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# Titian's 'Bacchus and Ariadne'

Arthur Lucas and Joyce Plesters

## An account of the condition, conservation, materials and techniques

Arthur Lucas and Joyce Plesters

In the first issue of the *National Gallery Technical Bulletin*, which appeared in September 1977, the case-histories given in detail were all of pictures which had very recently undergone examination and treatment. In the present issue it was considered that it might be of some general interest to review the case-history of a picture the most recent restoration of which dates from over ten years ago, Titian's *Bacchus and Ariadne* (No.35), indisputably one of the finest and most famous of all the National Gallery's paintings. At the time the matter of whether the picture ought or ought not to be cleaned became something of a *cause célèbre*. It may be that with a decade separating both authors and readers from the event, and passions in the meantime having somewhat cooled, it will be easier to present an objective account.

The history, iconography and provenance of Titian's *Bacchus and Ariadne* are given in detail by Cecil Gould in his National Gallery Catalogue, *The Sixteenth Century Italian Schools* (1), and in a monograph (2) published in 1969 on the occasion of the picture being re-exhibited after cleaning and restoration. It suffices here to say that originally it formed one of a series of paintings of Bacchanalian subjects commissioned by Duke Alfonso I d'Este of Ferrara and was finished by Titian in 1523.

Before its most recent conservation treatment, carried out between 1967 and 1969, the *Bacchus and Ariadne* was seen to be considerably darker and more discoloured than the two companion 'Bacchanals' by Titian, the *Worship of Venus* and the *Bacchanal of the Andrians*, both in the Prado, Madrid, although they were, and still are, by no means free from old and yellowed varnish. This in itself might have constituted a valid argument in favour of cleaning the *Bacchus and Ariadne*, but, as we shall see, was not the decisive factor in electing for cleaning, that being the physical safety and preservation of the picture as a whole. Varnish removal proved to be a necessary preliminary stage in a complete programme of conservation.

The decision which had to be made as to whether or not to treat the picture has to be seen in the context of the mid-1960s. The early sixties had witnessed a renewal of the 'cleaning controversy' which had raged from time to time in connection with the National Gallery ever since the 1840s. A late offshoot of the 1960s controversy was a series of letters written in 1966 (3), some addressed to the Director or Keeper of the National Gallery, others published in *The Times*,

on the subject of possible future cleaning of the picture. Although the major part of the correspondence constituted a plea for cleaning, there was a predictable hard core of objectors. In April 1967 the Trustees of the National Gallery considered a report by the Chief Restorer, Arthur Lucas, on the condition and an outline of his proposals for treatment. It was decided, however, that an international committee should be set up to advise on any proposed treatment before it was put into practice. The committee (4) sat between 22 and 24 April 1967. Their report (5), dated 24 April, concluded that the condition of the picture urgently required treatment and that that proposed by the Chief Restorer was appropriate and desirable, with cleaning, in the sense of varnish removal, as an integral part. The Chief Restorer began the task in 1967, completing it in 1969.

## History of condition and treatment before 1967

The earlier history of the picture is not without relevance to the disorders which compelled its most recent restoration. Titian began the picture in Venice in 1520 or 1522 and finished it at Ferrara early in 1523, the unfinished canvas having been sent by sea from Venice to the port of Ferrara. In 1598 the picture was transferred from Ferrara to Rome. It was not unusual in the past (and in Venice even today is still often essential) to take a canvas painting off its stretcher and roll it up for ease of transport whether on human- or horseback, by waggon or boat. This operation, particularly if the canvas is rolled into a cylinder of small diameter or rolled with the paint layer innermost, can be very injurious to both paint and ground layers. It would be quite likely to cause both vertical cracks and horizontal cleavage in a rather brittle material like gesso (a form of calcium sulphate bound with animal glue, which was in fact identified as the ground of the *Bacchus and Ariadne*). The many small losses noted in the paint layers coupled with the disintegrating state of the gesso ground before its recent consolidation are not inconsistent with rolling of the painted canvas combined with rough handling in transit. The third major journey which the picture underwent was to London in 1806 or 1807. It was known that it was restored on arrival in London and was cleaned either then, or before it left Italy, or both. The English artist, Henry Bone, made a sizeable enamel copy of it which was certainly in existence by 1811, when it was remarked on by Joseph Farington in his diary (6). The enamel was exhibited alongside the newly-cleaned original in 1969 and it was remarkable, making only a small allowance for difference of painting medium and possible slight alterations

during firing of the enamel, how closely the colours of enamel and newly-cleaned picture coincided. Enamel colours are not normally subject to the discolouring effects of light and atmosphere to which easel paintings, particularly when varnished with natural resin varnishes are prone. The close similarity in colours of the newly-cleaned picture in 1969 and Henry Bone's enamel, which he must have completed a little before 1811, also implies that when the enamel copy was made the original had just undergone, in about 1806 or 1807, as complete a removal of discoloured varnish as in its most recent cleaning. Unfortunately, even up to twenty-five years ago, by which time modern less-yellowing (or even non-yellowing) synthetic resin varnishes had become readily available, newly-cleaned paintings had to be revarnished using the same type of natural resin varnish as that just removed, the most common being mastic resin dissolved in turpentine distillate, with or without the addition of a drying oil such as linseed. (Happily, cases of the use of varnishes based on resins like copal or amber dissolved in drying oils by heating are comparatively rare on pictures cleaned within our time, which is fortunate, since with age they may become extremely difficult to remove; their removal in the past by harsh methods may have been responsible for damage to some pictures.)

Although a varnish of natural resin in a volatile solvent, such as mastic in turpentine, when initially applied in a thin coat imparts no perceptible colour to a picture, it may, with age and exposure, begin to show signs of discolouration in as little as twenty years and eventually the cycle of varnishing and cleaning, cleaning and varnishing would begin all over again. By the time the *Bacchus and Ariadne* was bought for the National Gallery in 1826 it is recorded that the varnish had already begun to turn brown. Twenty years later it was cleaned, but only partially, and revarnished with a mastic varnish containing a proportion of linseed oil.

It is not known when the first lining canvas, i.e. a new canvas stuck to the back of the old for the purpose of reinforcing the latter, was applied. Almost all canvas paintings of any appreciable age or value are found to have been lined at one time or another. By 1894 the existing lining canvas was reported to be in a bad state and a double lining canvas was substituted which in turn was replaced by a single one in 1929, this last mentioned being the canvas removed in the 1967–1969 restoration. Apart from simple mechanical reinforcement of the exceptionally thin and finely-woven original canvas (see p.38 and Fig.7), the main object of these repeated lining and relining operations on the *Bacchus and Ariadne* would have been to try to obtain better cohesion between the various layers of paint, ground and canvas. It is likely that the thin gesso ground on which the picture is now known to have been painted had long ceased to adhere completely either to the canvas or paint. Deterioration of the gesso ground could have been hastened by the action of water, either in leaching out the glue medium of the gesso or by providing suitable conditions for biological attack by micro-organisms. In fact, in a

letter to the Select Committee on the National Gallery of 1853, William Buchanan, through whose hands the picture had passed in 1806, states that he was informed 'that water had been freely used in taking away some surface dirt' and expressed the view that it would have penetrated through cracks and fissures in the surface into the absorbent gesso ground, eventually causing 'the body of the paint itself [...] to scale off' (7). It is not, however, clear from the context exactly when he believed this cleaning with water to have taken place.

The National Gallery is singularly fortunate in having records of condition and restoration going back to the beginnings of the collection. For much of the earlier data we have to thank Sir Charles Eastlake, the first Director of the National Gallery, who meticulously recorded condition and treatments of pictures as they were acquired in his Manuscript Catalogue, the first volume of which he began in 1856. His example encouraged his successors to keep up similar technical records.

In the case of the Titian *Bacchus and Ariadne* some relevant documentary evidence survives even from before the painting's acquisition. It might be of interest to give a summary of the picture's history of restoration, from documentary and published sources, up to the examination and treatment of 1967–1969:

#### 1803

Irvine wrote to Buchanan from Rome that Day, who had recently bought the picture from the Aldobrandini Palace, intended to have it cleaned (8).

#### 1807

Farington records remarks by Benjamin West, PRA: 'He said the picture was really in a fine preservation, but it was mortifying to see that Burch, the picture dealer, had been putting colour upon it, in many parts—upon the sky with ultramarine—and had stippled colour upon parts of the flesh. He said if the picture was his he would take off the whole of what Burch had done, for he knew he was the person that had done it in order to make the picture appear more showy; he knew his hand (9)'.

#### 1826

Picture purchased by the Gallery.

The journal *News of Literature and Fashion* for the 15 April of that year remarks: 'The real truth is that the *Bacchus and Ariadne* has had a great many tricks played with it. When at Rome, it was considered a fine picture, but exceedingly brown. When it came to England it was cleaned so effectually as to have become a perfectly blue picture, and now it has relapsed into dinginess again [...]'.<sup>1</sup>

#### 1846

Eastlake's initial entry for the picture in the Manuscript Catalogue concerning conservation: 'Lined: at what period uncertain. Cleaned to a certain extent by Mr. J. Seguier (10) in October 1846. See Return respecting pictures cleaned; Report from the Select Committee on the National Gallery, 1853, p.748. See also minutes of the Trustees (Parliamentary Paper No.40, 1847, pp.15,19). Gallery Varnish 1846' (11).

#### 1853

'Discoloured and decayed varnish removed so far as was thought prudent.' (Appendix to *Report from the Select Committee on the National Gallery*, 1853.) The remark refers to Seguier's cleaning operation of 1846 mentioned above. Before the Select Committee Mr. Retra Bolton, a picture-cleaner, stated his belief that the 'Bacchus' had been hurt by the Gallery Varnish: 'I remember that picture looking fresher



a great deal. I do think the oil varnish has acted upon that picture: it is getting streamy and smurky [*sic*] about the skies.'

1855

Reported as having been lined, at what period uncertain. Repairs visible in the left shoulder, neck and breast of Bacchus. Effects of discoloured varnish (probably not completely removed in 1846) apparent in the sky, 'but not so as to injure the appearance'. Canvas partially detached from the lining in the upper left corner, also in the upper right corner.

1857

Placed under glass.

1865

The varnish revived by the Pettenkofer process (12).

1894

'The picture was examined as to the "buckling" in the upper left-hand corner in August; the lining canvas being reported by Morrill (13) to be in a bad state, the picture was relined [double lined by Morrill, for which the bill exists in the Conservation Department's files]. The surface of the varnish was then taken off by Buttery with the finger (14), one or two very slight injuries repaired, and the picture was re-varnished with mastic, under my eyes' [signed E.J. POYNTER (15)].

1929

The two lining canvases removed by Morrill revealing that the back of the original canvas 'had at some period been covered with paint' [which was probably in fact an old adhesive, containing some lead white, from an even earlier lining]. Relined with a single canvas. The then Director, A. M. Daniel 'expressed the definite desire that the surface should be touched as little as possible, as I in no way wished the picture to be cleaned nor the old varnish to be removed', in spite of a warning from the restorer that in the process of relining the varnish 'might perish and become opaque'.

The new lining seems not to have been a success, for there exists pasted in the Manuscript Catalogue a further typewritten note signed by A. M. Daniel describing how, while Mr Morrill the restorer had been gluing the original canvas onto the lining, a blister had formed on the foreground beneath the feet of one of the Bacchantes. Morrill had considered the only course to adopt—though some might consider it a drastic one—was to cut the blister, thereby releasing the pressure within, 'before it spread further'. This cut, through the original canvas and about 14 inches long, could easily be seen (Fig. 1) before the 1967–1969 restoration. Morrill was strongly of the opinion—and his views were to be confirmed during the most recent examination and treatment of the picture—that the root of the trouble was the thin coat of paint, or paint-like material, on the back of the original canvas, which prevented 'the proper action of the glue in making at once adherent the original canvas and the lining'.

