National Gallery Technical Bulletin

Volume 11, 1987

National Gallery Publications
The National Gallery London

National Gallery Publications
Published by order of the Trustees

Scientific Adviser, John Mills
Chief Restorer, Martin Wyld
Editor: Ashok Roy

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British Library Cataloguing in Publication Data

National Gallery
National Gallery technical bulletin.—
Volume 11, 1987.
1. Painting — Conservation and restoration — Periodicals
I. Title
751.6'05 ND1640

ISSN 0140–7430

ISBN 0–947645–35–7

Designed by James Shurmer

Printed and bound in Great Britain by
William Clowes Limited, Beccles and London

Vincent Van Gogh's 'A Cornfield, with Cypresses'

John Leighton, Anthony Reeve, Ashok Roy and Raymond White

Introduction

John Leighton

Van Gogh painted three versions of *A Cornfield, with Cypresses*; a painting in a Swiss private collection (Fig.1) is almost identical in size to the National Gallery version (No.3861; Fig.2 and Plate 7, p.57), while a 'reduction' or small copy of the same composition is in an American private collection (Fig.3) [1]. The treatment of No.3861 and the materials used by Van Gogh are discussed below by Anthony Reeve and Ashok Roy; this introduction provides a context for the National Gallery *A Cornfield, with Cypresses* and puts forward some tentative suggestions about the relative status of the three versions of this composition. The recent exhibitions 'Van Gogh in Arles' and 'Van Gogh in Saint-Rémy and Auvers' with their excellent catalogues, have provided comprehensive art-historical studies of these periods in Van Gogh's career, yet there remains a surprising dearth of detailed technical analyses of the artist's work [2]. Until such a body of information is compiled, any generalizations about Van Gogh's working processes must remain unsubstantiated.

After a series of breakdowns at Arles in the winter of 1888, Van Gogh voluntarily entered the asylum of Saint-Paul-de-Mausole in Saint-Rémy-de-Provence on 8 May 1889. The first month at Saint-Rémy was spent drawing and painting within the hospital grounds, but early in June, Van Gogh was able to report to his brother Theo that he had begun to paint in the surrounding countryside. He first tackled a motif similar to that of No.3861 in the *Wheatfield* painted in mid-June [3]. By the end of the month he wrote to Theo:

> The cypresses are always occupying my thoughts, I should like to make something of them like the canvases of the sunflowers, because it astonishes me that they have not yet been done as I see them. [4]

As a subject, the cypress tree appealed both to Van Gogh's eye and his imagination; while the elegant

Figure 1 Vincent Van Gogh, *A Cornfield, with Cypresses*, canvas, 73 × 93.5 cm. Private collection, Switzerland. (Reproduced by kind permission of the owner.)

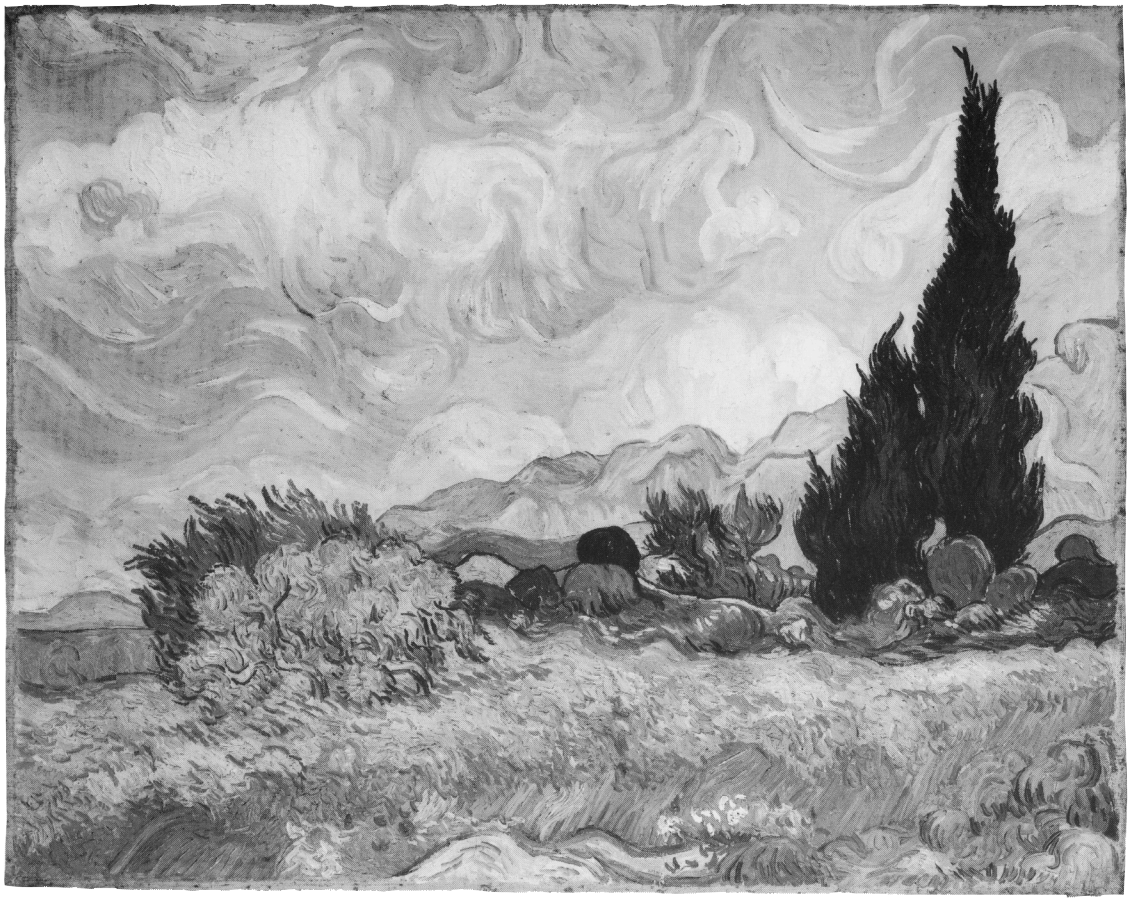


Figure 2 Vincent Van Gogh, *A Cornfield, with Cypresses* (No.3861), canvas, 74 × 93 cm. National Gallery, London.

Figure 3 Vincent Van Gogh, *A Cornfield, with Cypresses*, canvas, 51.5 × 65 cm. Private collection, U.S.A.
(Reproduced by kind permission of the owner.)

silhouettes were 'as beautiful of line and proportion as an Egyptian obelisk'. The traditional associations of the cypresses, the Provençal tree of death, may also have appealed to Van Gogh; he often described them as 'sombre' and once referred to the cypress as 'a splash of *black* in a sunny landscape [....]' [5]. Above all, the cypress trees, along with the olive trees, the fig trees and the vines were characteristic of Provence. As he became more involved in the Provençal landscape, Van Gogh spoke of his ambition to create a series of canvases which 'will form at best a sort of whole, "Impressions of Provence"' [6]. For Vincent, the cypress trees were as much a part of Provence as the willows were of his native Holland.

Cypresses appear in the background of several of Van Gogh's paintings at Arles and they are a dominant element in *The Starry Night* painted in mid-June 1889 [7]. In two canvases dating from the end of June however, the cypress trees have become a subject in themselves [8].

> Two studies of cypresses of that difficult bottle-green hue; I have worked their foregrounds with thick layers of white lead, which gives firmness to the ground. [9]

The first version of *A Cornfield, with Cypresses* (Fig.1) was painted shortly afterwards, early in July.

> I have a canvas of cypresses with some ears of wheat, some poppies, a blue sky like a piece of Scotch plaid; the former painted with a thick impasto like the Monticellis, and the wheatfield in the sun, which represents the extreme heat, very thick too. [10]

This description matches the painting now in Switzerland which has the same dense impasto as the recently completed *Cypresses*, a surface which is an accumulation of several layers of paint.

The activity of these early months at Saint-Rémy was brought to an abrupt halt by the severe attack which Van Gogh suffered while painting out-of-doors in mid-July. He was ill for about five weeks and did not resume painting until the end of August. Writing to Theo early in September, Van Gogh promised to send his brother 'twelve size 30 canvases by the end of the month, but they will nearly all be the same picture twice over, the study and the final picture' [11]. It seems likely that the National Gallery, *A Cornfield, with Cypresses* is one of these size 30 canvases, a studio repetition of the composition first painted in July. The recent treatment of No.3861 confirms that it was probably painted in a single sitting with some minor later additions, and the rapidly achieved impasto is quite distinct from the more heavily wrought surfaces of the earlier *Cypresses* and *A Cornfield, with Cypresses* (Fig. 1). There is considerable variation in the texture and thickness of paint in No.3861; in several areas, notably the sky and the cypress trees, the paint is thinly and evenly applied while the thickest impasto is in the foreground wheat and in the clouds. The ground is often allowed to show between the brushstrokes and in the sky this creates a subtle interplay between the warm ground colour and the cool blues.

In repeating the July version, Van Gogh has made several modifications to the composition. Some of the areas in the middle distance have been simplified and the silhouettes of the cypress trees are livelier and more animated. He has also exaggerated the rhythmic lines which run across the composition, especially the outline of the mountains and the far edge of the wheatfield.

The relationship between these two versions of the same composition is interesting as it is often assumed that Van Gogh produced repetitions of his own work either as gifts for his family or because he was forced to rely on the inspiration of his own work during periods of convalescence. The small reduction of *A Cornfield, with Cypresses* (Fig.3) certainly belongs to the former category as it was produced to send to his mother and sister, but there are a number of repetitions which played a more important role in Van Gogh's working procedure. Van Gogh was committed to working from nature yet he strove to render the 'inner character' of the landscape rather than to reproduce its superficial appearance. At Arles, under the supervision of Gauguin, he had experimented with the freedom of painting from his imagination rather than after nature but he quickly abandoned this approach finding it alien to his temperament. With the exception of a small number of canvases including *The Starry Night*, the paintings produced at Saint-Rémy are based on a direct observation of nature. The process of repeating a composition in the studio allowed Van Gogh to explore the more decorative and expressive elements in his art, while at the same time retaining a close link with the motif.

