy in transmission mode using a diamond compression cell.


11 See note 6.

Cat. 6 The Tribute Money

1 No selvedges are included in the canvas, so although vertical threads are presumed to be warp and horizontal ones weft, this is not certain. The additions have 13 vertical threads and 12 horizontal threads per cm.

2 The painting is in excellent condition with only a few small, localised losses, mostly in Christ’s blue drapery. Some wrinkling and drying cracks have occurred in areas where the composition was changed. Discoloration of smalt has resulted in the patchy appearance of the sky and change to the colour of the Pharisee’s stole. The varnish applied in 1937 is beginning to discoulour and many of the retouchings have altered in colour.

3 See Penny 2008, pp. 262–5, for the painting’s provenance and attribution history.


5 Penny 2008, p. 266.

6 Similarities of palette with The Entombment (Museo Nacional del Prado, Madrid), sent to Philip II in 1559, have led to suggestions that The Tribute Money might have been begun then. However, the intensity of the ultramarine in these paintings is common to most of Titian’s production for the King. Penny 2008, p. 263, goes further in suggesting that ‘in its original conception, with its powerful contrasts of characterisation and texture, strong gestures and lighting, it recalls the Ecce Homo (Kunsthistorisches Museum, Vienna), which was completed in 1543’. 7 Penny 2008, p. 260, perhaps influenced by his idea that the painting had an extended execution, and by the identification of smalt on both the main canvas and the extension, appears to argue that the extensions were added by Titian. For the evidence that this is not the case (subsequently reinforced by the discovery of the workshop replica beneath the Hermitage Saint Sebastian), see Dunkerton 1999.

8 A good and accurate copy, once belonging to the Duque del Infantado, Seville, was published and reproduced in Wethey 1969–75, vol. I, pp. 164–5, plate 130. Its dimensions of 101 x 107.3 cm are close to the original canvas of the National Gallery work, although it appears to have been reduced at the top. This may be another workshop replica, but, given its provenance, it could equally have been painted in Spain.

9 Identified by FTIR microscopy in transmission mode using a diamond compression cell.

10 At the National Gallery, a calcium carbonate ground has been found on Veronese’s The Adoration of the Kings (NG 268) and The Queen of Sheba before King Solomon (NG 3107) by Lambert Sustris (which was probably painted in Venice). Penny, Roy and Spring 1996, pp. 47–8, and Penny 2008, p. 126.

11 Analysis was carried out by SEM-EDX. The difference in the ratios of the atomic percentage of cobalt to arsenic in the smalt from the original and from the additions was clear, with that from the original having an As/Co ratio varying between 1.3 and 2.5 (average 1.7), and that from the additions conversely containing roughly one and a half to two times more arsenic than cobalt (Co/As 1.3–2.3, averaging 1.7). This suggests a more strongly roasted ore was used to make the smalt on the additions. See Spring et al. 2012, for methodology of analysis and context for interpretation of results, esp. pp. 118–20.

12 Smalt from other Venetian paintings such as those by Veronese is also high in arsenic. See Spring et al. 2012.

13 Dunkerton 1999, p. 119.

14 In the X-radiograph there is a suggestion of lettering on the first coin, which can be read to include the word ‘FERRARA’, an echo of Titian’s first painting of the subject. See Penny 2008, p. 264.

15 Penny 2008, p. 266, Penny also notes in the print the two little metal masks attached to the purse to the belt, which he suggests would be a characteristic detail of Titian’s that was perhaps present in the painting at an earlier stage when seen by Rota, but later deleted. It would seem that this is not the case, since there is no sign of them in the X-radiograph and one would expect them to have been painted using X-ray-opaque pigments such as lead-tin yellow.

16 A sample taken from the sky above the Pharisee’s head shows that small is combined with carbon black and a little ultramarine in the underpaint. Over it is a more intense blue layer consisting of ultramarine and lead white. Although degraded and discoloured through loss of potassium from the glassy pigment, the blue colour of the smalt is still retained in some of the larger particles. For the degradation of small, see Spring et al. 2012.