Unfortunately the recurring malady of flaking paint seems not to have been cured in the long-term by this latest relining:

1940

June and November. Flaking paint secured by Morrill.

1941

Loose paint laid by Morrill.

1945

Polished by Vallance (16).

1946

Varnish along right edge revived by Lucas.

1954

Fine flaking at top treated with wax by Woods.

In 1938 a report on the state of the painting was made by H. Ruhemann, then Consultant Restorer, who after detailing the well-preserved areas, paint losses, damages and retouchings, concluded: 'Could be greatly improved, but it would be an enormous job'.

In 1948 a very full report of the condition at that time was made by Philip Hendy, then Director, in collaboration with conservation staff. The observations and proposals for treatment, including removal of old varnish, laying of loose paint, impregnation of ground and paint with an adhesive, probably combined with relining, were not in fact very different from those to be made in 1967. The optimistic tone of the report suggests that it was expected that the proposals would very soon be put into practice, but it was not to be. In 1947–1948 there was held the 'Cleaned Pictures Exhibition' consisting of all the National Gallery pictures cleaned since 1936 (a total of seventy works), together with related photographs and background information, and catalogue (17). To some (including the authors) the 'Cleaned Pictures Exhibition' was a revelation; to others it was an outrage. It has to be recalled that this comparatively small group of cleaned paintings at that time stood out like beacons among the rest of the collection, many of which still bore the notorious 'Gallery Varnish' (11), and against the rather dingy post-war decor. Moreover, several generations of Gallery visitors had grown up accustomed to seeing pictures in an uncleaned state. The position is now reversed, for not only in the National Gallery, but in a good many of the great galleries of the world and in major international exhibitions, it is the uncleaned pictures which tend disturbingly to stand out. Although an international committee, the Weaver Committee (18), set up in 1947 'to inquire into and report on the safety of the methods and materials used in the cleaning of pictures at the National Gallery', affirmed that the safety of the pictures had never been jeopardized by cleaning, the storm of controversy subsided only gradually, leaving an atmosphere not conducive to starting on a major restoration of one of the Gallery's major masterpieces and the project was shelved until 1967. In the meantime anxiety about possible further deterioration of the painting did not, however, abate, for another longish report cataloguing the by now familiar symptoms of discoloured varnish, disfiguring retouchings, paint losses and further incipient flaking was entered in the Conservation Dossier in 1952.

## Condition and treatment, 1967–1969

Arthur Lucas

In April 1967 a new and thorough examination of the *Bacchus and Ariadne* was made by the then Director (Sir Philip Hendy), the then Deputy Keeper (Cecil Gould) and the Chief Restorer (Arthur Lucas), who jointly worked out a programme of treatment.

### Condition in 1967 before treatment

On this occasion assessment was greatly facilitated by a new set of X-radiographs covering the whole of the picture (Fig.2) and a set of full-sized infra-red photographs made at the same time (Fig.3). Infra-red radiation has the property of penetrating yellowed and semi-opaque varnish so that an infra-red photograph of an uncleaned picture will give a clearer image of the paint surface beneath than will an ordinary panchromatic photograph. At the stage of the examination at which cleaning tests were made these were supplemented by an equivalent set of full-size photographs taken by 'raking' light to show the surface texture (Fig.4).

The original canvas is remarkably thin and finely-woven (see p.38 and Fig.7), considering the relatively large size of the picture. In some past relining the turnovers and edges had been cut off close to the edge of the paint surface so that, as stuck down on the lining canvas, the cut edges of the original canvas lay within the edges of the stretcher. In the X-radiographs there can be seen some waviness in the weave of the original canvas towards the edges which must have been caused by uneven tension from the nails fastening it to its original stretcher (the existing stretcher probably dating only from 1894). The degree of damage to the original canvas could not easily be gauged before complete removal of the lining canvas, but the only conspicuous injury seemed to be the 14-inch long cut beneath the foot of the Bacchante with the cymbals which, as we have seen above, was deliberately made during the 1929 relining. Dark furrows seen in the X-radiographs which might be taken for rents in the canvas seemed more likely to result from irregularities in the thickness of the lining adhesive, or to be restricted to the paint layers. The reflected light photographs (Fig.4) show strikingly how the surface of the original canvas had become severely buckled and uneven as a result of past unsuccessful attempts at relining and shrinkage of old glue adhesives.

The lining canvas, dating from 1929, was in good condition as also was the layer of glue adhesive fixing the two canvasses together, but it was clear that the glue had not succeeded in penetrating the back of the original canvas. The relining operation had therefore failed to fulfil its primary introduction function which was to impregnate and reattach loose ground and paint by the introduction of adhesive through the back of the original canvas.

The ground, which chemical analysis subsequently showed to be gesso (see p.33) appeared to be very thin and its attachment to both canvas and paint layer



weak. In some areas of paint loss bare reddish-brown canvas was visible where the gesso ground had also fallen off.

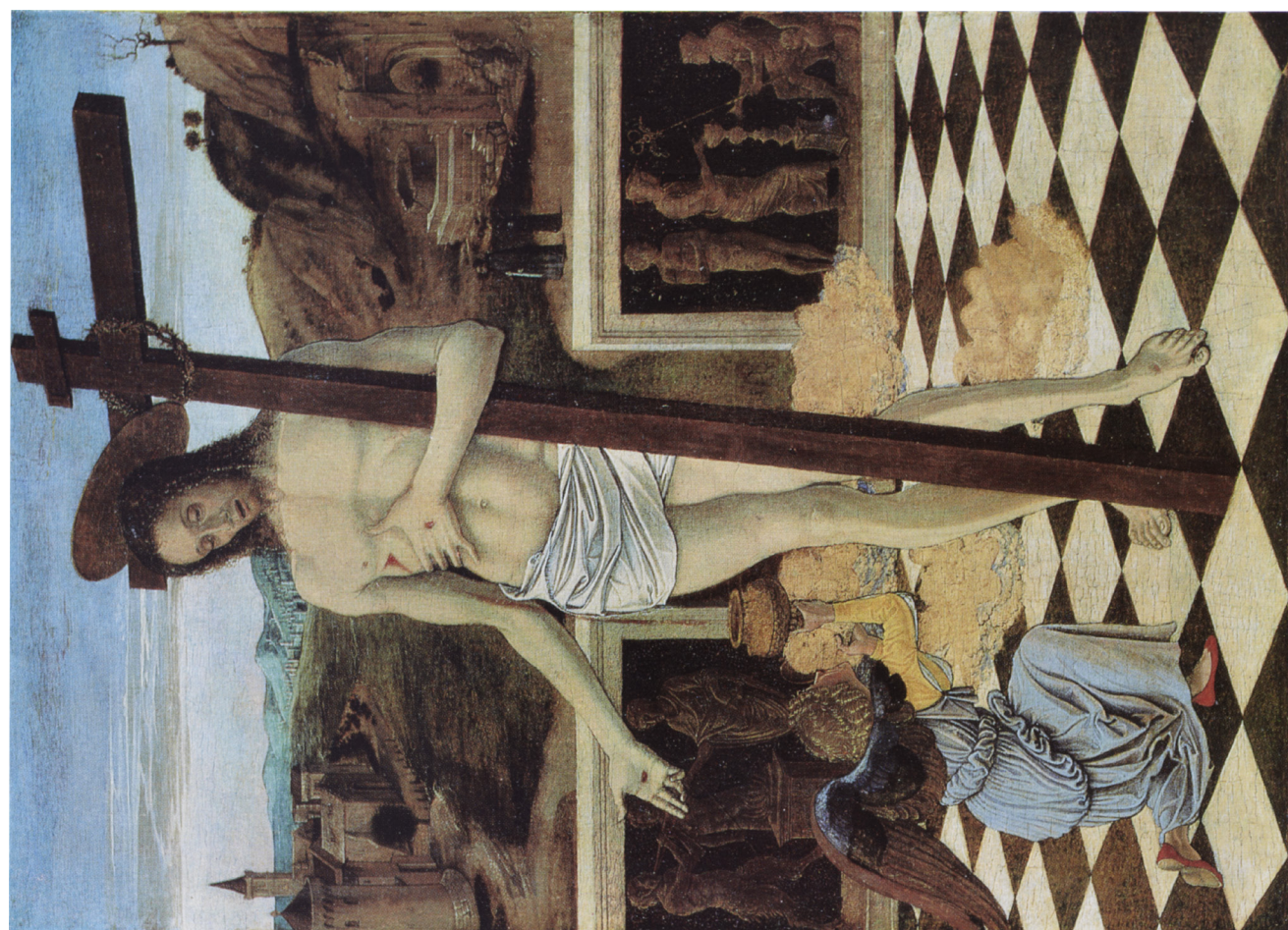
The thickness, discolouration and reduced transparency of the varnish made judgement of the condition of the paint film difficult with the unaided eye. The X-radiographs (Fig.2) gave rather an alarming first impression. The numerous small losses in paint and ground (including those which have been filled in later with a chalk putty) appear as strongly-silhouetted black patches (those losses filled with lead putty appear as corresponding white patches). Although the initial impression from the radiographs was that a great deal of paint was lost, a rough calculation put the figure at about 5 per cent. Whilst this is by no means negligible it is not exceptional for a picture of the age of the *Bacchus and Ariadne* (in fact, as will be seen below, the percentage as based on the X-radiographs proved to be rather an overestimate). The majority of the damages and retouchings seemed, from evidence from the picture itself, the X-radiographs and the infra-red photographs, to be in the top half of the composition, and for the most part in the sky. Individually the paint losses were not large. Of the figures, Bacchus seemed to have suffered most, having badly-discoloured retouchings on right arm, head and shoulder, but fortunately the damaged areas did not include the features of his face.

Most of the old retouchings had darkened from discolouration of the medium with age and exposure to light, but those on Bacchus's cloak showed as pale yellow spots through the discoloured varnish, presumably on account of a fugitive crimson-coloured pigment having been used in a past restoration.

The varnish, which was exceedingly thick and probably represents several successive varnishings, was very brittle, adhering in some places, but flaking in others. Microscopical examination of a sample revealed that as well as having become naturally discoloured with age, it had initially been deliberately tinted with brown and yellow pigment, probably the better to hide poorly-matching retouchings.

**Figure 1**  
Detail of 14 in.  
long cut made in  
1929 for the  
purpose of laying  
down a blister  
formed during the  
relining  
operation.





**Plate 1**  
Giovanni Bellini,  
*The Blood of the  
Redeemer*.  
After cleaning  
and restoration.

**Plate 2**  
(far right, top)  
Titian, *Bacchus and  
Ariadne*. Detail of  
yellow drapery  
beneath pitcher,  
during cleaning.

**Plate 3**  
(far right below)  
Titian, *Bacchus and  
Ariadne*. Detail of  
head and arm of  
Bacchante with  
tambourine,  
during cleaning.





**Plate 4**  
Titian, *Bacchus and Ariadne*.  
Whole picture, with initial  
cleaning tests.



**Plate 5**  
Titian, *Bacchus and Ariadne*.  
Whole picture, after cleaning  
and restoration.



**Figure 2**  
X-ray mosaic  
before cleaning  
and restoration of  
1967–69.  
(42 kV, 20 mA,  
48 sec.)



Solubility tests on samples of the old varnish indicated that it was most likely to be mastic, but analysis by gas-chromatography (see p.37) detected the presence of a small addition of linseed oil (most probably added as a deterrent to 'bloom' developing on the varnish).