In a letter to Emile Bernard written in 1888, Van Gogh had already given a clear statement about the relationship between a 'study' from nature and a finished picture.

> And I cannot work without a model. I won't say that I don't turn my back on nature ruthlessly in order to turn a study into a picture, arranging the colours, enlarging and simplifying; [....] I exaggerate, sometimes I make changes in a motif; but for all that, I do not invent the whole picture; on the contrary, I find it all ready in nature, only it must be disentangled. [12]

In another letter to Bernard written a year later, from Saint-Rémy, Van Gogh again stressed his difficulties in 'disentangling' what is already in nature [13]. By producing repetitions Van Gogh was able to develop his personal response to the subject without moving too far towards what he described as the 'enchanted ground' of abstraction [14].

When Theo Van Gogh wrote to Vincent to acknowledge receipt of the batch of paintings which included both the size 30 paintings of *A Cornfield, with Cypresses* he accused his brother of being preoccupied with 'the search for some style'. In his defence Vincent replied:

> [...] the fact is that I feel strongly inclined to seek style, if you like, but by that I mean a more virile deliberate drawing. I can't help it if that makes me more like Bernard or Gauguin. [15]

The small but important differences between *A Cornfield, with Cypresses* in Switzerland and the version in the National Gallery illustrate this attempt to achieve a more 'deliberate' drawing and show how, in the relative calm of the studio, Van Gogh sought to translate a heavily worked study after nature into a more concise and powerful pictorial statement.

The two paintings of *A Cornfield, with Cypresses* were sent to Theo on 28 September 1889. Van Gogh often

gave his brother detailed instructions on how to handle and display his works and his comments suggest that Vincent was well aware of the problems that his techniques might cause in the future. In September 1889, for example, he wrote to Theo about the *Bedroom*:

> [. . .] sooner or later it must be *recanvased* good and solid. It was painted so quickly and has dried in such a way that the essence evaporated at once, and so the paint is not firmly stuck to the canvas at all. That will be the case with other studies of mine too, which were painted very quickly and very thickly. Besides, after some time this thin canvas decays and cannot bear a lot of impasto.' [16]

On a number of occasions Van Gogh told Theo to wash his canvases when they 'are quite, quite dry with *water and a little spirits of wine* to take away the oil and the essence in the impasto' [17]. These instructions were repeated when he sent his painting of *Cypresses* to the critic, Albert Aurier, and Van Gogh also instructed him to give the painting 'a goodly coat of varnish':

> [. . .] you will, by varnishing, get the black, the very black tones, necessary to bring out the various sombre greens. [18]

It is not clear why both the size 30 versions of *A Cornfield, with Cypresses* escaped this treatment but the difficulties in finding a suitable protective layer for No.3861 are discussed below by Anthony Reeve.

Acknowledgements

I would like to thank Cornelia Peres of the Rijksmuseum Vincent Van Gogh, Amsterdam and Hans Susijn for their help and advice. I am also grateful to Susan Stein at the Metropolitan Museum of Art, New York for obtaining a reproduction of F743.

Notes and references

1. The three versions are: 'A Cornfield, with Cypresses', National Gallery No.3861, 74 × 93 cm; F615 in DE LA FAILLE, J-B., *The Works of Vincent Van Gogh,* rev. ed. (Amsterdam 1970). 'A Cornfield, with Cypresses', 73 × 93.5 cm; F717. 'A Cornfield, with Cypresses', 51.5 × 65 cm, F743.
2. 'Van Gogh in Arles', The Metropolitan Museum of Art, New York, 18 Oct. to 30 Dec. 1984. 'Van Gogh in Saint-Rémy and Auvers', The Metropolitan Museum of Art, New York, 25 Nov. 1986 to 22 Mar. 1987.
3. 'Green Wheat', Národní Galerie, Prague, F719.
4. *The Complete Letters of Vincent Van Gogh*, three vols., Thames and Hudson (London 1958), Vol.III, No.596.
5. *Letters*, Vol.III, No.596.
6. *Letters*, Vol.III, No.609.
7. See for example, F485, F496 and F513. 'The Starry Night', Museum of Modern Art, New York, F612.
8. 'Cypresses', The Metropolitan Museum of Art, New York, F613. 'Cypresses', Rijksmuseum Kroller-Muller, Otterlo, F620.
9. *Letters*, Vol.III, No.596. See also No.541 in which Van Gogh describes the cypress as 'funereal'.
10. *Letters*, Vol.III, No.597.
11. *Letters*, Vol.III, No.604.
12. *Letters*, Vol.III, B19.
13. *Letters*, Vol.III, B20.
14. *Letters*, Vol.III, B21.
15. *Letters*, Vol.III, T19 and No.613.
16. *Letters*, Vol.III, No.604. 'Van Gogh's Bedroom', Amsterdam, Rijksmuseum Vincent Van Gogh, F482.
17. *Letters*, Vol.III, No.593. See also *Letters*, Vol.III, No.563, where Van Gogh explains that, 'Gauguin has told me how to get rid of the grease in the things painted in impasto by washing from time to time.'
18. *Letters*, Vol.III, No.626a.

Cleaning and restoration

Anthony Reeve

A Cornfield, with Cypresses (see Plate 7, p.57) is one of four paintings by Van Gogh in the National Gallery [1]; the others are: *The Chair and Pipe* (No.3862), painted in Arles in 1888; *Sunflowers* (No.3863), probably painted in Arles in 1888, and *Long Grass with Butterflies* (No.4169), probably painted in the year of the artist's death, 1890.

Van Gogh's paintings like those of most artists, vary in technique and style. The thickness of the grounds and of the paint layers varies considerably from one picture to another. For example the paint of the *Sunflowers* is extraordinarily thick; it is not known what type of ground the picture has. The canvas of *The Chair and Pipe* is prepared only with a thin application of size, and is also thickly painted probably in two layers. *Long Grass with Butterflies* is similar to *A Cornfield, with Cypresses* in that the ground has been left showing through the paint.

Since the paint on No.3861 continues round the turned over edges, the canvas may have been pinned out on a board or frame when it was painted as the only visible set of tack and pin holes match up with the holes on the existing stretcher.

The paint was probably worked straight from the tube onto the canvas and then brushed while still wet, as traces of colour mixing can be seen, for example, of green in the blue of the mountains.

This picture is thought to have been painted in a very short time with very minor additions of yellow to the centre left and the right edge, and a few brown strokes across the corn as a final colour adjustment. These are most clearly seen in the UV-fluorescence photograph (Plate 9, p.57). Some of his paintings have been re-worked considerably after the initial painting. His canvases were generally commercially prepared, with an oil ground. It has also been noted that Van Gogh sometimes applied a layer of watercolour over the oil ground.

The vigorous swirling brushstrokes are very clearly displayed in the photograph of the reverse by transmitted light (Fig.4). The condition of the painting sets it apart from the three others in the Collection as it is both unlined and not impregnated with anything which would change the refractive index of the paint and ground. It has never been varnished or treated with polishing wax.

In various areas of thick impasto in *A Cornfield, with Cypresses*, *The Chair and Pipe* and *Long Grass with Butterflies* there are impressed marks of other canvases (Fig.5). This may have happened when the pictures were rolled for sending to their various destinations; and the supposition is strengthened by the direction of the vertical cracking visible in the sky paint of the *Cornfield*, perhaps suggesting that it was rolled from the short sides with the paint outwards to make the smallest bundle. It is also possible that the pictures were stored flat and that this caused the impressed marks.

The infra-red photograph (Fig.6) taken during examination of the picture also displayed the unusual but interesting phenomenon of omitting a section of the composition, the whole area of distant mountains, which must be caused by having been painted with

Figure 4
The back of the picture seen by transmitted light.