17 J. Dunkerton and M. Spring, see vol. 34 of this Bulletin, p. 24.

18 Powder X-ray diffraction analysis using a Debye-Scherrer camera confirmed the presence of orpiment (in agreement with JCPDS file no. 19–84).
19 Particles that were more opaque and a slightly lighter green than the very obvious large grains of verdigris were seen under the stereomicroscope and are likely to be malachite, although this has not been confirmed by analysis.

20 Identified by FTIR microscopy in transmission mode using a diamond compression cell.

21 HPLC analysis identified kermes from the scale insect Kermes vernillo Planchon, together with cochineal. The type of cochineal could not be confirmed but based on the date of the painting it is likely to be from a New World source such as Dactylopius coccus Costa. FTIR analysis suggested that the lake substrate included a proportion of sulphate. Although two dyes were detected in the sample by HPLC, it was not possible to determine whether these were present in two separate lake pigments. Differences in substrate composition seen by SEM–EDX can sometimes be helpful, but here the paint cross-section was too tiny to be able to make firm conclusions from analysis of individual lake particles. The EDX spectra did, however, indicate a substrate based on hydrated alumina.


24 For discussion of this much-quoted letter, the possible effects of old age on the eyesight of Titian (and other painters) and the use by them of spectacles, see Sohm 2007, pp. 77–81.

Cat. 7 The Virgin suckling the Infant Christ

1 No selvedges are included in the canvas, so although vertical threads are presumed to be warp and horizontal ones weft, this is not certain. This assumption is supported, however, by the observation that the horizontal threads are much less even and are slubby.

2 The painting is generally well preserved with only a few small areas of local damage, mostly around the edges. The paint is not particularly worn and abraded, although uneven paint discoloration and wrinkling, and ingrained residues of dirt and old varnishes in depressions in the brushstrokes and canvas weave, give the impression of a rubbed surface, which in the past has led to the assumption that it is in poor condition. The varnish applied in 1962 is in good condition and only a very little discoloured.


4 The pose of Titian's Infant Christ resembles that of the Child in Michelangelo's large drawing (perhaps a cartoon made for another painter) in the Casa Buonarroti, Florence (inv. 71F). The drawing, however, is generally dated to the 1520s, when Michelangelo was in Florence (Hirst 1988, pp. 88–9). It could have been taken to Rome, but equally the similarity may be generic or Titian might have seen another derivation.

5 Engraving by Pieter de Jode the Younger, reproduced in Penny 2008, p. 271, fig. 1.

6 Penny 2008, p. 270.


8 Charles Holmes, Director of the National Gallery when the painting was acquired as part of the Mond Bequest. Holmes 1923, p. 195.

9 The gesso was analysed only by SEM–EDX. The conclusion that calcium sulphate is present is therefore based on the detection of the elements Ca, S and O, but the type has not been established. Particles containing a combination of Ca, Mg and O are assumed to be dolomite.

10 Although HPLC analysis cannot distinguish between all Old and New World sources of cochineal, the date of this painting would almost certainly suggest the use of Mexican cochineal (Dactylopius coccus Costa).

11 Semi-quantitative analysis by SEM–EDX of the small particles shows that they are depleted in potassium, confirming that they are deteriorated (rather than a low grade that was always pale). The small contains a fairly high level of cobalt, at 4.3–5.0 wt% oxide, and is rich in arsenic (as found in the other works in this study), with the As/Co atomic % ratio being in the range 1.3–1.5.

12 This local underpainting was incorrectly reported in Penny 2008, p. 268, as an imprimitura applied across the whole canvas (on the gesso) before painting.


14 A cross-section of a sample from the shadowed area of the brown background at the top edge towards the left shows that it was laid in with a mixture consisting mainly of yellow and red earth (the latter sometimes in large agglomerates) with a little coal black. The shadow paint applied on top contains mainly black pigment with a little earth, explaining the dark appearance in the infrared image of the strokes around the contour. It also contains some red lead and a very small amount of colourless powdered soda-ash glass, both probably added to enhance drying.