The next stage was to carry out some cleaning tests, removing the varnish from small selected areas of the picture. It was found that the varnish was easily soluble in solvent mixtures customarily used for removing old mastic/turpentine varnish, though on this occasion the mixture chosen was of 2-ethoxyethanol (1 part by volume), isopropanol (5 parts) and white spirit (refined turpentine substitute) (18 parts). The proportion of linseed oil in the varnish was obviously not sufficient to decrease its solubility to any marked extent. Nine cleaning tests were made, each of the order of about seven centimetres square. Those in the sky to the left of the picture not only showed more numerous paint losses, especially around the figure of Bacchus, than in cleaning tests elsewhere, but also some wearing of the top surface of the paint layer which had been disguised by roughly scumbling over with blue paint in an easily-soluble resinous medium. In other cleaning tests the paint seemed in remarkably good condition. The cleaning tests did reveal that paint and ground were flaking in small patches throughout the picture, but worst round the centre.

The cleaning tests can be seen in a colour photograph of the whole picture (Plate 4), which also gives a fair idea of the general tone before cleaning. The test in the sky above the centre of Bacchus's cloak was chosen as being representative of what was known to be the most damaged area. The one in the head and arms of the Bacchante with the tambourine shows that her dress is mauve, whereas in the uncleaned area it appeared grey. The one on the left leg and blue drapery of the Bacchante with the cymbals was in an area which had seemed from the infra-red photographs (Fig.3) to be much damaged and to have very disfiguring wide craquelure, but which on cleaning was revealed as reasonably well preserved. The tests in the lower right corner displays the almost perfect preservation of the iris, where, as in many other parts of the foliage in the picture, the green pigment has retained its colour and not become browned with age as in some other of Titian's works. A detail of the test on the yellow drapery beneath the urn in the bottom left corner is shown in Plate 2 (p.29).

At the time the cleaning tests were made (April 1967) it was noted in the dossier: 'Although the picture looks very blue in the cleaning test areas, it will not look so unbalanced in colour when it is cleaned completely, since the greens and carmine colours are well preserved and are not too brown'. It was also added 'from the picture-restorer's point of





**Figure 3**  
Infra-red mosaic,  
before cleaning  
and restoration.

view there are no serious problems other than a great number of holes to be filled in and painted out'.

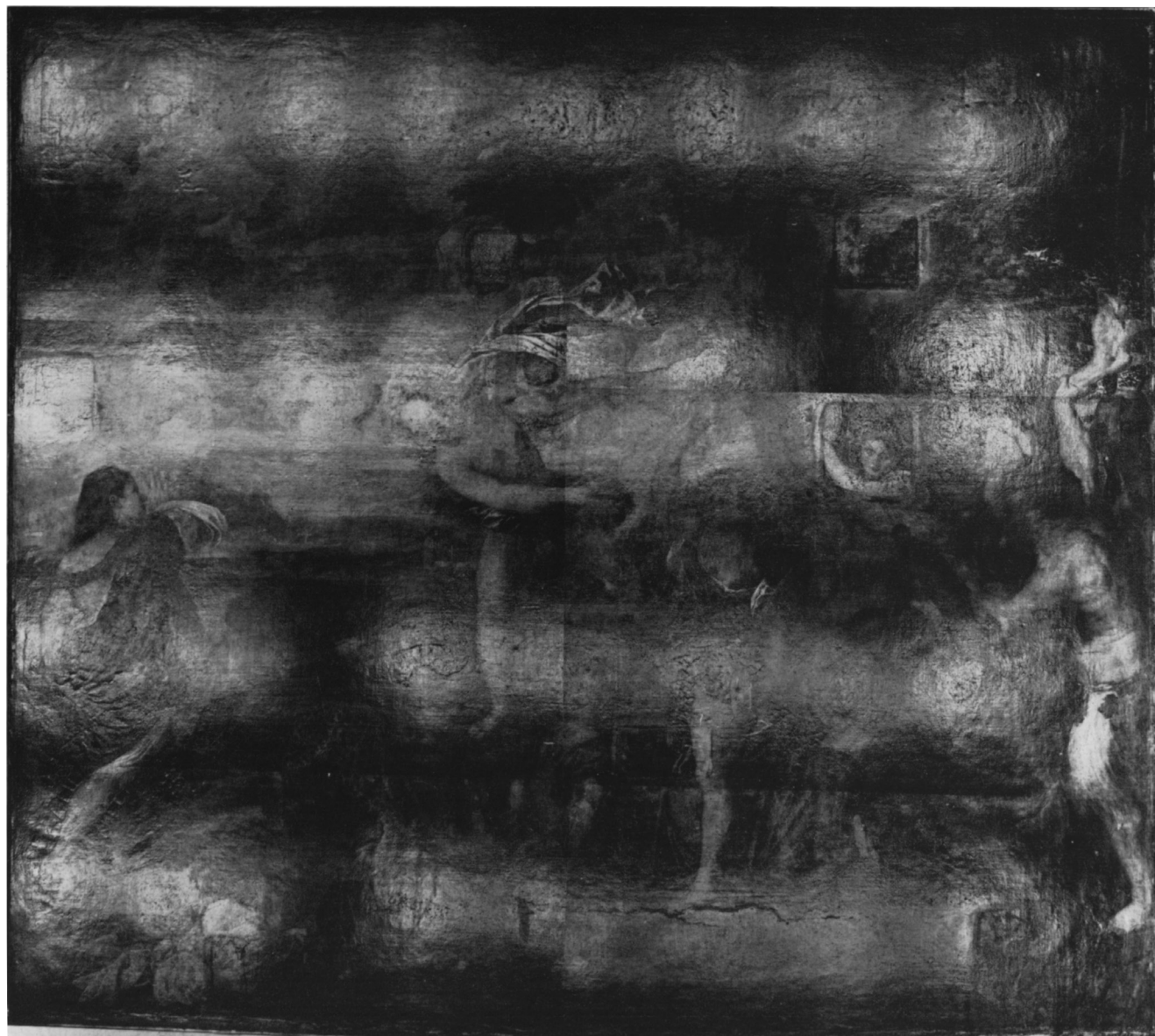
#### **Treatment proposed in 1967 and carried out between 1967 and 1969**

The most important task to be done was to secure all loose paint and ground. It was clear that this would have to be carried out in several stages. Before work could commence on the back of the picture it was essential to stick a facing of paper to the front surface to protect and support the paint layer, but before that the old varnish would have to be removed since its brittleness and the fact that it was flaking away from the paint in some places would have made it impossible to achieve the firm bond which was essential between facing paper and paint film. It was emphasised that failure of previous linings to reinforce and reattach loose ground and paint could be traced to the imperviousness of the coating on the back of the original canvas. It would seem that Morrill in 1929 was probably aware of this, but did not dare scrape the back of the original canvas as clean as he would have liked

for fear of the facing coming away, bringing the varnish with it and leaving the paint unsupported and loose, but, as was mentioned above, he was specifically forbidden by the then Director to remove the varnish. The success of any treatment was likely to depend on thoroughly cleaning the back of the original canvas so that adhesive could be got through it to impregnate the weak gesso ground and so reattach the paint layers. A programme of treatment was designed around this basic concept.

#### **The international committee**

The international committee (4), already mentioned in the Introduction to this article, met on the 22–24 April 1967. The committee examined the picture and the relevant photographs and radiographs, and studied the report of the recent examination outlined above and a report from the Scientific Department. The Chief Restorer elaborated his proposals for treatment and he and other of the National Gallery staff were questioned on various aspects. The committee recorded that, for entirely satisfactory protection of the



**Figure 4**  
Raking-light  
mosaic, before  
cleaning and  
restoration.

picture, the present state could be assessed as hazardous. They stated that, among methods of treatment known, that recommended offered the most likely promise of regaining adequate firmness in the support-ground-paint complex of the work. They also recorded that tests in limited areas suggested that removal of complex extraneous coatings (varnish, retouchings and repaint) carried no more than the usual risks. They therefore came to the formal conclusions that the treatment most likely to achieve a satisfactory bond between all the constituents of this picture and to prolong its existence to the maximum included as an integral part the removal of the present varnish film; and that the treatment proposed had been discussed and studied in detail and, with the usual safeguards was acceptable. The text of the committee's report is in the National Gallery's archives.

This report, dated 24 April 1967, was submitted to the Trustees at a meeting on the 4 May. They resolved that the treatment proposed by the Chief Restorer should be carried out.

#### **Treatment carried out in 1967–1969**

The limited amount of laying of loose paint which was possible on the upper surface of the painting with the old varnish layer *in situ* was done, using gelatine dissolved in water (1 part by weight to 15 parts of water), the adhesive being kept warm at 30°C., and the loose paint flakes pressed back into place by means of a thermostatically-controlled, electrically-heated spatula. A hindrance to treatment was that whereas in most pictures detachment of the paint or ground layers from one another or from the support usually first manifests itself in the form of raised-up blisters, which can therefore be laid down before actual loss occurs, loose paint in the *Bacchus and Ariadne* occurred mainly as thin flat flakes which it was difficult to locate before they were about to fall off, or indeed had fallen off. After the initial paint laying, varnish removal was proceeded with, and it was found that the most expedient method was to treat small areas of about 100cm<sup>2</sup> at a time, carrying out cleaning and fixing of loose paint more or less simultaneously. The procedure was first to fix the paint down as much as



possible then clean the varnish out of the natural age cracks in the paint since its presence inhibited the gelatine adhesive penetrating through the cracks to reinforce the gesso ground. Wax was not used to fix down the paint, because of the likelihood of its staining or darkening the absorbent gesso ground. Cleaning solvents chosen removed the actual varnish layers quite easily, but the action of the organic solvents in dissolving the resin varnish was halted at four separate stages by intermediate coats of greasy colouring material which it was easier to remove with a mild soap (a solution of sodium oleate, 1 part in 15 parts of water). The cleaning, in the sense of varnish removal was the least arduous and problematic part of the entire restoration. Many of the retouchings and the scumbled repaint in the sky could be removed with the varnish layers, the remainder being left for further attention at a later stage. After the varnish had been completely removed, the entire paint surface was faced with a layer of mulberry paper (a fine but strong, long-fibred tissue paper) using an adhesive of mastic in turpentine incorporating some wax, after which the picture could safely be laid face down for work to commence on the back. The old relining canvas, of which the adhesive was animal glue was removed quite easily by dry scraping of the glue layer. It could then at last be seen that the back of the original canvas was, as stated many years previously by Morrill, really covered with a thin but very compact, whitish coating. Analysis by chemical microscopy and gas-chromatography showed that it contained some lead white (basic lead carbonate) in a medium of drying oil (probably linseed) mixed with rosin and animal glue. The composition suggests an adhesive, probably the residue from some past relining, rather than paint in the protective or decorative sense. The results of analysis signified that any solvent or chemical reagent capable of removing it, would also be capable of attacking the original paint on the front of the picture, particularly in view of the thinness of the canvas and gesso ground and the disintegrated state of the latter. The method which had to be resorted to was scraping off the lead white layer, which though thin was very hard and tough, millimetre by millimetre with a small surgical scalpel. It was by far the most difficult and tedious part of the restoration and also very nerve-racking, especially since from time to time small holes in the original canvas were uncovered giving a glimpse of the reverse of the paint layers on the other side. The later stages were made easier by carrying out the scraping under a Zeiss foot-operated stereo-binocular 'Operation Microscope', (see Fig.4, p.6) then just acquired by the Conservation Department, and in fact designed for delicate surgical operations.