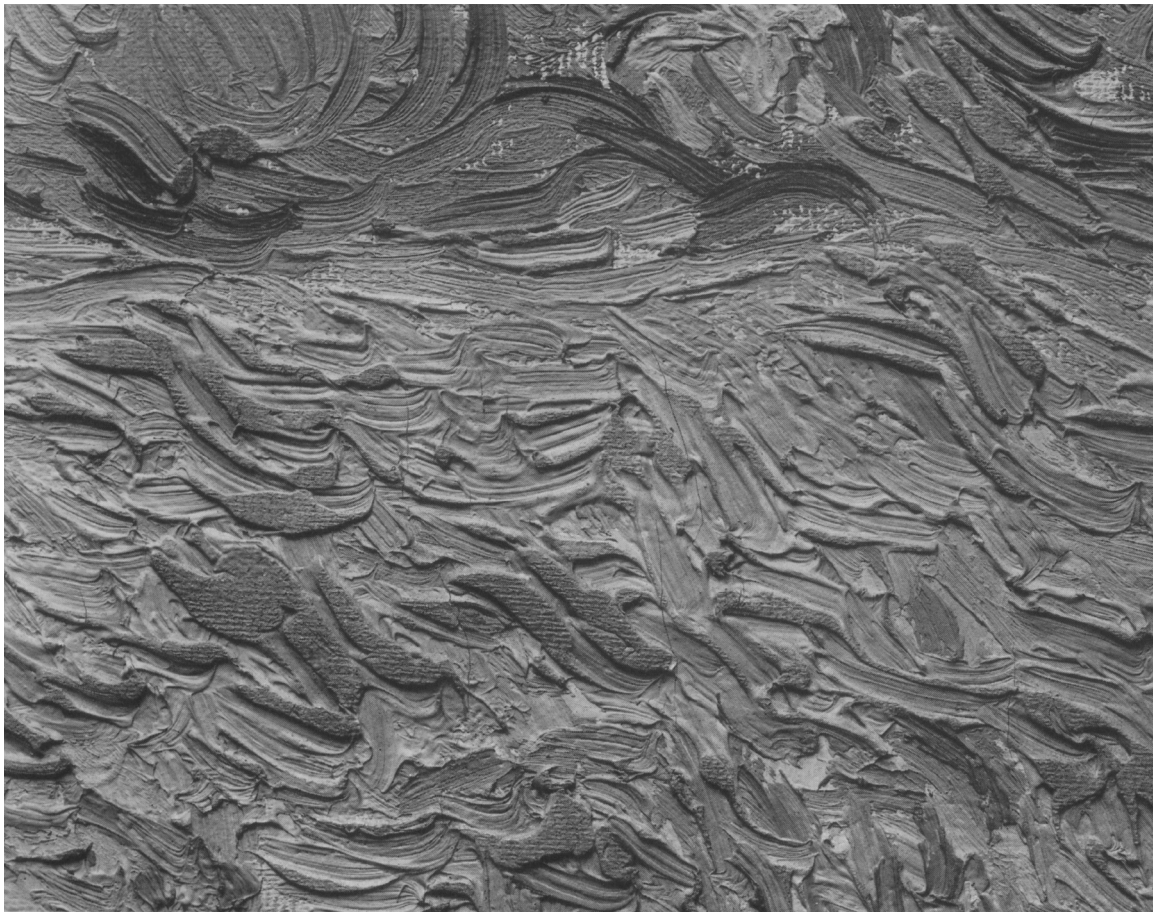


Figure 5 Macro detail of the impression of another canvas in the paint.

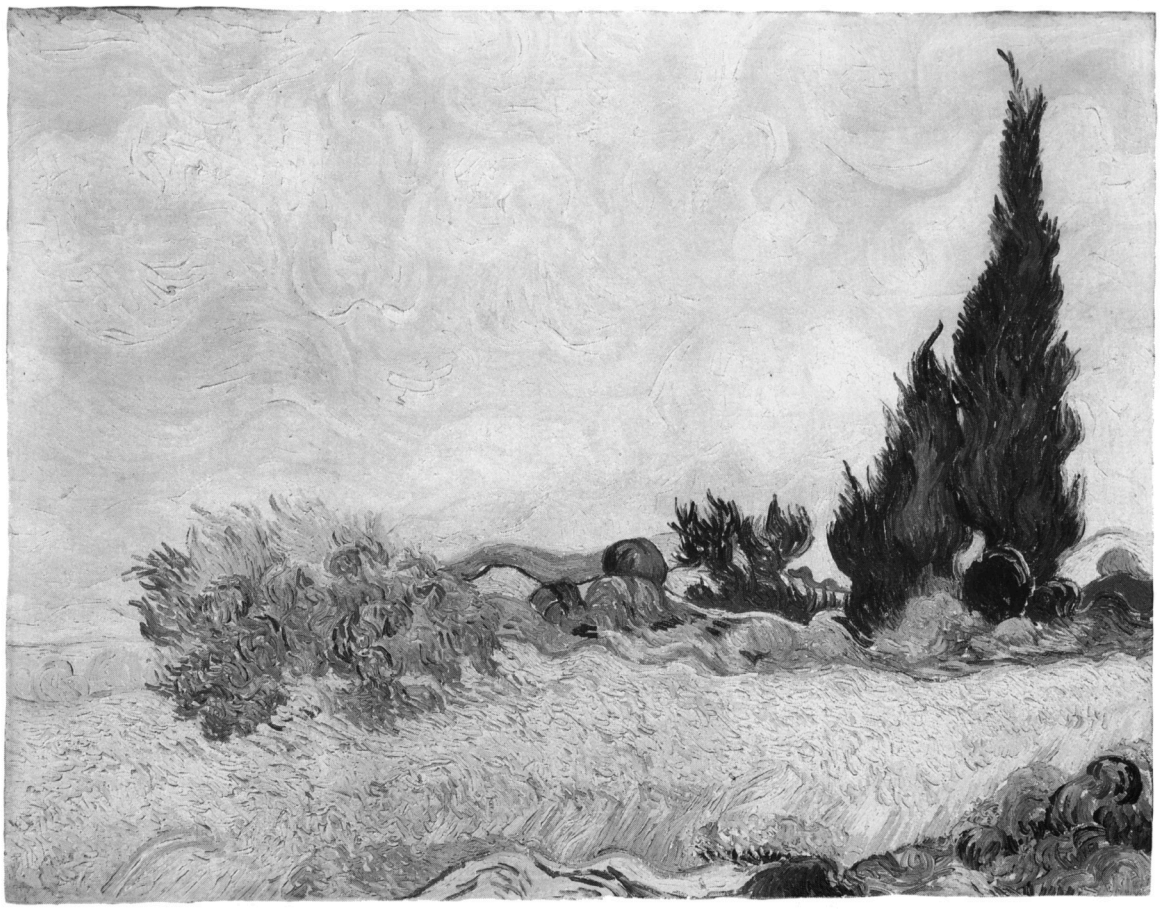


Figure 6 Infra-red photograph of the whole.

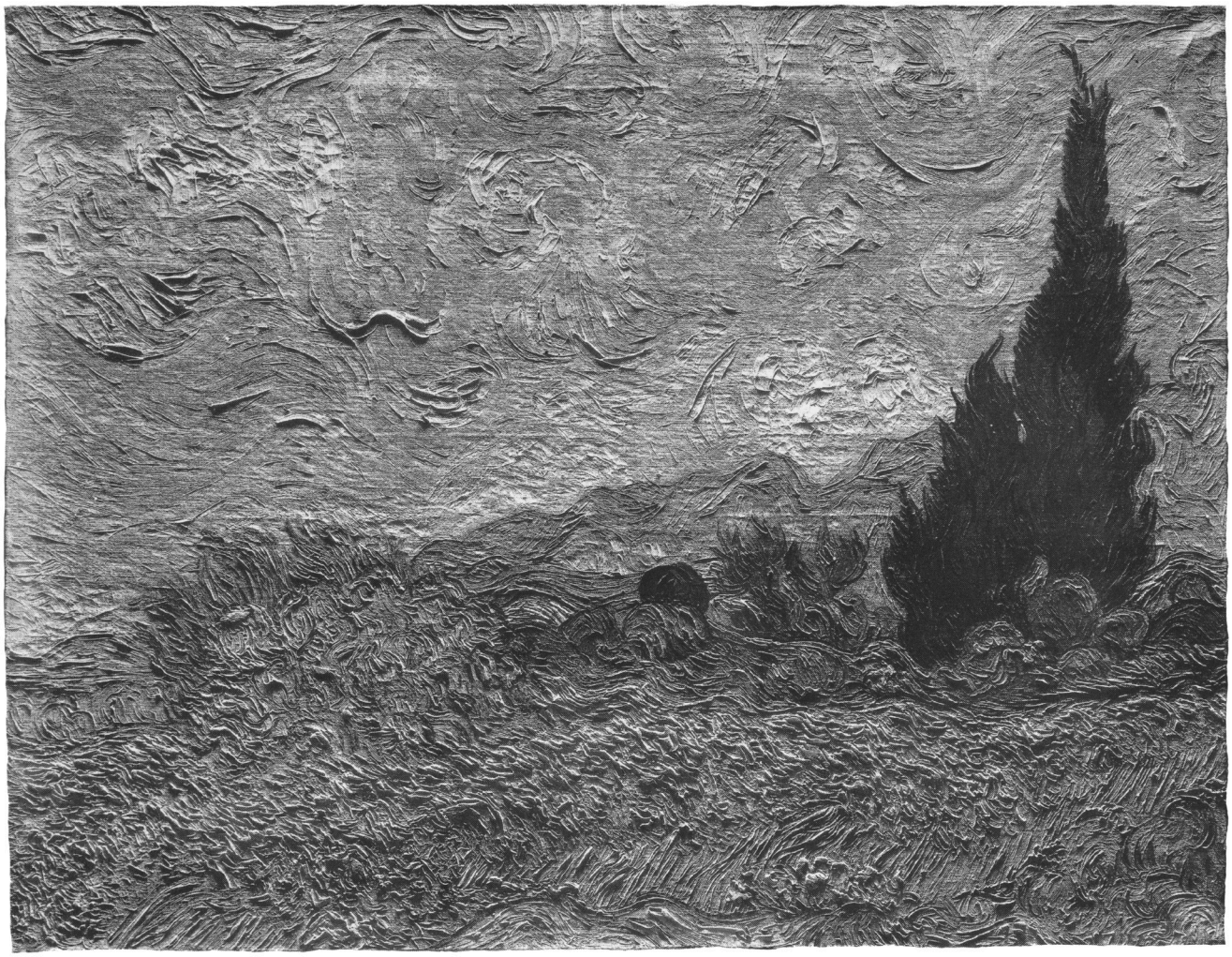
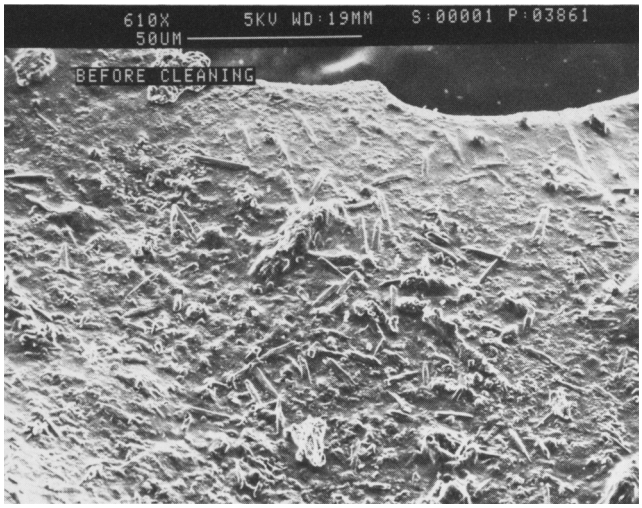


Figure 7 Raking light photograph of the whole.