Cat. 8 The Death of Actaeon

1 The thread count of the canvas is very variable, measuring between 12 and 15 warp per cm and 16 to 18 weft per cm. The average value is given in the entry.

2 Apart from a surface clean and revarnish, no treatment has been made to this painting since it was acquired by the National Gallery in 1972. The varnish already present before the surface clean, identified as mastic by GC–MS, may date from around 1920 if it was indeed cleaned at that time by Cavenaghi as had been proposed, or possibly earlier, and has discoloured to yellow but retains reasonable saturation and transparency. The paint is mostly in fairly good condition but there is a large damage in the bottom right corner, which has resulted from the insertion of an irregularly shaped piece of canvas (approx. 25 × 32 cm). Elsewhere, paint has been lost from around the edges, the thicker paint of the trees on the right has suffered flaking and there are other small damages, which may be the result of the canvas having been folded or rolled. Thinner paint has suffered some wearing, exposing the top of the canvas threads. Some retouchings have discoloured, particularly noticeable in the sky in the top left corner. Smalt, used in various places, including the sky and Diana’s dress, has discoloured, and the red lake pigments have faded somewhat.


5 It was described as ‘not quite finished’ as early as 1636–8, when it was included in the list of paintings submitted by Lord Fielding (the British ambassador to Venice) to the Marquess of Hamilton; see Penny 2008, p. 253. Among the scholars who believed the painting to be incomplete are Wethey 1969–75 (but only lacking ‘some final glazes’.
The Vendramin Family.

The Entombment. Nymph and Shepherd. Gallery of the Diana and Callisto, where it seems that Titian's painting technique from 1540 was first X-rayed at the Courtauld Institute in 1961. See also the National Portrait Gallery online resource 'British picture restorers, 1600–1950' (2nd edition, August 2014), compiled by Jacob Simon, which outlines the career of the artist and picture restorer Stanley Kennedy North, who was based in London (http://www.npg.org.uk/research/programmes/directory-of-british-picture-restorers/british-picture-restorers-1600-1950-n.php). He worked on a number of pictures in the Royal Collection, including Duccio's Triptych in or after 1930, and Andrea Mantegna's The Triumphs of Caesar at Hampton Court in 1931–4, which he relined. For this he used a wax adhesive, as he did for the lining of Titian's Diana and Actaeon and Diana and Callisto in 1932, and for Titian's Venus Rising from the Sea in 1931, which was also in the collection of the Duke of Sutherland.

The Conservation History of Titian's Diana and Actaeon and Diana and Callisto

1. Fry 1933.
2. Kennedy North 1933. See also the National Portrait Gallery online resource 'British picture restorers, 1600–1950' (2nd edition, August 2014), compiled by Jacob Simon, which outlines the career of the artist and picture restorer Stanley Kennedy North, who was based in London (http://www.npg.org.uk/research/programmes/directory-of-british-picture-restorers/british-picture-restorers-1600-1950-n.php). He worked on a number of pictures in the Royal Collection, including Duccio's Triptych in or after 1930, and Andrea Mantegna's The Triumphs of Caesar at Hampton Court in 1931–4, which he relined. For this he used a wax adhesive, as he did for the lining of Titian's Diana and Actaeon and Diana and Callisto in 1932, and for Titian's Venus Rising from the Sea in 1931, which was also in the collection of the Duke of Sutherland.