After removal of the lining canvas and old adhesive layer there was found to remain on the back of the original canvas a gesso ground, similar to that on the front but so thin as not to hide the fine canvas grain. An unexpected discovery was that of some drawings and inscriptions on the gesso on the back of the canvas. Being in black pigment, the drawings, which are rather faint, showed up well in infra-red photographs,



one of which is illustrated in Fig.5. The quality of the drawings, seemingly done with the point of the brush, was such as to suggest that they were by studio assistants rather than by Titian himself. In the upper right corner of the back of the canvas was the upper part of a woman's body with part of a circle drawn round it and flanked by two profiles on a larger scale. In the upper left corner were diagrams and a further profile, somewhat resembling that in the bas-relief in Titian's *Portrait of a Lady* (No.5385). At the base are inventory numbers: 'No.203 di Titiano', and again (larger) 'No.203'. This was the number allotted to the picture when it was in the Aldobrandini collection in the 17th century. The drawings and inscriptions had necessarily to be covered up again during the application of a new support to the painting, as described below, but were fully recorded in photographs.

After complete removal of the old adhesive layer the gesso ground which remained on the back of the picture was sized with a dilute solution of skin glue to prevent wax-resin adhesive from staining it. The careful laying of loose paint from the front of the picture subsequent to varnish removal was so successful that it was finally decided that lining with new canvas combined with wax-resin adhesive impregnation of both ground and paint film could be dispensed with. It was also considered that a rigid support might be preferable to lining canvas, having regard to the thinness of the original canvas and the history of the picture's condition. The canvas was therefore stuck down with a wax-resin adhesive onto a composite

**Figure 5**  
Detail, top right,  
of drawings on  
the back of the  
original canvas  
revealed after  
removal of the old  
lining canvas and  
adhesive. Infra-red  
photograph.





**Figure 6**  
The picture after  
cleaning, before  
restoration.  
Photographed 7  
February 1969.

solid support consisting of two sheets of 'Sundeala' synthetic board sandwiching a honeycomb paper core. The construction provided a non-warping rigid support having solidity without excessive weight.

With the picture safely mounted on its new support and the surface cleaned free of all surplus adhesives, the remaining retouchings and repaints which had not come away during the varnish removal were tackled individually, either with suitable solvents or by gentle scraping.

Losses in the paint and ground were first filled with putty then inpainted to match surrounding original paint using modern non-fugitive pigments in a synthetic resin medium. The whole was then varnished with a thin coat of colourless synthetic varnish of fairly high gloss to compensate for the somewhat 'dry' or matt appearance of the paint surface.

#### **The condition of the picture after cleaning and before retouching**

As recounted in the Introduction above, consideration of whether or not the restoration, including cleaning,

of the Titian *Bacchus and Ariadne* should be carried out was a matter for detailed and long discussion on the part of the international committee, the National Gallery Trustees and members of the staff. Even after there was general acceptance of the fact that treatment would be in the best interests of the physical preservation of the painting, there was some heart-searching. The late Sir Martin Davies, who had replaced Sir Philip Hendy as Director in January 1968, described the dilemma very cogently as 'whether seeing without obfuscation what is preserved of this picture could be advantageous [. . .]', or 'that to see Titian's picture clearly in its present state would be disadvantageous, i.e. it is so much damaged that obfuscation is the means of conserving admiration' (19).

In the event, actual paint losses were rather fewer than had been anticipated from the X-radiographs. Some of the black patches in the radiographs which looked like lacunae in the paint on the front turned out to be losses in the lead white adhesive layer on the back of the original canvas and were probably the result of attempts to remove that layer in the past. There was,

happily, very little wearing of the major part of the paint surface, apart from the sky on the left, as mentioned above. Fig.6 shows a black-and-white photograph taken after cleaning and before restoration illustrating the extent of loss and damage. Plate 3 (p.29) shows the head and arm of the Bacchante with the tambourine during and before retouching.

### The picture after cleaning and restoration

Putting and inpainting of paint losses presented no special difficulties, although the large number of small losses made it a painstaking and lengthy task, but nevertheless a satisfying one in the course of which the visual disturbance caused by so many small holes and damages were gradually suppressed, enabling once again the picture to be appreciated as a unified image. The gain in colour and clarity with cleaning was enormous. The effect can, to some extent at any rate, be appreciated by comparing the colour photograph of the picture uncleaned except for the preliminary test areas (Plate 4, p.30) with that of the picture after cleaning and restoration (Plate 5, p.30). Looking at the picture before cleaning it required the eye-of-faith to comprehend how Titian could have been considered the greatest colourist of all time. Now it is possible to admire again the skill with which he succeeded in harmonizing such strong and contrasting colours, scarlet and blue, orange and green, crimson and white, a skill so admired and commented on by critics of the past, but in more recent times lost from many of his pictures for probably several generations of viewers. No less astonishing are the newly-found subtleties of the primrose-yellow drapery beneath the urn in the left foreground (Plate 2, p.29), the delicate violet drapery of the Bacchante with the tambourine (Plate 3, p. 29), and not least the great variety of flesh tones, from the pallor of Ariadne to the dark russet of the satyr with the snakes.

Of the many differences revealed by cleaning one of the most important has been the re-establishment of the effect of recession. The 19th century varnish, by blurring the transitions from blue to green in an all-over muddy tone, had had the effect of diminishing the distances within the picture. Before cleaning, the promontary above the head of the cheetahs looked near instead of about half a mile away as it now appears. The ground on which the procession moves can be seen to be rising to the right. The intensity of blue of the sky can be seen to vary, as it does in nature, being more intensely blue overhead. At the same time the faintly purplish (ultramarine) blue of the sky is now differentiated from the slightly greenish (azurite) blue of the distant landscape.

It may be concluded that although the primary aim of the restoration of 1967–1969 was to safeguard the physical survival of the painting, it conferred the added benefit of the rediscovery of Titian's masterpiece after more than a century of semi-oblivion.

### Notes and references

1. GOULD, C., *National Gallery Catalogues, The Sixteenth-Century Italian Schools*, Published by Order of the Trustees (London 1975), pp.268–74.
2. GOULD, C., *Titian, Bacchus and Ariadne*, Published by Order of the Trustees, Publications Department, National Gallery (London 1969).
3. *National Gallery Report, January 1965–December 1966*, Published by Order of the Trustees, Publications Department, National Gallery (London 1967), pp.73–5 and 122–3.
4. Members of the international committee were: Dr Arthur van Schendel, at that time President of the International Council of Museums and Director of the Rijksmuseum, Amsterdam (Chairman); Dr Harold Plenderleith, at that time Director of the Rome Centre (International Centre for the Study of the Preservation and the Restoration of Cultural Property); Mr George Stout, at that time Director of the Isabella Stewart Gardner Museum, Boston (he had been a member of the Weaver Committee in 1947, see below, Note 18).
5. The Report of the international committee is in the National Gallery archives.
6. FARINGTON, J., *The Farington Diary*, edited by J. Greig, Hutchinson & Co. (London 1924), Vol. VI, p.266. The copy, small (18in. × 16in.) compared with the original, but large as enamels go, was eventually sold by Bone for 2,200 guineas.
7. *Report from the Select Committee on the National Gallery, together with the Minutes of Evidence*, The House of Commons (London 1853), Appendix No.XI, p.769.
8. BUCHANAN, W., *Memoirs of Painting*, Vol.II, R. Ackerman (London 1824), p.147.
9. FARINGTON, J., *op. cit.*, Vol.IV, p.116.
10. John Segulier was a leading restorer of the time and the younger brother of William Segulier, first Keeper of the National Gallery from 1824 until his death in 1843. The two brothers had been in partnership as restorers and dealers. Records indicate that they both did surface washing and cleaning of the pictures and revarnishing, but not often varnish removal.
11. The 'Gallery Varnish' was a topic much discussed at the 1853 Select Committee. There seems no doubt that it was a varnish of mastic in turpentine with a proportion of drying oil (i.e. oil, usually linseed, heated with a lead compound, such as litharge, in order to render it quicker-drying). The proportion of drying oil used seems not very well defined and may have been quite large on occasion. In his evidence to the 1853 Select Committee, Segulier gives several reasons for the addition of the drying oil, one being to avert the 'bloom' or bluish haze which tends to develop on varnish films, particularly on mastic varnish and more so in a polluted atmosphere such as prevailed in the neighbourhood of the National Gallery in the mid-19th century.
12. The 'Pettenkofer Process' was a means of reviving and clarifying, without removal, a dull or semi-opaque varnish on a painting by exposing the surface to alcohol vapour. Patents were taken out



by its inventor in the 1860s and the method also published by him (see PETTENKOFER, M. v., *Über Ölfarbe und Konservierung der Gemälde-Galerien durch das Regenerations-Verfahren* (Braunschweig 1870). The beneficial effects produced were not likely to have been very long-lasting. The process is of interest as the forerunner of modern 're-forming' techniques sometimes used as a preliminary stage to varnish removal.

13. William Morrill & Son, Est. 1827, describing themselves as 'Picture Liner etc.', was a family firm of restorers which did work for the National Gallery over a good deal of the 19th and early 20th century.

14. H. Buttery, 'Restorers of Pictures in Ordinary to H.M. the Queen', was another family firm of which several generations worked for the National Gallery. Taking off varnish 'with the finger' signifies dry rubbing which was occasionally used as a method of cleaning. It depends on the fact that old varnish films, in particular mastic and dammar resins, tend to lose their film-forming properties with age and become brittle, so that old varnish can sometimes be rubbed off the picture as a dry powder. It is not a very efficient method of removal and unlikely to succeed if the varnish contains drying oil, as did that of the *Bacchus and Ariadne*.

15. E. J. Poynter, R.A. was Director of the National Gallery from 1894 to 1904.

16. Polishing, presumably with wax, was probably done to freshen up the surface of the picture after it had been brought out of its wartime storage. W. Vallance was a member of another family firm employed from time to time by the National Gallery. As will be seen from David Bomford's article (p. 00 of this *Bulletin*), the Conservation Department of the National Gallery was established as late as 1946, in the sense of a permanent salaried staff working full-time on the premises. Before then the Gallery had employed private restorers on contract who worked under supervision in the Gallery and brought their own materials. W. Vallance was one of the last to be employed on this basis and was still undertaking some work in 1950 after the setting up of the new Department.

17. *An Exhibition of Cleaned Pictures (1936-1947)*, printed for the Trustees of the National Gallery (London 1947, second edition 1948).

18. A Committee of Confidential Inquiry, consisting of Mr J.R. Weaver, President of Trinity College, Oxford, as Chairman: Mr G.L. Stout, then head of the Department of Conservation, Fogg Museum of Art, Harvard University, and Dr Paul Coremans, head of the Central Laboratory, Belgian National Museums. An abridged version of the Committee's Report was published in *Museum* (UNESCO, Paris), 3 (1950), pp. 112-76.

19. *National Gallery Report, January 1967-December 1968*, Published by Order of the Trustees, Publications Department, National Gallery (London 1969), p. 45.

## The materials and technique

### Joyce Plesters

Titian's technique has had a fascination for artists and connoisseurs alike from his own contemporaries down to the present day and over the centuries has been the subject of much speculation. The treatment of the *Bacchus and Ariadne* in 1967-69 provided a unique opportunity for collecting data on the materials and structure of the painting and attempting to interpret such data in terms of painting practice.