Figure 8 The lower edge of the picture showing original paint on the turnover.



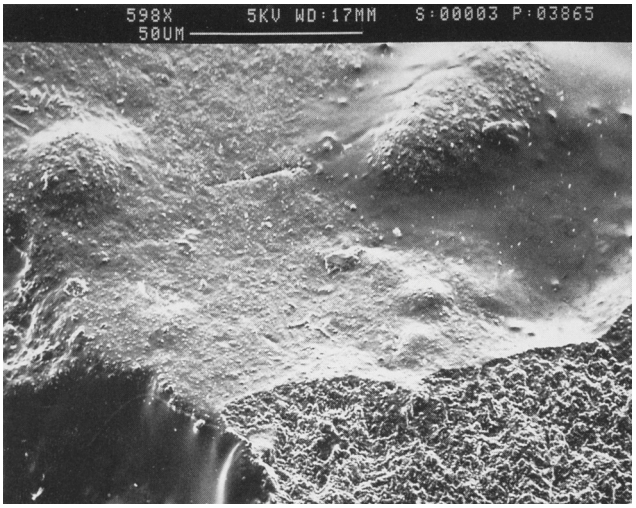


Figure 9 SEM micrographs of the surfaces of samples from the sky. **(a)** *Above left*. Before cleaning, showing surface dirt. Gold-coated 610×. **(b)** *Above right*. After cleaning, showing that the cleaning method has successfully removed the dirt film without disruption of the relatively smooth paint surface beneath. A fractured edge of the sample can be seen to the lower right, indicating the difference in texture between the cleaned surface and the granular interior of the paint film. Gold-coated, 598×.

Figure 10 Consolidation on the low-pressure table.

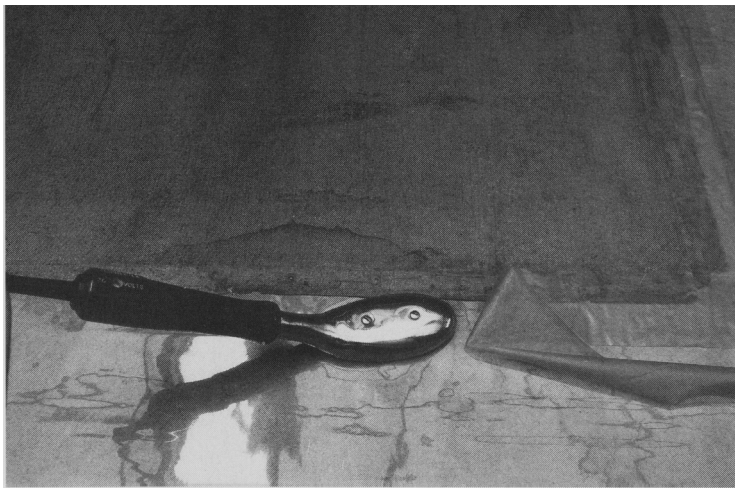


Figure 11 Reinforcement of the turnovers before remounting on a new stretcher.

pigments showing a high reflectance for infra-red (see below).

The painting posed a most difficult problem for cleaning as can be seen in a raking light photograph (Fig.7). The impasto is extensive and very raised with many delicate brittle points. This rough surface could not be cleaned using normal methods. Instead of using conventional lightly rolled cotton-wool swabs on wooden sticks, a long-handled long haired semi-soft bristle brush was used, enabling the raised paint surface to be cleaned at every angle very gently. The picture was first tested using de-ionized water. This proved to be very suitable for removing a thick layer of dirt, after which the paint surface was swabbed with white spirit (see Plate 8, p.57). In order to assess the effectiveness of the cleaning method, samples of the paint surface before and after treatment were examined in the scanning electron microscope (Figs.9a,b). The picture was inspected again, and on further testing a second layer of dirt more firmly ingrained than the first was found. This was removed using 1% potassium oleate in de-ionized water using the same cleaning method as before. No varnish was found on the picture, and no other layer (for example egg white, which is mentioned in one of the letters).

After cleaning, the unlined linen canvas was removed from its stretcher. The stretcher is thought to be that on which the picture was first supported, though it is not known how much time elapsed between the picture being painted and its being stretched. The original paint was turned over the edges on the right and bottom sides (Fig.8) proving the picture was not painted whilst on this stretcher. These edges have now been reclaimed by using a larger stretcher. The original blued tin tacks had been used evenly at an average distance of $2\frac{1}{2}$ in. (*c.*6 cm) apart and the small turnovers on the corners were held with one smaller blued tin tack.

The canvas turned over the sides of the stretcher and around the back is of a varying width and was held down with four layers of paper and an aqueous glue. The first, a reddish brown fibrous paper next to the original was only present on two sides. The second was a similar fibrous paper, but much darker brown in colour. Then came a thin light paper with definite parallel lines running $\frac{1}{8}$ in. (4 mm) apart, which passed around to the

edge of the paint. The last reddish fibrous paper must have extended across an earlier frame. The removal from the previous frame could have been the cause of the cuts on the right side in the original canvas just at the edge of the turned over paint.

Since the painted edges were to be reclaimed and minor surface deformations removed, it was decided to relax and regenerate these areas so far as possible using moisture treatment on the low-pressure vacuum table [2] with heating to 35°C and moisture vapour applied for twenty minutes under a low vacuum. The picture was dried in the relaxed state maintaining the vacuum for three hours. The painting relaxed and reformed in a much flatter plane than before, so there was no need for the impregnation of an adhesive. A few minor flake losses and some cracking were secured with dilute sturgeon glue on the low-pressure table (Fig.10) by removing the surface membrane and drawing the adhesive in using the vacuum. As the edges were brittle having been turned around the stretcher, a strip-lining of Stabiltex [3] (polyester multifilament fabric) impregnated with Beva 371 was nap-bonded onto the back of the original using a warmed spatula (Fig.11). The strips extended to the edge of the paint so as to support the turnovers for re-securing to a new stretcher. The small losses were filled using chalk and gelatine and retouched using watercolour. The usual surface coating of a natural or synthetic varnish applied after restoration was not suitable in this case as it would inevitably darken the picture. The ground plays an important part in the colour composition and any form of darkening would cause a serious imbalance. There is therefore probably some loss of colour intensity which is seen when the surface is wetted with white spirit. A gelatine based coating was considered as a possible varnish layer to regain the lost depth of colour, and also to give some protection.

Further tests were done on the paint solubility. A minute rub test was performed using de-ionized water. Some of the colours proved slightly water sensitive: the strong yellow-greens (background), darker yellow (corn), dark blue (trees), and this has now totally ruled out a water bound protective coating [4]. It was decided to leave the picture unvarnished, but unfortunately it has now to be glazed to protect the surface from accumulating further dirt.

Notes and references

1. Davies, M., *French School: Early 19th Century, Impressionists, Post-Impressionists*, National Gallery Catalogues (London 1970), pp.136–39.

2. Reeve, A.M., 'A New Multi-Purpose Low-Pressure Conservation Table for the Treatment of Paintings', *Studies in Conservation*, **29**, 3 (1984), pp.124–28.

3. Stabiltex is supplied by the Swiss Silk Bolting Cloth Co., Grütlistrasse 68, Postfach CH–8027, Zurich 2, Switzerland.

4. Sensitivity of the paint to abrasion in the absence of any solvent has been noted in the yellows and yellow-greens of another Van Gogh landscape. See Ruhemann, H., 'The Restoration of "La Haie": Landscape Near Arles', *Studies in Conservation*, **1**, 2 (1953), pp.77–78.

The materials of Van Gogh's 'A Cornfield, with Cypresses'

Ashok Roy

The cleaning and conservation treatment of the National Gallery *A Cornfield, with Cypresses* presented us with a welcome opportunity to examine the technique of the painting and to identify the materials involved, particularly the pigments, in a number of samples taken during treatment. It is of interest to us to know something of the history of the artists' palette in French painting in the later part of the nineteenth century, and we have now been able to explore the painting materials in individual pictures by Monet [1,2], Renoir [2], Cézanne [2] and Manet [3]. Consistent patterns in the uses of nineteenth-century pigments begin to emerge, although the techniques of painting remain a characteristic of the painter. The present Van Gogh shows much that is close to the Impressionist palette, although the painter's predilection for zinc white in place of the more usual lead pigment for oil painting seems to be unusual amongst his contemporaries.

We are fortunate to be able to compare the results of our pigment analyses with those given in a recent comprehensive and excellent study made at the Fogg Art Museum, Harvard University of the Van Gogh *Self-Portrait Dedicated to Paul Gauguin* [4] painted in Arles about a year before the National Gallery landscape. The palette between Arles and St. Rémy clearly evolved little. In addition the requests for supplies of painting materials in some of Vincent's letters to Theo [5] gives another source for comparison with the palette that can be deduced from the paint analyses noted here.