5. Toyneee 1903, p. 77. See also Kennedy North 1933, p. 10, where he quoted this phrase, implying that it could be assumed that the two Bridgewater Titians had certainly undergone this kind of treatment, an assumption that has made its way into much of the subsequent literature on these works. For the conservation history of Sebastiano del Piombo's Raising of Lazarus (NG 1), which did undergo transfer while in the Orleans Collection, see Dunkerton and Howard 2009.
7. Herbert George Haines (1857–1933) was the last in a dynasty of picture restorers, starting with William Henry Haines, whose uncle was William Seguier who was appointed Keeper at the National Gallery in 1824. W.H. Haines set up business with his younger brother Frederick in 1844. H.G. Haines was listed in the 1891 census records as 'restorative artist (pictures) and art expert'. The Haines family business ran until 1931. For this and a full description of the activity of the Haines family as restorers see 'British picture restorers, 1600–1950' (details in note 2).
10. See Kennedy North 1932, p. 4.
11. See Kennedy North 1932, p. 2.
12. The paintings seem to have had glue-paste linings in place before the treatment undertaken by Kennedy North. The lifetime of a lining is expected to be between about 70..
and 100 years, so it is unlikely that these linings dated from the recorded treatment by Haines only around 30 years before Kennedy North’s examination. It is therefore very possible that the most recent relining before 1932 was in the eighteenth century, either in London as Kennedy North presumed, or even earlier while the paintings were in the Orleans Collection, possibly in the 1770s when it is known that many of the paintings underwent conservation treatment.

15 Kennedy North 1930.
16 The phrase in Kennedy North’s obituary is quoted in Burnstock et al. 1993, p. 682. In 1931 Kennedy North had treated the Peasant Family (Petworth House), one of the paintings by Le Nain discussed in this article, and had documented it in the same detailed way as for the Titians.
17 See Ruhemann 1968, pp. 54–5, for remarks on the context and new developments in the conservation profession in the 1930s.
18 Kennedy North 1932, p. 3.
19 Kennedy North 1932, p. 3.
20 Kennedy North 1932, p. 3.
21 Kennedy North 1932, p. 3.
22 See Saunders 2000, which also includes these quotations (originally from the National Gallery archive).
23 Ruhemann 1968, p. 50.
24 For the treatment by Haines see ‘British picture restorers, 1600–1950’ (details in note 2). The 1942 cleaning is recorded in the National Gallery conservation dossiers for these works and even includes some early colour measurements comparing cleaned and uncleaned areas with a Tintometer by F.G. Rawlins. These seem to confirm the yellow state of the varnish.
25 See cats 54 and 55 in Edinburgh 2004, pp. 160–2. In the ‘Technical Note’ initialled by John Dick (JD) it states that this adhesive was ‘wax-resin’ rather than wax alone, which would have given it better adhesive properties, but given the relatively rapid deterioration in the lining after the 1932 treatment Kennedy North may well have used only wax, as he implied in his documentation.
26 Kennedy North 1932, p. 8.
27 Kennedy North 1933, p. 10.
28 Ruhemann 1968, p. 42.
29 Kennedy North 1933, p. 15.
30 Fry 1933, p. 3.
31 John Dick was Keeper of Conservation at the National Galleries of Scotland from 27 January 1964 to 14 January 1999. He completed the restoration of these two works between 1998 and 1999.
33 See Ruhemann 1968, p. 290.
35 Brigstocke 1978, p. 162.
36 Brigstocke 1978, p. 162.
37 Kennedy North 1933, p. 15.
Titian’s Painting Technique from 1540

Ruhemann 1968

Saunders 2000

Seccarone 2006

Seccarone 2012

Sohn 1991

Sohn 2007

Spring 2012

Spring, Grout and White 2003

Spring, Penny, White and Wyld 2001

Spring et al. 2005

Spring et al. 2012

Stege 2004

Tegliaferro and Aikema 2009

Terczynska-Madej, Cholewa-Kovalska and Lacza 2010

Toynbee 1903

Valkanover 1979

Vasari (1568) 1966–87

Venice and Washington 1990

Vienna 1996

Vienna and Venice 2007–8

Wald 1999

Wethey 1969–75

Wethey 1987
H.E. Wethey, Titian and his Drawings, Princeton 1987.

Whistler 2009