It would have been impossible to make any proper study of the original paint unless the thick discoloured varnish had been removed. In 1967 when the first cleaning tests were about to be made it had been our intention to take some samples for microscopical examination and chemical analysis in order to try to discover the condition and composition of the paint beneath the old varnish. An unexpected difficulty was encountered. Not only did the thickness of the old varnish make sampling difficult, but in most areas the adhesion of the varnish to the paint layers was found to be stronger than the adhesion of the latter to each other or to the gesso ground. In the few small areas where varnish had flaked off it had probably done so taking the top surface of the paint layer with it. As a result it was almost impossible to take suitable samples for the preparation of paint cross-sections with the varnish present, and it was decided to defer sampling until after the cleaning tests. Only one of the cross-sections of samples of which the colour photomicrographs are shown in Plate 6 (p. 47), Sample(h), has the old varnish still *in situ* before cleaning. The sample was from the sandy shore beneath Ariadne's feet, an area which before cleaning looked brown but is now light grey. In the section it can be seen that, above a trace of gesso ground and lead-white underpaint, the thin granular, grey paint which represents the sandy beach contains a few blue (azurite) particles, a deliberate addition by the artist to impart a cool tonality. The varnish layer above, turbid yellow-brown, is approximately four times as thick as the grey paint layer beneath it. It might be said that, although patchy and uneven, the discoloured varnish present on the *Bacchus and Ariadne* before its most recent cleaning was on average thicker than any previously encountered on a National Gallery picture. Some idea may be gained from the fact that the varnish layer in the sample just described has an average thickness of about 80  $\mu\text{m}$ , while a single sprayed coat of a modern varnish is approximately 10  $\mu\text{m}$  thick. Solubility tests on samples of the old varnish indicated that it was likely to be mastic resin (applied in a volatile solvent like turpentine distillate). Analysis of a sample by gas-chromatography carried out by J. S. Mills detected the presence of a little drying oil, probably linseed. The composition would not be inconsistent with that of the 'Gallery Varnish' (described on p. 36, Note 11), but fortunately the addition of linseed oil, although sufficient to make the varnish film rather tough, and possibly increase its yellowness, did not render it appreciably less soluble in the usual cleaning solvent.

In view of the picture's history of cleanings and re-varnishings it seems almost superfluous to state that the varnish removed had nothing to do with Titian. Whether or not the picture was varnished originally by Titian, or in his lifetime, is not a question which can be answered here, or indeed perhaps at all.

In turning to the results of examination of the picture itself, it may be convenient to deal with each component of the layer structure in turn:

### The support

The original support is a linen canvas of surprisingly fine weave for the size of the picture (Fig.7). The threads are fine and smooth, the plain (tabby) weave very regular, a thread count giving average values of 24 threads/cm for the warp and 23 threads/cm for the weft. Both canvas and textile fibre seem in good condition for their age. There is a vertical seam down the centre of the picture, inclining slightly to the right near the top, the selvages neatly overcast with small stitches and fine thread. The total width of canvas required for 1.9m painted surface plus turnover allowance (now cut off) for the original stretcher would have been about 2m, indicating a loom width for each vertical strip of canvas of approximately 1m. Measurements on a number of very large sixteenth century Venetian canvas paintings, having several widths of canvas seamed together, indicated that the most commonly occurring loom-width was about 1m (plus or minus about 4cm, accurate measurements being of little significance because of variations from picture to picture in degree of stretching). It is tempting to speculate on whether the loom-widths in which canvas was available might have influenced the size and shape of paintings. It is known, however, that Alfonso d'Este sent ready-stretched canvases to Titian in Venice for the purpose of painting the *Bacchanals*, so it might be expected that in their case the overriding factor would have been the size and shape of wall-space allotted by Alfonso in the decorative scheme for his *Studio*. It should come as no surprise that a Venetian painting of the early 1520s is on canvas. Painting on canvas first began to predominate over painting on wood panel in Venice in the early to mid-sixteenth century, particularly for large-scale works, probably because of the impracticability of fresco-painting on damp and salt-impregnated walls. A number of quite large paintings of earlier date than this by other

Venetian painters, including Carpaccio and Gentile Bellini, are on canvas, as are some of Giorgione's, and of Titian's own works more are on canvas than on wood panel.

### The ground

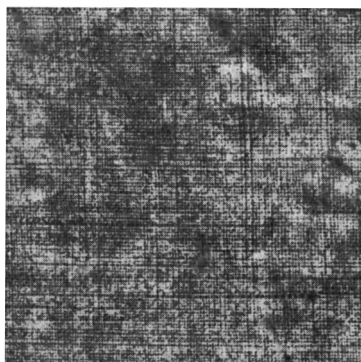
The preparation on the canvas is a thin layer of gesso (calcium sulphate, usually as a mixture of anhydrite and gypsum, in a medium of animal glue), so thin as barely to cover the canvas grain. Its thinness is perhaps fortunate from the point of view of conservation, for a thicker layer might have cracked and disintegrated even more disastrously, particularly if in the past the canvas had been rolled for ease of transport. In paint cross-sections in which a fragment of the gesso ground is included, the latter is translucent brown, not due to any addition of brown pigment, but to a high concentration of animal glue, browned with age and probably not all original but partly the result of past lining and paint-laying operations. Gesso grounds are more often associated with Early Italian wood panel paintings, but in Venice the use of the traditional gesso ground seems to have been taken over by painters working on canvas. A reference to the practice occurs in the Volpato Manuscript, dating from the late sixteenth or early seventeenth century and deriving from Bassano. The manuscript is in the form of a dialogue between two painter's apprentices and includes a discussion of the disadvantages of the 'old-fashioned' (i.e. sixteenth century) gesso ground on canvas as compared with the 'modern', consisting of red ochre in oil medium (1). One apprentice remarks that old pictures on canvas are better preserved if the gesso ground is very thin, as indeed it is in the *Bacchus and Ariadne*.

William Buchanan, before the 1853 Committee of Enquiry, displayed his awareness of the *Bacchus and Ariadne* having a gesso ground (see p.26 of this *Bulletin*) but the knowledge seems to have been lost in more recent times and replaced with a rather generally-accepted idea that Titian painted on red-brown grounds. In the past few years, however, we have been able to examine ten paintings by Titian of widely varying dates and all proved to have gesso grounds. A late work, the *Madonna and Child*, in the National Gallery (No.3948) seemed at first sight to have a red-brown ground, but examination under a binocular magnifier revealed that the colour was that of the bare canvas threads in tiny spots where both paint and ground were worn away. In a comparatively thinly-painted picture like the *Bacchus and Ariadne* the use of a white or light-coloured ground would impart and help retain luminosity.

### The underdrawing

The infra-red photographs (Fig.3) revealed practically nothing in the way of underdrawing. Some features in the infra-red photographs, such as the outlines of the hub and spokes of the wheel of Bacchus's chariot, which look like underdrawing, can be seen from comparison with the picture to be in black paint

**Figure 7**  
Detail, full size, of back of original canvas to show fineness of weave. Average thread count: warp (vertical on photograph) 24 threads/cm, weft 23 threads/cm.





**Figure 8**  
Location of  
samples shown in  
colour  
photomicrographs  
in Plate 6, a–i  
(see p.47).



at or near the paint surface, though there does seem to be a trace of drawn outline of Ariadne's hand clutching her draperies. In only one of the paint cross-sections prepared (Plate 6c, p. 47) was there a scattering of black pigment particles which might be construed as drawing, not, as expected, on the gesso, but on top of a yellow ochre underpaint.

Many fourteenth and fifteenth century paintings with gesso or chalk grounds have preliminary underdrawings, sometimes detailed and highly finished, on the white ground. An underdrawing of this sort, provided it is done in black pigment, no matter whether with charcoal, brush or pen, can often be revealed by infra-red photography and sometimes also appears in paint cross-sections sandwiched between ground and paint layer. The Giovanni Bellini *Blood of the Redeemer* (No.1233) described on pp.11–24 of this *Bulletin* is a good example of a picture of this sort with detailed underdrawing. The apparent absence of underdrawing on the gesso ground of the *Bacchus and Ariadne* does seem to call for some attempt at explanation. In an early work by Titian in the National Gallery, the *Noli Me Tangere* (No.270), the only drawing visible in the infra-red photographs (and that in the areas where drawing was most likely to be revealed, the figures of Christ and the Magdalen) was a rough outline of the Magdalen's left arm and hand and a zig-zag line just indicating a fold of the white

sleeve. Many fourteenth and fifteenth century painters (and, of course, countless others since) have made preliminary drawings on paper for their easel paintings and it might be conjectured that such was Titian's practice, but not only do no studies by him for the *Bacchus and Ariadne* survive, not more than about twenty drawings in all can be attributed with any certainty to him (2), and interestingly enough, drawings of Giorgione, the young Titian's contemporary and mentor, are equally rare. Most of the painters who preceded Giorgione and Titian, as well as those working in the early sixteenth century in a less *avant-garde* style, carried on in the traditional way, starting with sketches and working up to finished drawings or even cartoons on paper, before proceeding to a detailed drawing and perhaps monochrome undermodelling on the gesso ground of the painting itself.

The actual painting process, i.e. the application of areas of local colour, was almost last in a long series of steps in the production of the finished picture. It is rather anticipating discussion of the paint layer to mention here X-radiography of paintings, but whereas infra-red photography can be used to show up underdrawings just below the paint layer, X-radiographs will show up features in the paint layers themselves. X-radiographs of paintings by Titian frequently reveal alterations made by the artist himself in the course of painting. These are not merely minor

corrections, such as the slight shifting of a profile of a face, but radical changes in composition like those which have been discovered in two early works by Titian in the National Gallery, the *Portrait of a Lady* (No.5385) and the *Noli Me Tangere* (No.270) (3), and, incidentally, in Giorgione's best-known work, *The Tempest* (4) (Accademia Galleries, Venice). The *Bacchus and Ariadne* shows fewer changes in the radiograph, though Titian seems to have had a struggle with positioning Ariadne. From evidence of the X-radiographs, however, the tentative hypothesis might be advanced that Titian (and perhaps Giorgione) preferred to dispense with preliminary drawings and to work out the composition of their pictures in paint. The introduction of a new subject as in *The Tempest* or the rediscovery of the world of classical mythology of *Bacchus and Ariadne* would require a good deal of working out of the composition and be likely to result in *pentimenti*. The danger of generalizing is illustrated by the fact that when Titian's *Vendramin Family* (No.4452), a work about twenty years later than the *Bacchus and Ariadne*, was cleaned fairly recently it was found to have a mass of black underdrawing on the gesso ground, very sketchily done, some of the drawing of the robes just hasty scribbles, and not always corresponding with the final painted image. In this picture, though, instead of having the freedom to develop a new and exotic subject, Titian was as tightly constrained as any early painter of saints and donors in that he had to fit a large number of figures into a limited space in strict order of rank, age and size, so that a preliminary sketch was a real necessity. Vasari commented that if Titian had added the art of drawing to his mastery of colour he would have been an even greater artist (5).