Pigment identifications from the National Gallery painting were made by a combination of optical and chemical microscopy, X-ray diffraction analysis (XRD), and emission spectrography with the laser microprobe (LMA). The results are presented in summary form in Table1. We note below the difficulties that arise in characterizing by analytical means alone certain nineteenth-century pigments, particularly the variety of chrome yellows which had become available [6], and

Notes to the Table

1. The pigment identifications noted are by spectrographic analysis, X-ray diffraction, and where no method is recorded, by optical microscopy. Pigments listed in brackets are present only in small quantities in the sample.

2. Appearance of the paint layer in ultra-violet light (see Plate 9, p.57). A = light/fluorescent behaviour, where zinc white is present; B = dark/non-fluorescent behaviour.

3. Appearance of the paint layer in the infra-red photograph (Fig.6). The paint absorbs infra-red radiation where the copper pigment, emerald green is used, and to some extent where pure chrome yellow (lead chromate) occurs.

4. Weaker emission lines from minor components are listed in brackets.

5. X-ray diffraction analysis with the Debye-Scherrer camera. The column notes where agreement was found with the JCPDS file, given in square brackets. Where relevant, the appropriate mineralogical name of the pigment is quoted.

6. Sample possibly contains strontium chromate.

7. Microscopical identification only.

Table 1 Pigment mixtures used in Van Gogh's *A Cornfield, with Cypresses.*

Sample	Pigment/s[1]	UV-behaviour[2]	Infra-red photograph[3]	Spectrographic Analysis (LMA)[4]	X-ray Diffraction Analysis (XRD)[5]
White ground	lead white	A	light	Pb	hydrocerussite [13–131]
White cloud	zinc white	A	light	Zn	zincite [5–664]
Pale blue sky, top edge	zinc white (cobalt blue)	A	light	—	—
Mid-blue sky, top edge	zinc white cobalt blue	A	light	Zn, Co, Al	—
Mid-blue mountain, l.h. edge	zinc white cobalt blue	A	light	Zn, Co, Al	zincite [5–664] cobalt aluminium oxide [10–458]
Dark blue line, middle distance (Plate 10c, p.57)	ultramarine emerald green	B	dark	Al, Si, Cu, As	—
Dark blue line, r.h. edge	ultramarine (red lake)	A	light	—	ultramarine [2–325]
Red of poppies	vermilion	B	light	Hg	cinnabar [6–256]
Darkest yellow of cornfield	chrome yellow	B	grey	Pb, Cr	crocoite [8–209]
Brownish yellow of cornfield, l.h. edge	chrome yellow (earth pigment?, vermilion, viridian)	B	light	Pb, Cr (Fe, Al, Si, Hg)	crocoite [8–209]
Mid-yellow of cornfield, l.h. edge	chrome yellow zinc white	A	grey	Pb, Cr, Zn	crocoite [8–209] zincite [5–664]
Lightest yellow of cornfield, l.h. edge	zinc white chrome yellow	A	light	Zn, Pb, Cr	zincite [5–664] crocoite [8–209]
Dull yellow of cornfield, l.h. edge	chrome yellow zinc white (emerald green)	A	light	Zn, Pb, Cr (Cu, As)	zincite [5–664] crocoite [8–209]
Mustard yellow hillside, l.h. edge	chrome yellow zinc white (earth pigment?, emerald green, vermilion)	A	grey	Pb, Sr, Cr, Zn (Fe, Al, Si, Cu, As, Hg)	—
Turquoise sky, top right	zinc white viridian	A	light	Zn, Cr	
Pale green bushes, l.h. edge	zinc white chrome yellow viridian	A	light	—	
Mid-green, bottom edge	zinc white viridian chrome yellow[6] (emerald green)	A	grey	Zn, Cr, Pb, Sr (Cu, As)	
Dark green, bottom edge	viridian emerald green chrome yellow (zinc white, vermilion)	B	dark	Cr, Cu, As, Pb (Zn, Hg)	
Dull green, bottom edge (Plate 10d, p.57)	zinc white emerald green viridian chrome yellow[6] (vermilion)	A	dark	Zn, Cu, As, Pb, Sr Cr (Hg)	
Yellow-green, bottom edge	chrome yellow emerald green zinc white (viridian)	A	grey	—	
Mid-green bush, in front of cypresses	emerald green	B	dark	—	
Mid-green bush, right of cypresses (Plate 10b, p.57)	zinc white ultramarine viridian emerald green (chrome yellow)	A	grey	—	
Mauve-grey streak, foreground (Plate 10a, p.57)	zinc white ultramarine chrome orange?[7] (viridian)	A	light	—	

which here form an important part of the paint of the cornfield. For these samples, scanning electron microscopy (SEM [7]) was used to look closely at pigment particle morphology, and an attempt made to correlate the results with the observed colours of the paint and with crystallographic identification of the materials by XRD.

Analysis of the paint medium by gas-chromatography is given by Raymond White in Table 2 below.

It is evident that Van Gogh would have painted the *Cornfield, with Cypresses* quite rapidly, and the intermingling of colours revealed by some of the cross-sectional samples confirms this. For example, in the streaks of mauvish grey in the foreground at the very edge of the cornfield, the colour can be seen to have been worked into the underlying white and yellow layers whilst the paint must still have been wet (see Plate 10a, p.57). Elsewhere, though, a more organized, discrete layer structure is found suggesting subsequent adjustments to the composition after the initial layers had dried (see, for example, Plate 10b, p.57). There is also evidence from the constitution of the paint that modifications to the design, if only minor, were made at a later stage (see the pigment section below under 'white'), which supports the view that No.3861 was not the first in the series of paintings, but evolved by Van Gogh in the studio as a version of the theme. Several of the samples show a thin, discontinuous layer of black pigment recognizable microscopically as wood charcoal on top of the white ground, indicating some preliminary sketching of the design before painting (see Plate 10c, p.57). It is likely that Van Gogh would have defined the principal parts of the composition in a charcoal drawing on the canvas when working from one of his earlier pictures of the group. In each case the underdrawing is present beneath lines of paint which divide the main elements of the landscape horizontally — at the point for example where the dark blue line separates the cornfield from the more distant blue hills and mountains, and in the immediate foreground where the yellow stalks of corn give way to pale green and cream.

No sign of the drawing shows in the infra-red photograph (see Fig.6), partly because it is present beneath paint containing pigments which reflect infra-red radiation strongly, such as synthetic ultramarine, and partly also because the paint is so thickly applied that there can be no penetration of infra-red.

The use of individual pigments is described in more detail below.

White

Apart from a thin ground on the canvas which was shown by X-ray diffraction to be lead white, all the white pigment used is zinc white (zinc oxide, ZnO). It is very thickly applied for the sky, both in the white clouds and for the blue and turquoise parts (Fig.7) where it is combined with blue and green pigments (see Table 1). Zinc oxide has only a moderate absorption coefficient for X-rays, about half the values for lead white and vermilion and roughly equal to that for emerald green (copper acetoarsenite) [8], also used extensively in the picture. The paint in the sky is so heavily applied, however, that the thickest swirls of cloud appear as areas of high density in the X-radiograph (Fig.12).

Van Gogh's liking for zinc white is evident from his letters [5]. He clearly regarded it as in some way more permanent than lead white. He was also aware of its relatively poor drying qualities, and in the impasto of the pure white of the sky in No.3861 relatively deep, sharped-edged cracks have formed. In addition it has been shown that zinc oxide and moisture may generate hydrogen peroxide in the paint film by a photochemical reaction, leading to degradation of the medium and possibly to chalking of the surface [9,10]. In the *Cornfield, with Cypresses* however, the zinc-white-containing paint seems stable and no ill effects resulted from moisture treatment of the canvas (see above). By the later part of the nineteenth century it is likely that transition metal siccatives were added to zinc white, particularly manganese, to assist drying although the quantity would probably be too low to be detected in the emission spectrum of samples.

Zinc white was a French invention of the 1780s attributed either to Curtois or to Guyton de Morveau both of Dijon [11], but it was not until the 1840s that it became commercially available in quantity as an oil paint. Its application as a watercolour pigment had been appreciated earlier in the century since it does not discolour in aqueous media as lead white is prone to do. From his letters Van Gogh appears to have made use of both kinds of white, but some of the lead white may well have been intended for grounds.

Although pure zinc oxide will absorb UV-light strongly [12], it generally also exhibits a strong bluish or yellowish white fluorescence when illuminated with radiation below about 380nm. In microscopic samples and cross-sections the fluorescence is seen as small sharp bright points of light against an overall light background. This effect arises from a highly fluorescent impurity in the pigment, usually zinc sulphide. The sulphide may be present from manufacture or formed in situ by reaction of the oxide with atmospheric hydrogen sulphide, although the proportion must be low since no phase other than zinc oxide is detected by XRD. In any event the characteristic UV-fluorescence which results is diagnostic for the pigment, although a microchemical test or some other confirmatory method of identification such as XRD is desirable. The painting as a whole shows a generally strong light-coloured fluorescence in UV-light which cannot be attributed to any component of the paint medium (see below). The effect is particularly clearly demonstrated in an ultra-violet photograph taken on colour film (Plate 9, p.57). Almost all areas of paint have been shown by analysis to contain zinc white, and it is only where the white is absent that the UV-fluorescence photograph appears dark. Perhaps the most striking example is in the two neighbouring patches of green to the right edge by the cypress trees, which appear very alike in colour on the painting, but are brought into sharp contrast in UV-light. One appears entirely dark whilst the other is a light sage green. The explanation lies in the quite different pigment composition of the paint. The section which shows no UV-fluorescence is essentially a single thick layer of

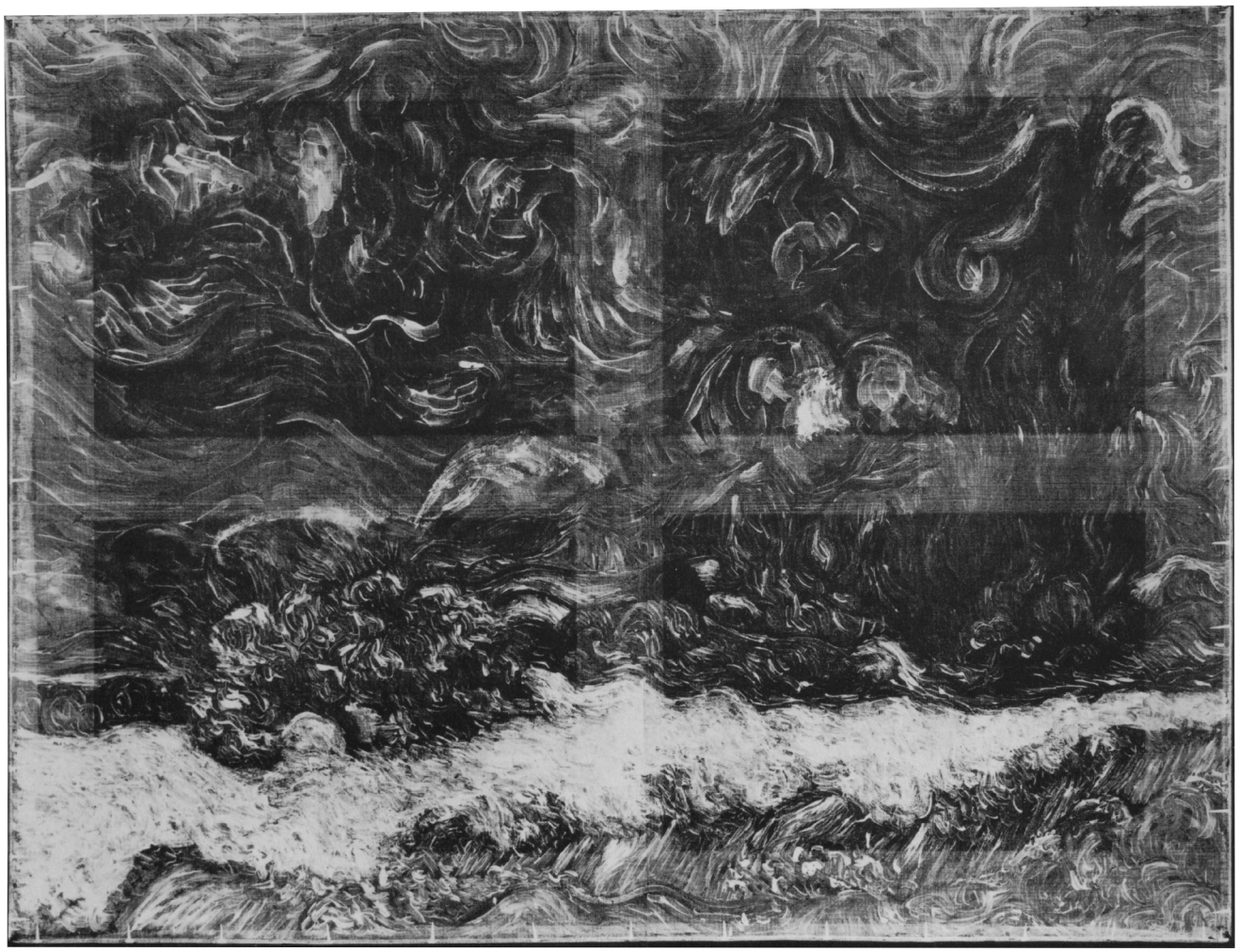


Figure 12
Van Gogh, *A Cornfield, with Cypresses*, composite X-radiograph.

emerald green (see below), whereas the bright-seeming adjacent area combines zinc white, ultramarine, viridian, emerald green, with some chrome yellow (Plate 10b, p.57). It is the white component which dominates the fluorescence, the other pigments showing no significant brightness in UV-light. The pigment composition of each of these greens is so distinctive that it suggests they were probably applied at quite separate stages of the painting.

In those other parts which appear dark in the UV-photograph, zinc white was also demonstrated analytically to be absent from the paint, for example in the darkest yellow strokes on the cornfield which comprise a pure deep chrome yellow, and the dark green interior of the cypress, where only green pigments are used.

Blue

Two blue pigments are present in the samples. Cobalt blue (cobalt aluminate, $CoO.Al_2O_3$) is used most extensively: to tint the zinc white for the blue of the sky, and at a greater concentration in the wedge of mountains which occupy the middle distance. Interestingly, no matter how thickly the paint was applied, in those areas which contain cobalt blue the drying cracks in the sky are less pronounced than in the passages painted in zinc white alone. The effect of cobalt pigments in assisting the drying of oil paint is well-established [13], and probably accounts here for the good state of preservation of the mixed light blues in the picture. The infra-red photograph (Fig.6) shows a striking change in the image when compared to the picture in visible light. The division between sky and mountains all but disappears, merging into a single light area. Reflection of infra-red by zinc white, and all white pigments is strong, but a high IR-reflectance in the blue pigments is most usually associated with ultramarine, whether it is synthetic or natural. Here, however, it is the cobalt blue which also strongly reflects the infra-red radiation [14], eradicating the horizon from the image. Significantly perhaps, both ultramarine and cobalt blue show a strongly rising reflectance at the red end of the spectrum [15], quite distinct from the reflectance curve for azurite, the copper-containing blue pigment, which registers as totally dark in infra-red photographs. The IR-photograph incidentally also shows that no copper green was used in the turquoise areas of sky, which in fact contain the transparent chromium oxide pigment, viridian, to tint the white.

The second blue pigment is used more sparingly. Synthetic ultramarine ($Na_{8-10}Al_6Si_6O_{24}S_{2-4}$) mixed with emerald green forms the darkest line separating the cornfield from the more distant landscape, and the outlines of the bushes to the right. It probably also appears in the deepest blue shading of the cypresses, although no sample was taken, and is incorporated into some of the colour mixtures, particularly the greens. In the darkest parts the ultramarine is used at full strength showing to good advantage its high tinting strength.

The paler appearance of the cypresses in the infra-red photograph is presumably the result of ultramarine-containing paint.

No Prussian blue was found in the picture.

Red

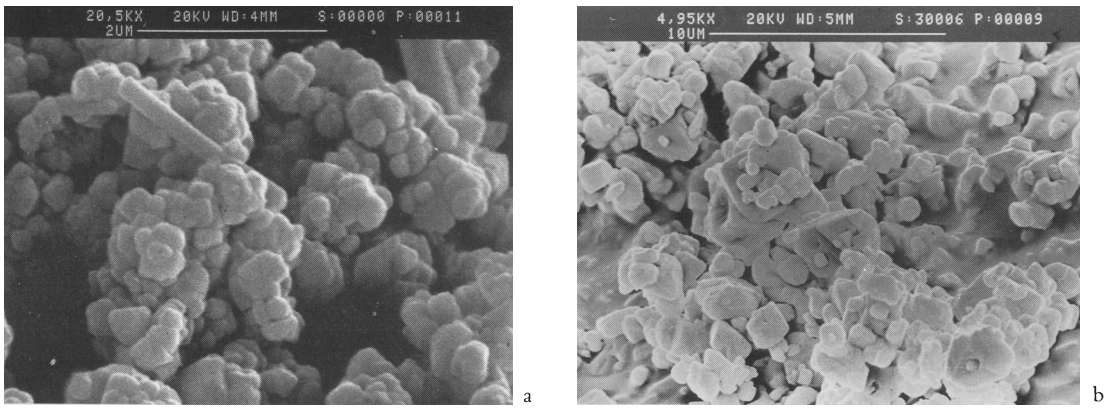
Red pigments are not prominent in the composition, except for the brilliant scarlet of the poppies which border the cornfield. The red pigment here is vermilion (mercuric sulphide, HgS) used as completely pure touches. Examination of a dispersed sample in the SEM shows the particle form to be similar to reference specimens of precipitated mercuric sulphide (Figs.13a,b). The 'wet process' had become the main method of manufacture in Europe for vermilion by the nineteenth century superseding the earlier so-called 'dry process' which involved direct synthesis from mercury and sulphur, followed by sublimation [16] (see also p.80 of this *Bulletin*). Other than in coarsely-ground specimens of natural cinnabar vermilion, the detail of the particle morphology is beyond the resolving power of the optical microscope and it is only in the SEM that it can be examined; the average grain size in the Van Gogh sample lies well below 1 μ, although the particles clump together to form aggregations in the 1–2 μ range. Where the particle form is best developed, precipitated vermilion shows interlocking distorted cubes associated with more rounded particles, which have fused into rosette-shaped clumps. The distribution of morphology and grain size is likely to vary from specimen to specimen [17].