## The pigments

Venetian sixteenth century painting has always been famous for its colour. Venice was in an enviable position with regard to supplies of pigments, being not only the port through which exotic materials like lapis lazuli entered Europe from the East, but also a centre of the textile and dyeing industry and famous for its lake pigments which were a byproduct of the latter. Titian, as a successful painter with wealthy clients, would have had first pick of all the materials from the point of view both of variety and quality. Other than such basic requirements of the artist's palette as lead white, blacks and yellow, red and brown earth pigments, the following were identified in the main colour areas of the picture:

### Blues

*Natural (lapis lazuli) ultramarine* (6) is the predominant blue pigment—one might almost say the predominant pigment—in the picture. It occurs mixed with varying proportions of lead white in the sky, the bluer passages of the more distant landscape, the lights and middle tones of blue drapery, the iris and the columbine flowers. Used pure, i.e. unmixed with white, it is found in the very dark shadows of Ariadne's blue cloak and the drapery of the Bacchante with the

cymbals. Unfortunately when used alone in oil medium, ultramarine dries slowly and if applied in a thick layer, as in these shadowed areas, rather than as a thin final glaze, the top surface dries out first, shrinks and splits forming a network of unsightly broad shallow cracks. The effect is less noticeable now than before cleaning because previously the cracks were filled with deposits of old varnish, dirt and glue. They are clearly visible in the infra-red photographs (Fig.3) taken before cleaning, because the high reflectivity of the ultramarine for infra-red radiation causes the paint to appear almost white while the dirt-filled cracks are in strong contrast. When lead white is mixed with the ultramarine it assists drying and prevents this defect. Ultramarine is also the blue component in a mixture with lead white and a little red lake pigment, of the delicate mauve drapery of the Bacchante with the tambourine (Plate 3, p.29 and Plate 6d, p.47). The ultramarine in the *Bacchus and Ariadne* is of the most intense colour and high purity of any so far met with. In the mid- and light blue areas of sky and drapery it is likely to be little changed, but in the very dark shadows mentioned may have become darker and duller in colour because of the combination of its very low refractive index (c.1.5) with the increase in refractive index and possible yellowing of the oil medium with age. A few tiny particles of a paler ultramarine (perhaps ultramarine ash, the last residue of the extraction process) occurred in the shadows of Ariadne's flesh (Plate 6a, p.47). It would be interesting to know if the lavish display of the most expensive of all pigments and of the highest quality was due to Titian's own enterprise or Alfonso's directions and whether its cost formed a separate item of payment.

*Azurite* (basic copper carbonate,  $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ ) occurs as the blue of the sea and of the slightly more greenish areas of the distant landscape, giving a very subtle contrast to the faintly purplish hue of ultramarine. From its appearance under the microscope as large, rocky particles, it seems likely to be the natural mineral form.

The cheaper blue pigments, indigo and smalt, are conspicuous by their absence.

### Greens

*Malachite* (basic copper carbonate,  $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ ) was identified as the brilliant, rather bluish green in landscape and foliage. Under the microscope at about  $125\times$  it is seen as angular, rocky particles, similar to those of azurite, above (as distinct from the 'globular' particles of a green copper carbonate pigment described in this *Bulletin*, p.23 and p.65 in connection with pictures by Giovanni di Paolo and Giovanni Bellini). It can be seen in a paint cross-section from bright green foliage in Plate 6e (p.47). The pigment is by no means as frequently-occurring in easel painting as its blue counterpart, azurite, but similar examples of what, as here, seem to be the mineral form, have been identified by us in pictures by Tintoretto and Veronese.

*Verdigris* (basic copper acetate,  $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{Cu}(\text{OH})_2$ ) and 'copper resinate' green seem to comprise the



remainder of the landscape and foliage greens and include some green glazes which have become brown with age. Verdigris can be used as a powder pigment mixed with a medium in the usual way, but seems often to form the starting material for transparent green glazes made by dissolving it in a resinous or oleo-resinous medium of some kind. Its regrettable tendency to discolour to shades of brown or even black with age and exposure is discussed elsewhere in this *Bulletin* (p.49). It would have been in demand about the time that the more naturalistic treatment of landscape was developing under the influence of Giorgione and Titian, in order to extend the range of green shades available, for it can be used as a final modifying glaze or in mixtures with other pigments in various combinations. In the *Bacchus and Ariadne* some final greens have browned; a browned 'copper resinate' glaze in which under the microscope a few green verdigris particles are still perceptible is seen in Plate 6f, p.47). Here the foliage had been applied as a single glaze layer over the blue paint of the sky, making it very vulnerable to effects of light. It is known, incidentally, that the change of colour from green to brown in this sample from the leaves around the raised arm of the satyr at the extreme right must have taken place, for in an early seventeenth century copy of the *Bacchus and Ariadne*, sometimes attributed to Poussin, and lent from the Duke of Northumberland's collection for the exhibition in 1969 of the newly-cleaned original, the same leaves are depicted as green. Compared with some early works of Titian, the green colours in the *Bacchus and Ariadne* are miraculously well-preserved. The appearance of the *Noli Me Tangere* (No.270) must originally have been very different, for the brown foliage of the large tree and much of the landscape has been identified as discoloured 'copper resinate' green. By contrast, it was interesting to discover that the orange-brown tree which figures in the top right corner of the *Bacchus and Ariadne* is painted in ochre (iron oxide) colours, with no trace of browned 'copper resinate'. Its appearance would suggest an autumn landscape, but for the fact that other plant life depicted, such as the iris and columbine and the tender young vine shoots, seem to typify late spring or early summer. Titian may have introduced the brown tree to provide a patch of warm contrasting colour in that area of the picture. *Green earth* (a complex silicate mineral, containing iron and magnesium; usually celadonite). This grey-green pigment can be seen as the lowest layer of underpaint for a brighter green of foliage in Plate 6e (p.47). It was also identified as a minor component of flesh paint in the greenish shadow of Bacchus's left forearm.

#### Reds

*Vermilion* (red mercuric sulphide, HgS) makes a single dramatic appearance as the pigment of Ariadne's scarlet sash and can be seen in Plate 6a (p.47) in a cross-section of a sample taken from where the scarf goes over her shoulder. The very thick layer of finely-ground vermillion is intensified in colour by a thin final layer of larger, darker red particles of the same pigment.

*Crimson-coloured lake pigments* (organic dyestuffs precipitated onto an inert, insoluble, inorganic substrate such as aluminium hydroxide or chalk) were noted, particularly in Bacchus's flying cloak and the drapery of the small faun in the foreground, in both of which they occur mixed with lead white in the light and middle tones and thickly applied as a dark crimson glaze in the shadows, the colour of which is remarkably well-preserved (see Plate 6b).

Crimson-coloured lake pigment also provides the colour in Ariadne's flesh (Plate 6a) and is a component of the pale mauve drapery of the Bacchante with the tambourine (Plate 3, p.29 and Plate 6d, p.47). It would also seem (Plate 6c) that the dark blue drapery of the Bacchante with the cymbals was initially painted in crimson or rose pink. It is a matter for regret that at the time the picture was under treatment and it was possible to take samples, the methods which have since been developed in the Scientific Department for the identification of the dyestuffs of red lake pigments (7) were not available.

#### Yellows and orange

*Lead-tin yellow* (lead-tin oxide,  $Pb_2SnO_4$ ) was identified as the pigment used for the pale yellow drapery beneath the urn near the bottom left corner of the picture. X-ray diffraction powder patterns of samples (8) confirmed that it was Type I (formula given above) of two types described by H. Kühn (9). The pigment seems not to occur in paintings much later than the mid-eighteenth century, and some confirmation of this is given by a remark of Sir Thomas Lawrence reported by Farington (10). On inspecting the picture in 1807 Lawrence praised the yellow drapery and added: 'The yellow colour used is such as we have not. Naples yellow wd. be weak to it'. A colour photograph of a cleaning test on the yellow drapery made in 1967 (Plate 2, p.29) shows how effectively the old varnish obliterated this distinctive shade of yellow. In fact in the seventeenth century copy from the Duke of Northumberland's collection the same drapery was painted in a rather dirty white, presumably because the copyist must have assumed that there was white drapery beneath discoloured varnish covering the picture at that time, a curious reversal of the usual state of affairs that a discoloured varnish makes white paint look yellow.

*Orpiment* (yellow arsenic sulphide,  $As_2S_3$ ) and *Realgar* (orange arsenic sulphide,  $As_2S_2$ ). These pigments occur together in the orange drapery of the Bacchante with the cymbals, realgar in the main body of the drapery, orpiment in the lights. The pigments share with ultramarine the drawback of drying slowly when used in oil medium. During the formation of shallow drying cracks, the coarsely-ground pigment particles seem to have bunched up into small islands, producing a rather rough paint surface. Both pigments were recognized microscopically from particle characteristics and optical properties, the orpiment being notable for the laminated form and lustrous surface of the large crystalline particles. Confirmation of the presence of arsenic and sulphide was by the usual methods of chemical microscopy, and more recently

arsenic was confirmed (in a small sample of realgar saved from 1967) by A. Roy by means of laser microspectrography.

Orpiment and realgar are rather rarely-occurring pigments in European easel paintings, though common in Far Eastern art. As well as the natural minerals, artificial forms, made by subliming together arsenic and sulphur, have been known since classical antiquity, probably first prepared as an alchemical exercise. Cennino Cennini, in fact, mentions only the synthetic variety (11).

Sixteenth century Venetian paintings have provided the majority of occurrences noted by us. Realgar, with orpiment in the lights, was identified as the orange of S. Joseph's cloak in an early picture by Titian in the National Gallery, *The Holy Family and a Shepherd* (No.4). It seems worth making the observation that Titian in the earlier part of his career, and Giorgione, seem to have had a predilection for the sort of orange drapery highlighted with yellow which is so striking a feature of the *Bacchus and Ariadne*. A similar colour combination occurs in the National Gallery's small panel by Giorgione, *The Adoration of the Magi* (No.1160), both in S. Joseph's cloak and in the spectacular orange and yellow doublet and hose of the young man on the right leaning on a staff. The voluminous orange and yellow cloak of the grey-bearded 'philosopher' dominates Giorgione's *Three Philosophers* (in Vienna), and though no record of identification exists, the appearance of the paint surface suggests orpiment and realgar. On the other hand, it seems unlikely that the two pigments, of rather doubtful durability in fresco, could have been used in Titian's frescoes in the Scuola del Santo at Padua in which the same orange and yellow colours run like a theme through the whole series.

Some remarks on Titian as a colourist will be deferred until the layer structure has been described.

### The medium

Preliminary solubility and combustion tests on one or two paint samples, combined with the limited range of biological staining tests then in use indicated that the medium had the characteristics of drying oil. There was nothing in the results to suggest the presence of natural resins, and certainly not of natural resins soluble in the range of organic solvents used for picture cleaning. In 1967 the system evolved in the Scientific Department by J. S. Mills and first published in 1966 (12) for the identification of painting media by means of gas-chromatography was just beginning to be applied to samples of paint from actual pictures. One sample from the *Bacchus and Ariadne*, of white paint, was analysed by this method and the ratio of fatty acids present showed that the medium was essentially a drying oil, and specifically linseed oil. It has to be admitted that as yet no analytical method is available for the detection of minor components, particularly natural resins, in the oil, nor does the method used throw any light on its initial preparation, whether for example it was boiled or sun-thickened. Nevertheless, it was a considerable step forward at the

time to have ascertained that the medium of the *Bacchus and Ariadne* was essentially linseed oil. Since then the media of several samples of three other major works by Titian have been analysed by gas-chromatography, one turning out to be linseed, the other two walnut oil (13) and see p.58 of the 1977 *Bulletin*. Over the centuries the idea has been current that the special quality of Venetian painting in general and of Titian's painting in particular resided in the use of some special and secret medium. In the eighteenth century a variety of recipes and nostrums changed hands, sometimes for large sums of money, which purported to be the 'Venetian Secret', including such unlikely candidates as pastel colours (14).

The situation was further confused from Titian's own time right up to the present century by attempts to copy paintings by Titian and other sixteenth century Masters, often, of course, from originals half-obsured by discoloured varnishes. At the beginning of this century, Max Doerner, the authority at that time on techniques of the Old Masters, discovered that he could make plausible copies of old pictures, including those of Titian, Tintoretto and Rembrandt, using an egg and oil emulsion for the impasto whites and an oil medium with a high proportion of a fairly easily-soluble resin such as mastic (or even an entirely resinous medium) for the translucent darks and glazes (15). He therefore concluded that because he could copy accurately the surface appearance of, say, a picture by Titian using a particular range of materials and techniques, the original artist must also have used the same materials and techniques. The fallacy of this argument is demonstrated daily in the National Gallery's and other conservation departments where paint losses are inpainted to match the surrounding original paint using modern pigments and synthetic resin media. The fact that the translucency which oil paint develops with great age can sometimes be achieved at once by the use of a medium with a high proportion of natural resins or balsams led to the belief that the media of the originals, and particularly of the glazes, must contain a high proportion of 'soft' or easily-soluble resinous material and hence be vulnerable to solvents used in varnish removal. The argument was very persuasive. The results of the gas-chromatographic analyses cited above constitute the first objective and non-speculative evidence of the composition of Titian's painting medium.