Yellow

The cornfield itself is dominated by yellow, ranging from a dark mustard to a light straw colour. The entire area makes use of large quantities of chrome pigment, very thickly applied. Precise identification of the material is problematic for several reasons. The nineteenth century saw the introduction of a number of yellow chromate pigments. The most important of this group was lead chromate ($PbCrO_4$), generally called chrome yellow, but the compounds of barium, strontium and zinc also found application as artists' pigments. The first two are usually described by the manufacturers as 'lemon yellow', but the term may equally have been applied to a light shade of lead chromate or to mixtures of different pigments. All these chromates are crystalline, so in principal X-ray diffraction analysis might be used for their identification, especially if the elemental composition is known from spectrographic or X-ray fluorescence analysis to assist interpretation of the powder patterns. However, the XRD patterns for the usual form of pure lead chromate (crocoite) is very close to at least one crystalline modification of strontium chromate, and where white pigments are also present in the samples, for example zinc oxide, the patterns become very difficult to assign with certainty. In addition, nineteenth-century paint often contains extenders such as barium sulphate which confuse elemental analyses of the yellows. There are further complications. Lead chromate itself can exist in two crystalline forms — one monoclinic, the other orthorhombic [18] and in the variety of shades of colour that are sold as pigments both types may be present. Orthorhombic lead chromate is unstable with respect to the monoclinic modification, but may be stabilized in solid solution with lead sulphate with which it is sometimes co-precipitated for pigment use. The monoclinic variety is also manufactured in combination with lead sulphate, and so X-ray diffraction analysis provides no clear solution to identification, particularly since the XRD patterns for lead sulphate and zinc oxide overlap to a significant degree. The variety of possible chrome yellow types is therefore rather large especially when some additional component may be present either from manufacture or mixed in by the artist. Chrome yellows have always been prepared in a range of hues, from primrose to dark brownish yellow, depending on conditions of formation and admixture with other materials. Van Gogh's letters, for example, mention in one case, '3 [tubes] chrome I, 1 [tube] chrome II', and in another section, '6 [tubes] chrome 1 citron, 6 [tubes] chrome 2 citron, 6 [tubes] chrome 3 citron' [19], presumably referring to different shades of the pigment.

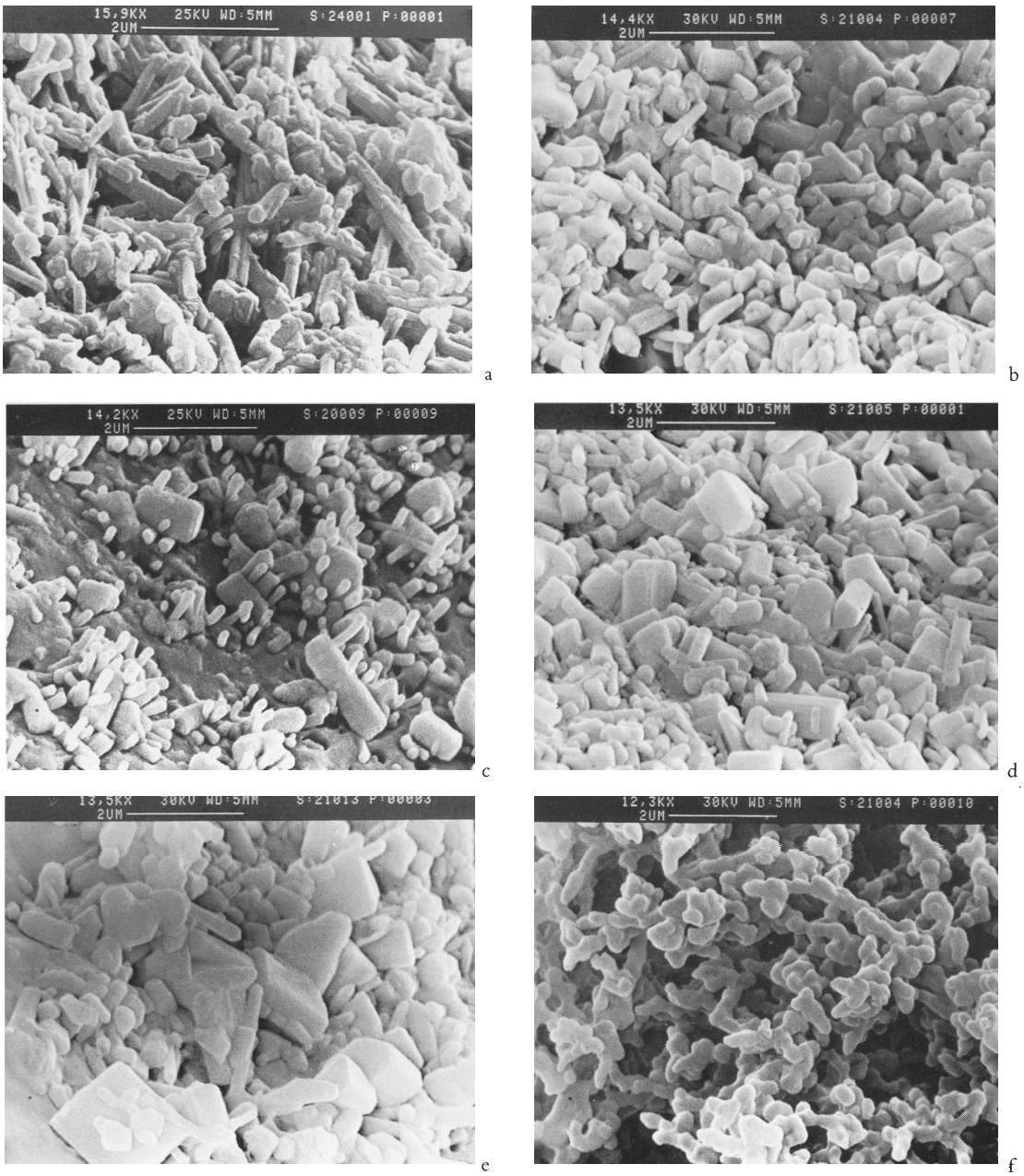
Five samples of yellow were taken from the paint of the cornfield, ranging in colour from the palest straw-coloured tint to a dark yellow-brown used for the strokes in the foreground. These were examined by XRD, LMA and fragments were dispersed by various methods for examination of the particle form in the SEM. Spectrographic analysis (LMA) in each case showed intense lines for lead, chromium, and in all samples but the darkest colours, lines for zinc. A strongly coloured brownish yellow of the cornfield, and the mustard yellow of the adjacent hillside to the right also showed some concentration of iron, silicon and aluminium suggesting a content of a little earth pigment. The latter sample contained strontium in addition. The only X-ray powder patterns that could be unambiguously interpreted were for the dark yellow-brown specimens, which agreed well with that for pure monoclinic lead chromate (crocoite). Zinc white was shown by XRD to be absent from these samples, which in confirmation were also from areas exhibiting no UV-fluoresence. The other samples all contain greater or lesser amounts of zinc white, detectable in the powder patterns, emission spectra, and in UV-light under the microscope. The XRD results can be interpreted as showing a content of lead chromate, as the monoclinic (crocoite) form, in all of the yellow samples, but the presence or absence of lead sulphate cannot be demonstrated for the reasons explained above. In the sample which showed emission lines for strontium, strontium chromate may have been used, although the zinc white would tend to obscure the relevant extra lines in the diffraction pattern.

In an SEM micrograph, a reference specimen of pure lead chromate comprises mainly rod-shaped crystals in the range of 1–2 μ in length and less than *c.* 0.4 μ diameter (Fig.14a). They are associated with a small quantity of more rounded, rough-edged particles less than 1 μ across. The darkest yellows from the Van Gogh are rather similar (Fig.14b), although the rod-shaped particles are accompanied by a proportion of irregular hexagonal biprisms. Rods are seen in all the samples, but they tend to be shorter (*c.* 0.5 μ) in the light-coloured specimens (Fig.14c). The proportion and dimensions of the hexagonal-faced prisms are also variable. The ratio



a b

Figure 13 SEM micrographs of vermilion particles. **(a)** Sample from the foreground poppies in Van Gogh's *A Cornfield, with Cypresses*. Medium partially extracted with dimethylformamide. Gold-coated, 20,500 ×. **(b)** Reference specimen of wet precipitated vermilion. Gold-coated, 4950 ×.



a b c d e f

Figure 14 SEM micrographs of particles of chrome yellow and pigment particles extracted from yellow samples in Van Gogh's *A Cornfield, with Cypresses*. All specimens gold-coated. **(a)** Reference sample of pure lead chromate (crocoite), showing mainly rod-shaped crystallites, 15,900 ×. **(b)** Dark yellow of cornfield, 14,400 ×. **(c)** Light yellow of cornfield, 14,200 ×. **(d)** Dull, mid-yellow of cornfield, 13,5000 ×. **(e)** Lightest yellow of cornfield, 13,500 ×. **(f)** Zinc white pigment associated with a dark yellow from cornfield, 12,300 ×.

to rod-like particles is highest in the mid-tone shades (Fig.14d), and their individual average volume greatest for the pale yellows (Fig.14e). These bulkier particles may represent solid solutions of lead chromate and lead sulphate. Where zinc white is present in the samples it is distinguishable by a very low average grain size (*c.* 0.1 μ, see Fig.14f) and the tendency for the fine particles to link into a network of sinuous chains.

The thickness of application of chrome yellow in the cornfield produces a dense image on the X-radiograph (see Fig.12), and the lead content of the paint has ensured that the whole area has dried well with scarcely any cracking.

Green

It has been pointed out earlier that some of the greens of the landscape make use of pigment mixtures, although nowhere has blue and yellow alone been combined for the purpose. All the samples contain either viridian (hydrated chromium (III) oxide $Cr_2O_3.2H_2O$) or emerald green (copper acetoarsenite, $Cu(CH_3COO)_2.3Cu(AsO_2)_2$), and sometimes both pigments (Plate 10d, p.57). The occurrences are noted in Table 1. Viridian and emerald green are often found to have been mixed together in Impressionist painting [1,2], but although certain of the samples from the Van Gogh contain the two, they are also used independently. For example, the two round bushes immediately in front of the taller cypress are painted in virtually pure emerald green over the white ground, whilst streaks of unmixed viridian underlie lighter yellowish mixed greens of the meadow to the left-hand edge. The names of these pigments in English and French are confused by contradictory terminology, since in France 'verte emeraude' (emerald green) is the transparent chromium oxide pigment (viridian), and what is called 'emerald green' in England, is in France usually called 'Veronese green'. In the English edition of the letters, Van Gogh specifies a pigment translated as 'malachite green', and this is most likely to be copper acetoarsenite [20].

The green pigments are also used in mixture with synthetic ultramarine for the deepest greenish blues of the cypresses, and for the lines which define the neighbouring landscape. Wherever the copper pigment occurs, the paint appears relatively dark in the infra-red photograph. In the cold green sections of sky the pigment is viridian mixed with white.

Other pigments

The main group of pigments used in No.3861 is given above, but there are small quantities of some others detected in the samples. In several of the spectrographic analyses, particularly of the yellows, but also in one of the blue samples, iron and silicon were detected suggesting the addition of earth pigments. A fine-grained crystalline orange of fairly high refractive index also occurred in mixture with zinc white, synthetic ultramarine and a little viridian for the mauvish grey foreground colour (Plate 10a, p.57), and although this could not be separated for specific identification, appears microscopically similar in particle form to reference specimens of chrome orange (basic lead chromate, $PbCrO_4$,$Pb(OH)_2$).

Plate 10 Vincent Van Gogh, *A Cornfield, with Cypresses* (No. 3861). Photomicrographs of paint cross-sections, photographed in reflected light under the microscope at 110× (*a, d*) and 220× (*b, c*). Actual magnifications on the printed page shown opposite.

(a) Mauve-grey streak, foreground, lower edge.

1. Yellow of cornfield: chrome yellow+zinc white+trace viridian.
2. Mauve-grey surface paint comprising zinc white, ultramarine, an orange pigment (probably chrome orange) and a little viridian.

(b) Mid-green bush, right of cypresses.

1. Lead white ground.
2. Mauve underlayer containing zinc white, cobalt blue, ultramarine and a little red lake pigment with viridian.
3. Zinc white combined with ultramarine, viridian, emerald green and a little chrome yellow.

(c) Dark blue line, middle distance, centre.

1. Lead white ground.
2. Line of charcoal drawing.
3. Thick dark blue paint comprising mainly ultramarine with some emerald green.

(d) Dull green, lower edge, right.

1. Lead white ground.
2. Light green underlayer of zinc white with viridian and emerald green.
3. Dull green surface paint containing zinc white, emerald green, viridian, chrome yellow and a little vermilion.

Plate 8
Detail during cleaning.

Plate 9
Ultra-violet colour photograph detail.

Plate 7
(Far left) Vincent Van Gogh, *A Cornfield, with Cypresses* (No. 3861), after cleaning and restoration.

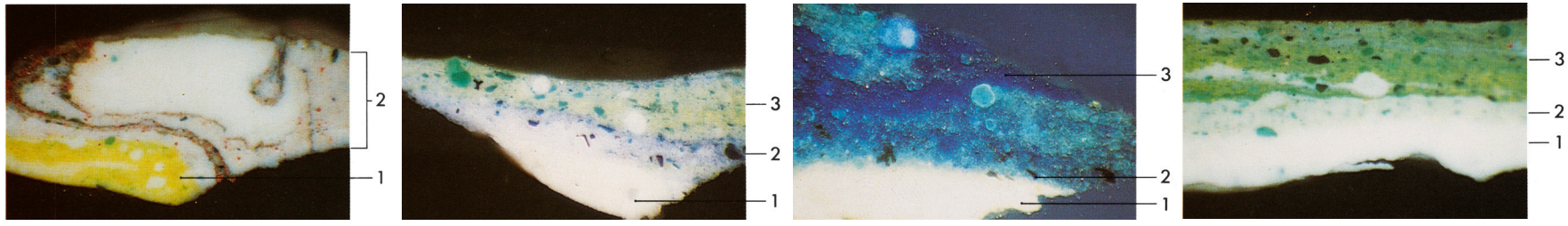


Plate 10 Vincent Van Gogh, *A Cornfield, with Cypresses* (No. 3861). Full caption on facing page.

In a single sample, a light mauve paint layer underlies the green of the landscape to the right-hand edge of the picture (Plate 10b, p.57), representing an experiment in the colour composition of the middle distance, and perhaps originally intended to reflect the pale mauvish patch of the present foreground. The paint composition beneath the green comprises white mixed with cobalt blue, a small quantity of viridian and some red lake. This area is unusual amongst the samples in containing a lake pigment. It is here and in the foreground mauve, which differs markedly in pigment constitution, that the picture shows most evidence of a change of mind in the evolution of the final composition.

Four of Van Gogh's published letters to Theo are relevant and give lists of requests for supplies of tube colours: two are from the Arles period, and two from St. Rémy [5]. The St. Rémy palette from this source comprises: lead white (flake white), zinc white, cobalt and ultramarine blue, various earth pigments (yellow ochre, red ochre, raw sienna), red lead (orange lead), emerald green (malachite green), viridian (emerald green), and ivory black. Only traces of black are present in No.3861. The earlier Arles lists are more extensive, including Prussian blue, vermilion, a variety of chrome yellow pigments, and three kinds of red lake pigment. The complete selection for the National Gallery *Cornfield, with Cypresses* is found to be listed in these four letters, although certain of the colours are absent, for example the Prussian blue and red lead. Only the smallest amount of red lake is used. The full analytical study [4] of the Van Gogh *Self-Portrait* made at the Fogg Art Museum is interesting since it includes the results of pigment identification for several other Arles period pictures. The pigments which were used most regularly seem to be the whites of zinc and lead, emerald green, vermilion, and chrome yellow in the form of lead chromate; these must form the core of Van Gogh's palette in the late 1880s.

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15. Staniforth, S., 'Retouching and Colour Matching: The Restorer and Metamerism', *Studies in Conservation*, **30**, 3 (1985), p.104.
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18. Kühn, H., 'Chrome Yellow and other Chromate Pigments', *op.cit.*, p.192.
19. *The Complete Letters of Vincent van Gogh, op.cit.*, Vol.III, No.584, p.152.
20. Genuine malachite, green basic copper carbonate, is not usually identified as a nineteenth-century pigment, although it has been noted in a painting by Renoir. See Gettens, R.J. and Fitzhugh, E.W., 'Malachite and Green Verditer', *Studies in Conservation*, **19**, 1 (1974), p.8.

Table 2 Vincent Van Gogh, *A Cornfield, with Cypresses*. Paint medium analysis.

Sample	Drying Oil[a] A/P[b]	P/S[c]	Ceresine[d]	Fatty acids as salts (soaps of palmitic and stearic)	Comments
1. Ground	3.6	3.7	not detected	not detected	Poppyseed oil binder. Some protein present, probably glue size[e] on canvas
2. Golden-yellow of cornfield, right edge	0.2	3.5	present	present	Some drying oil
3. Dark blue of mountain tops, right edge	0.8	2.0	not detected	not examined	Some drying oil
4. White of cloud, right edge	0.3	2.6	present	not examined	No protein detected, hence no egg (fats) present. Some drying oil
5. Red impasto, right edge	0.1	3.3	trace	substantial	Soft, plastic impasto, vulnerable to action of water[f,g]. Some drying oil
6. Green of bushes, left edge	0.6	2.8	not detected	not examined	Some drying oil
7. Pale yellow of distant cornfield, left edge	0.2	1.3	not detected	not examined	Some drying oil, no protein present[e]

Notes

a. Saponification, acidification and methylation of resulting fatty acids, see p.92.

b. Azelate to palmitate ratio; for significance see text.

c. Palmitate to stearate ratio.

d. GC analysis of benzene solubles or by presence of hydrocarbon peaks (base peak m/z 57) in saponified, acidified and methylated ether extract [4,5].

e. Ninhydrin test on hydrolysed fragment.

f. The presence of substantial fatty acid soaps would account for this.

g. A methanol extract of a fragment showed negligible free fatty acids. Benzene solubles of the acid-treated sample, after methylation showed A/P ≈ 0, P/S $= 1.95$.

The medium

Raymond White

It is clear from the values of the ratios for methyl azelate to palmitate and methyl palmitate to stearate, that the ground has a binder based on pure poppyseed oil. There can be little doubt that the protein present originated from glue size on the canvas, since it was impossible to obtain a sample of ground without some fibres from the support being included. A survey of the A/P ratios in Table 2, reveals a wide range of values. Where A/P ratio of much above 1.0 is recorded, one can have complete confidence that pure drying oil has been used. Smaller values would suggest incorporation of non-drying fats, such as egg fats and tallow, or non-drying oils. As the A/P ratio decreases, so we may reasonably infer progressively greater dilution of the drying oil by such fats and oils. That such non-drying components do not originate from admixture with egg tempera is demonstrated by the absence of detectable protein in samples of pale yellow and white paints. On balance, the analytical results for the medium of this painting would suggest the use of oil paint supplied by artists' colourmen. The presence of fatty acid soaps and ceresine wax to aid and maintain the dispersion of pigment in the medium in tube colours would seem quite reasonable. As the picture had not been re-lined, there is no question of the wax originating from such a process. Moreover, given the notoriety of zinc white pigment (present in these samples) for causing shrinkage and serious cracking of dried oil paint, the presence of non-drying oils in the mixture would minimize this by acting as a plasticizer. In passing it is worthy of note that there are recipes of the period, incorporating soaps with oil paint to furnish 'flexible paint [....] It is used to paint on canvas' [1]. Certainly Van Gogh, in his correspondence, mentions the slow drying of his paints, only part of which he attributed to zinc white [2]. Non-drying oils incorporated as plasticizers would slow down the drying process somewhat. In the case of *A Cornfield, with Cypresses*, he speaks of the necessity to 'wash it a good many times with plenty of water in order to get the oil out', and 'It will be a year before the study that I am going to send you will be thoroughly dry' [3].

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