### The layer structure

The layer structure provides some information about the painting procedure of the artist and also about alterations made in the course of painting by the artist himself (*pentimenti*) or by a later hand. X-radiographs are useful for gaining an overall concept of the layer structure; the microscopical examination of cross-sections of paint samples for gaining precise information about very small specific areas. The two are complementary. A composite photograph of the X-radiographs is shown in Fig.2. Plate 6 (p.47) shows photomicrographs of some of the paint cross-sections of samples from the *Bacchus and Ariadne*



photographed at  $c.150\times$  magnification, with, on the facing page, captions giving details of layers present in each, so that it is unnecessary to repeat all that information here. The layer structure of the *Bacchus and Ariadne* sections is more complex and at the same time less regular than that which has been observed in samples from fifteenth century paintings, as for example some by Crivelli and Giovanni Bellini. Also, the layer structure of the Titian *Bacchus and Ariadne* samples cannot be interpreted in terms of the orderly and systematic technique of earlier painters in which underdrawing, underpainting, main paint layer and final glaze or scumble follow each other logically and may be read off, as it were, from the paint cross-section. From the information derived from the paint cross-sections and detailed in the captions on p.46, it is possible to deduce from the cross-sections (a–f) respectively that:

(a) Ariadne's scarlet scarf is painted over the flesh of her shoulder and in turn the flesh of her shoulder over the blue paint of the sea.

(b) The (azurite) blue paint of the distant landscape, together with its lead white underpaint, goes just over the edge of the crimson-glazed shadow of Bacchus's cloak near his right arm (a section of a second sample, not illustrated, of the main area of the crimson cloak showed a pink opaque underpaint, followed by crimson-coloured glaze, painted directly on the gesso ground).

(c) The dark blue drapery of the Bacchante with the cymbals was initially coloured crimson or deep rose-pink, but was subsequently obliterated with a layer of lead white and then repainted in several layers of deep blue. The crimson colour can, in fact, be seen at the bottom of some of the cracks in the blue drapery on the picture itself.

(d) No changes have occurred in the mauve drapery of the figure with the tambourine, but it can be seen that there is a thin brown layer (of undermodelling?) between the mauve paint and the gesso ground.

(e) The sequence of green and blue layers representing foliage on landscape has beneath it two yellowish opaque layers which might be from a *pentimento* of Bacchus's golden chariot.

(f) The dark brown (once green) feathery foliage has been painted over blue sky, but beneath that pair of paint layers is another almost identical sequence of green, not-discoloured, glaze over blue sky. The artist must have repainted sky and foliage in this area.

Therefore of the six samples of which the paint cross-sections are illustrated in Plate 6a–f inclusive, five might be termed *pentimenti* either in the sense of deliberate alterations (c and f), or as one feature of design or area of colour overlapping another (a and b). The occurrence of even one of these changes in an earlier and more traditional picture would excite comment. The evidence from the paint cross-sections does seem to point to Titian having worked out the composition of the picture as he proceeded with the painting, using either the minimum of underdrawing of the design or even none at all.

At this stage it is useful to consult the X-radiographs (Fig.2), although at first sight they seem to present

a rather confused image on account of the numerous small losses and puttyings. The gesso ground, containing only the light element calcium, would contribute virtually nothing to the impedance of X-rays, particularly by contrast with any paint layer containing lead. Now the blue paint of both sea and sky contains a high proportion of lead white, as does the pale grey and fawn of the sandy beach, hence these background areas look white in X-radiographs. Since the total absorption of X-rays in a particular area is a sum of the absorption of each of the layers, it should easily be possible to see which features of the design have been painted directly on the gesso ground and which on top of the blue sky. Clearly some feature which is painted directly on the gesso ground is more likely to have been conceived early on in the production of the painting than one applied to existing paint. This principle having been accepted, an interpretation of the X-radiographs in the light of the paint cross-sections can be made:

Bacchus's cloak, particularly in the deep crimson-glazed part streaming out to the right, appears in the X-radiograph as a dark silhouette against the light background of the lead-containing paint of sea and sky. This shows that it was painted directly on the gesso ground and not over the blue paint of sea or sky and agrees with the paint cross-section in Plate 6b, which shows a little of the blue-green paint of the sea over the crimson glaze of Bacchus's cloak. Around the figure of Bacchus, which appears beautifully modelled in the radiograph in carefully modulated thicknesses of lead white, there is a strong black contour, though discontinuous in parts, as if the surrounding sky, land- and seascapes had been painted not quite up to the edges of the flesh.

By contrast, the figure of Ariadne appears in the radiograph, apart from her legs and feet, as a swirling mass of lead white, denser than anything else in the picture. Within the area all colours visible on the picture's surface, flesh, blue and white drapery and scarlet sash, seem equally opaque to X-rays. The contours of the cloak and sash or the outline of the hand can be discerned only by the direction of the brush strokes. Ariadne's blue cloak, so similar in appearance to the deep blue drapery of the Bacchante with the cymbals, looks disproportionately denser in the radiograph. Part of this thickness of lead-containing pigment could be accounted for if the figure of Ariadne had been painted on top of the blue sea and sky, but would not fully explain the dense, shapeless, yet disturbed nature of the mass. A possible explanation is that Titian, having at any rate positioned the figure of Bacchus in the early stages of painting had some difficulty in getting the right pose for Ariadne in relation to him and had to resort to repainting her. It also looks from the radiograph that at least some of the figures in Bacchus's train were laid in on the gesso ground at an early stage in the composition, as was his chariot, the cheetahs which draw it, and the little dog, since these last three all appear in the radiographs as black silhouettes surrounded by the light opaque paint of the shore and landscape. The enchanting little faun in the centre foreground must

belong to a later stage of painting for even on the picture itself a *pentimento* of the chariot wheel is visible under his leg. On the upper right the trunks of the tall trees can be seen to have been laid in on the gesso ground before the sky was painted, but the foliage applied on top of the blue paint of the sky, as in the cross-section of browned foliage seen in Plate 6f. Titian then added a few patches of blue paint to indicate blue sky seen through the trunks of the trees, and these show up strongly in the radiographs. It might therefore be tentatively proposed that the artist had from the very beginning a fairly clear idea of how he wanted to dispose most of the group on the right, and seems, from the radiograph to have painted Bacchus with an unhesitating brush. He may have delayed painting the figure of Ariadne until later, or else been dissatisfied with his first attempts and done some extensive repainting of it before arriving at the present happy solution.

With regard to documentary sources on Titian's technique, the only nearly-contemporary one is a description given by his pupil Palma Giovane (1544–1628) to Marco Boschini (16), the historian and biographer of Venetian art and artists, some years after Titian's death. His account of how Titian laid in the composition with areas of solid colour, and of his ruthless alteration and revision of his half-finished pictures shows fair agreement with what has been observed in the *Bacchus and Ariadne* and other of Titian's pictures we have examined. His report of Titian rubbing glazes and scumbles onto the surface of his pictures with the finger rather than the brush seems more in accordance with the very late works, such as the National Gallery *Madonna and Child* (No.3948), or the *Pietà* (Accademia Galleries, Venice) which Palma Giovane in fact finished after Titian's death. It is these late works which would probably have been fresh in his mind in his reminiscences to Boschini. In any case, *Bacchus and Ariadne* was painted twenty years before Palma's birth.

### Titian as a colourist

The reputation of Venetian sixteenth century painting for excellence of colouring rests firmly on Titian. In the mid-sixteenth century there were rival advocates of Florentine art, as personified by Michelangelo and his mastery of drawing, and those of Venetian art, as personified by Titian and his mastery of colouring, *disegno* versus *colore*. This led eventually to the idea that perfection in art would be achieved by a combination of both excellences, as advocated for example by Paolo Pino in his *Dialogues of Painting* of 1548 (17). It seemed worthwhile, as a conclusion, or rather, perhaps, corollary to this article, to attempt to assess, from the standpoint of materials and techniques, and in the light of the results of examination of the *Bacchus and Ariadne*, what physical factors contributed to Titian's enormous reputation as a colourist. It should be pointed out that in order to attempt this there is no need to survey the entire *oeuvre* of his very long life. By the time Pino was writing in 1548 it is clear that Titian's supremacy as a colourist was already well-established and indeed he may have gained a reputation

as such as early as 1518 with the completion of the great altarpiece of the *Assumption of the Virgin* in the church of Santa Maria Gloriosa dei Frari in Venice, which since its recent cleaning looks at least as colourful as *Bacchus and Ariadne*. In any case, in some of his late works Titian is no longer interested in the juxtaposition of large areas of pure colour, but more in the flickering effect of light over surfaces, as in the National Gallery's *Death of Actaeon* (No.6420). Since the *Bacchus and Ariadne* seems always to have been admired for its colouring, it seems fair that it should serve as an exemplar.

The principal physical characteristics which contribute to the 'colourfulness' of the *Bacchus and Ariadne* seem to be (not necessarily all in order of importance):

1. The inclusion *within a single picture* of all the most colourful pigments available (comprising, as we have seen, some rather uncommon ones like malachite and realgar).
2. The choice of the finest quality of the most colourful pigments (the ultramarine and vermilion are of outstanding purity and richness of colour).
3. The employment of each of these pigments separately in sizeable areas of colour, whether sky, drapery or foliage), well-spaced within the picture area (N.B. for this purpose orpiment and realgar may be regarded as a pair, one being used for lights the other for shadow within the same area).
4. The juxtaposition of areas of strong contrasting colours.
5. The use of each of these colourful pigments at *full strength*, i.e. unmixed with another pigment, or mixed only with white to produce a brighter colour of the same hue. In the colourful areas of sky, sea, landscape and drapery physical mixtures of pigments, other than with white, seem to have been avoided, presumably because all such mixtures tend towards grey. (The only example of a 'colourful' area which has been produced by mixtures containing two different coloured pigments in the same paint layer is the mauve of the drapery of the Bacchantes with the tambourine.)
6. The intensification of the colour in some areas by means of glazes; an example is the final layer of large deep blue particles of ultramarine on top of the blue body colour of the drapery of the Bacchantes with the cymbals. The use of a dark, transparent glaze over a lighter underlayer produces an increase in saturation (i.e. apparent depth of colour) without as great a loss of brightness as would occur if the two pigments were mixed instead of being used in separate layers. The use of a green 'copper resinate' glaze over green or yellow underpaint is a further example, but the intended effect has in some areas been destroyed by the browning of the 'copper resinate'.

This is not, of course, the whole story, for what was most admired in Titian's paintings was his skill in unifying such strong contrasting colours to produce 'harmony'. The meaning of the term as applied to art is less precise than in music, but we could do worse than settle for: 'agreeable effect of apt arrangement of parts' (O.E.D.) getting close to the idea of tone.

In fact, other painters may employ the same formula



but with not quite the same results. It so happens that the identical range of pigments occurs in Sebastiano del Piombo's *The Raising of Lazarus* (No.1), and there is even repeated a touch of the lilac colour which appears in the drapery of the Bacchante with the tambourine in the *Bacchus and Ariadne*. Although Sebastiano began his career in Venice, he settled in Rome in 1511 and this picture was painted some years later, although he still signs himself on it as 'SEBASTIANUS VENETUS'. Cecil Gould made the point (on the occasion when the colours of that particular picture were revealed after cleaning) that 'The colours are not tonally related, as in Venetian painting [ . . . ]' (18). In addition the many small bright areas of contrasting colour in the middle distance give a rather jumbled effect. The Florentine Mannerists sometimes employ a not very different range of colours, but used in a rather arbitrary or 'non-naturalistic' way, if one dare use such an equivocal term. In addition, many of their pictures of this period, for example those of Bronzino who is an almost exact contemporary of Titian, are painted on very smoothly prepared wood panels and have an enamel-like 'unpainterly' surface. Although the *Bacchus and Ariadne* is a comparatively thinly-painted picture, Titian has exploited to the maximum textural effects (they may have been reduced in the course of the many past lining operations) which help to give variety to the areas of pure colour. An example is the pale lead-tin yellow drapery beneath the urn in the bottom left corner (Plate 2, p.29) where almost all the modelling of the folds is in the form of the brushstrokes, rather than painted shadows.

The large separate areas of pure colour in the *Bacchus and Ariadne* are also skilfully knit together by the quieter earth-colours of the foreground landscape. In this connection it might be remarked that the picture would probably seem much less pleasing or 'harmonized' were it not for the comparatively good state of preservation of the green areas. The flesh tones also provide a link right across the picture and it is interesting to note how subtly they are varied. The very pale flesh paint of Ariadne is faintly tinged with a crimson-coloured lake pigment, with, as we have seen, ultramarine blue in the shadows, while the shadows of Bacchus's flesh contain green earth, and the flesh of the Bacchantes and satyrs is coloured with a variety of red and brown ochres. In general the flesh tone increases in warmth and depth of colour from left to right of the picture, culminating in the Laocöon figure with the snakes, but with the proviso that female figures are depicted lighter-skinned than males.

No amount of analysis, chemical or otherwise, can explain the particular magic of the picture, but the results of technical examination may have given some small glimpse of the mechanism of what goes on behind the scenes. If nothing else, it will have served to refute the statement (meant as complementary rather than the reverse!) by the eighteenth century historian and critic Antonio Zanetti that 'the pigments on Titian's palette were ordinary and few' (19).

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**Plate 6** Titian, *Bacchus and Ariadne* (No.35).

Photomicrographs of paint cross-sections, photographed by reflected light at a magnification of 250×, magnification on the printed page quoted beneath photomicrograph.

**(a)** Scarlet of Ariadne's scarf, left shoulder.

1. Gesso ground (trace).
2. Azurite + lead white; presumed to be blue paint of sea.
3. Lead white + crimson-coloured lake pigment, presumed pale flesh tone.
4. Deeper pink layer of similar composition.
5. Paler pink with addition of a few blue pigment particles, possibly cool highlight on flesh.
6. Finely-ground, close-packed vermilion.
7. Final thin layer of large, deep red vermilion particles.

The scarf at this point seems to have been painted over fully-modelled flesh, which is painted on top of the blue of the sea.

**(b)** Crimson from edge of Bacchus's cloak.

(Gesso ground missing from sample)

1. Lead white underpaint of cloak.
2. Very thick translucent glaze of crimson-coloured lake pigment.
3. Lead white layer, possibly underpaint for layer 4.
4. Azurite + lead white, corresponding to blue of distant landscape.

In this sample the blue paint of the sky goes just over the edge of Bacchus's crimson cloak, indicating that the latter was laid at an early stage before the sky was painted (cf. (a) above).

**(c)** Dark blue drapery of Bacchante with cymbals.

1. Gesso ground (trace).
2. Yellow ochre underpaint or undermodelling.
3. One or two grains of carbon black (intermediate drawing?).
4. Crimson-coloured lake pigment in large granules.
5. Lead white + scattered small ultramarine particles.
6. Thin layer of dark blue, high-quality natural ultramarine.
7. Brighter blue; ultramarine + lead white.
8. Final glaze of ultramarine.

It appears from this section and from inspection of the area on the picture, that the drapery was initially deep pink and the artist then repainted it in blue.

**(d)** Mauve drapery of Bacchante with tambourine.

(Gesso ground missing from sample.)

1. Yellow ochre (trace) underpaint or undermodelling.
2. Lead white underpaint.
3. Very pale pink; lead white + crimson-coloured lake pigment.
4. Lead white with scattered particles of crimson-coloured lake pigment and ultramarine.

**(e)** Bright green foliage just above and to left of Bacchus's left leg.

1. Gesso ground, yellow-brown from excess glue.
2. Double layer of yellow ochre + lead white, which seems to be a *pentimento* of part of Bacchus's chariot.
3. Green earth + lead white; underpainting for foliage or landscape.
4. Azurite + lead white, presumably blue of distant landscape.
5. Malachite + lead white.
6. Slightly-browned 'copper resinate' type final green glaze.

Although the green glaze has browned with age and exposure, the area has maintained its intense green colour because of the malachite underpaint (cf. (f) below).

**(f)** Dark brown feathery foliage of trees right.

(Gesso ground missing from sample.)

1. Lead white underpaint, faintly pink-tinged with crimson-coloured lake pigment.
2. Ultramarine + lead white.
3. Green glaze of 'copper resinate' type.
4. Lead white layer, presumably to obliterate layers 2 and 3.
5. Ultramarine + lead white, similar to layer 2 above, but a higher proportion of blue pigment.
6. Very dark brown 'copper resinate' type glaze in which a few unchanged green particles of verdigris are still visible under the microscope.

Layers 5 and 6 are virtually a repeat of layers 2 and 3, so that it looks as if the artist was dissatisfied with his first attempt at painting sky and foliage, covered it over and began afresh. Layer 3, protected from light and atmosphere, has retained its green colour, whereas layer 6 is now almost completely brown.

**(g)** Orange drapery of Bacchante with cymbals, lightest area.

Crushed sample showing crystalline particles of orpiment and realgar pigments; photographed dry at 250× magnification.

**(h)** Sandy shore beneath Ariadne's feet; sample taken before cleaning.

1. Gesso ground (trace).
2. Lead white underpaint.
3. Granular grey layer; lead white + scattered small blue and black pigment particles.
4. Thick discoloured varnish.

Before the picture was cleaned the area looked yellow-brown instead of grey.

**Plate 7** Giovanni Bellini, *The Blood of the Redeemer* (No.1233).

**(a)** Less-brown green of landscape, left of Christ's right arm; sample taken after cleaning.

Top surface of sample photographed by reflected light at 110× magnification, showing 'globular' green copper carbonate pigment particles in a brown matrix of medium.

**(b)** Partly-browned green of landscape to right of crucifix.

Cross-section photographed by reflected light at 110× magnification.

1. Gesso ground.
2. Line of brown glue priming on the gesso.
3. Lead white underpainting.
4. Brown matrix containing green globules of copper carbonate pigment.

**Plate 8** Giovanni di Paolo, SS. *Fabian and Sebastian* (No.3402).

Photomicrographs of paint cross-sections, photographed by reflected light at 110× magnification.

**(a)** S. Fabian's red robe, area of highlight where glaze is in good condition.

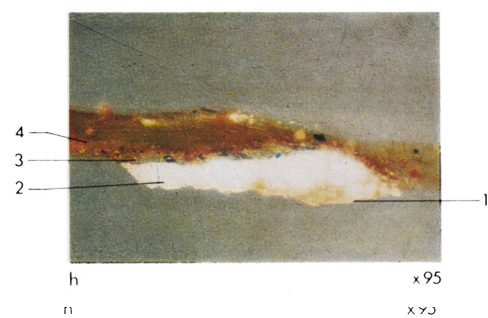
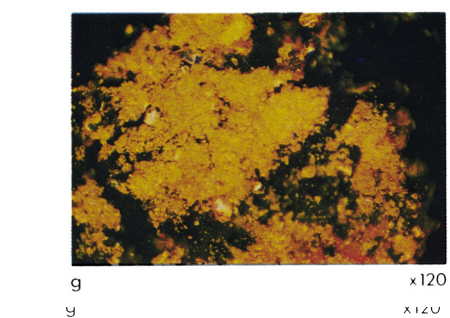
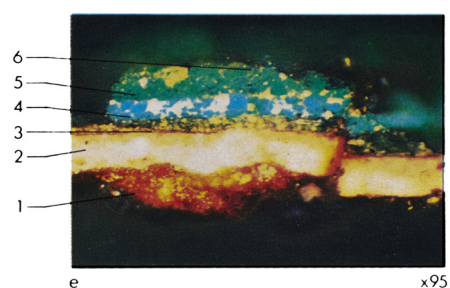
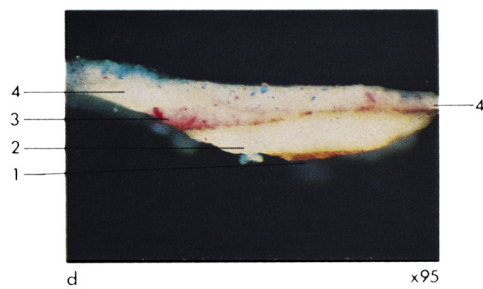
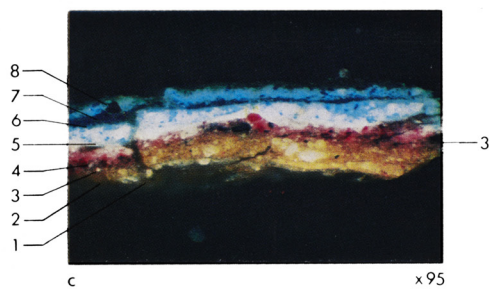
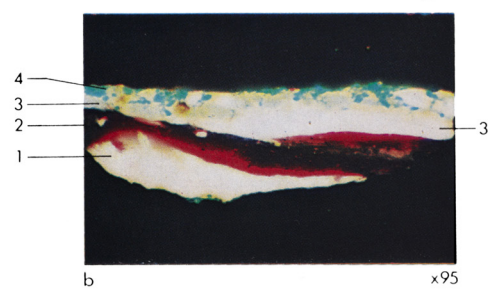
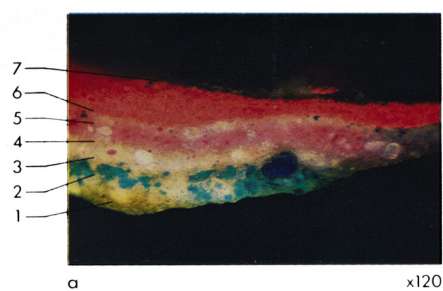
1. Gesso ground.
2. Orange-red bole.
3. Silver leaf.
4. Lead white (to give highlights), in egg tempera medium.
5. Red glaze (lac lake in egg tempera medium).

**(b)** Green lining of S. Fabian's cope, shadowed outer edge.

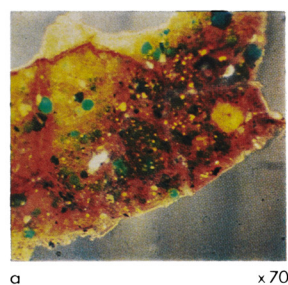
1. Gesso ground.
2. Thick black undermodelling (charcoal).
3. Thin layer of orange-red bole.
4. Thick light green layer: lead-tin yellow mixed with spherulites of malachite.
5. Darker green layer: malachite spherulites in browned medium.
6. Old discoloured varnish.



**Plate 6**  
Titian,  
*Bacchus and Ariadne*,  
No. 35.  
Full caption on facing  
page.



**Plate 7**  
Giovanni Bellini,  
*The Blood of the Redeemer*,  
No. 1233.  
Full caption on facing  
page.



**Plate 8**  
Giovanni di Paolo,  
*SS. Fabian and Sebastian*,  
No. 3402.  
Full caption on facing  
page.

