

**The Shroud of Turin is one of the most remarkable and mysterious objects in the world. JOHN TYRER CText ATI looks at the evidence for its provenance as a textile.**

## LOOKING AT THE TURIN SHROUD AS A TEXTILE

### History and the Shroud linen

Professor Raes showed that the fibre used in the Shroud was flax. Flax was certainly grown in Mediaeval Europe but Pausinius tells us that 'the flax of Palestine (first century) is a beautiful yellow colour. Galilee is the centre of production - in a city called "Arbeel" '. Dam retting was apparently used. Raes has also identified occasional cotton fibres spun into the yarns as *Gossypium Herbaceum*. Cotton was not grown in Europe so this places the Shroud as a Mid-eastern product. No animal hairs have been found in the Shroud, which would satisfy the Laws of Moses that wool and linen must not be mixed. It could be used by a Jew, so the fibre analysis therefore provides no difficulties to challenge the authenticity of the Shroud.

The point has been made that the regularity of the yarns in the Shroud is such as to indicate a later date than the first century for its production. So far as I can judge from photographs, they appear to be quite even and regular, but this could not be regarded as evidence that the Shroud could not be first century. The yarns of many of the Ancient Egyptian textiles in Manchester and Halifax Museums are perhaps even more regular than those of the Shroud. The regularity of a yarn is dependent upon the length of the fibres used to spin it, the effectiveness of the preparatory processes which align the fibres, and the evenness of the drawing and twisting. The knowledge and skill of the spinner is of prime importance. Regular yarns, ancient or modern, cost time and skill, and there is no doubt that the hand-spinners of flax yarns in the ancient world were more than a match for their mediaeval or modern counterparts.

It has been pointed out that the Ancient Egyptians spun their yarns with the spindle running anticlockwise to give 'S' twist, the direction in which the flax fibre turns when wetted. Since the Shroud yarns are 'Z' twist, the placing of the linen in the first century has been doubted.

The Egyptians had certainly developed a flax plant with a fibre fineness equivalent to the best grown modernly. This is demonstrated by exhibits at the Halifax Museum. There are some remarkably finely sett linen fabrics in both Manchester and Halifax Museums. One cloth from the Tarkan dynasty (3600 BC) has 140 warp and 50 weft threads per inch. Having examined over a hundred grave cloths in these museums, I have little doubt that the Egyptians favoured 'S' twist yarns and plain weaves.

Even the famous 'Girdle of Rameses' in

The Shroud of Turin is a piece of linen approximately 4.36 metres long by 1.1 metres wide, woven 3/1 herringbone reversing twill, that is believed by many to be the burial cloth that was used to enclose the body of Jesus Christ after the Crucifixion. It carries a number of patches and evidence of burns that it suffered in a fire at the convent at Chambery where it was being kept in 1532. There are also tide markings and stains caused by the water used to douse the charring. Of most interest, however, are faint darkish markings that make up the front and rear image of a naked man and which give the immediate impression that a human body has left the imprint of itself upon the cloth. The body appears to have been laid upon its back upon one half of the cloth which was then drawn over the head and laid upon the front of the figure.

The Shroud first appeared in history about 1350 in the possession of the family of the local knight at Lirey in France who had been killed fighting the English. The secret of how he obtained the Shroud died with him, and firm historical evidence connecting the Shroud to first-century Palestine is lacking, although an interesting case has been made out by the historian Ian Wilson. Dr Frei, the Zurich criminologist, says he has found pollen grains on the Shroud that originate from plants grown in the Middle East and around Jerusalem.

When Secondo Pia, the first man to photograph the Shroud in 1898, developed his plates, he was amazed to find that in the reversal of light and dark, a positive image of remarkable refinement appeared. The same has occurred with the thousands of photographs taken since.

Medical doctors who have studied the photographs have concluded that the man in the Shroud had been beaten about the face, flogged with a weighted scourge that produced marks similar to those made by a Roman flagrum, and had some kind of spiked cap forced upon his head. Bruise marks showed that he had carried a heavy weight across his shoulders, had been crucified through the wrists and feet, and pierced through the side by a sharp instrument. Experiments with corpses showed that nails through the palms, as illustrated by religious art, would tear through the flesh and not support the body weight.

Nails driven through the group of wrist bones and the feet would support the victim, who would then have to pull and push against them to breathe. Death would be hastened if the legs were broken, or by an appropriate spear thrust.

The parallel between this description and the New Testament account of the death of Jesus Christ is so close that if the linen of the Shroud can be shown to be first century, then claims made for it must be taken seriously. If the cloth is a fourteenth-century product, then the image must be an artefact but still one of the most remarkable religious works of art.

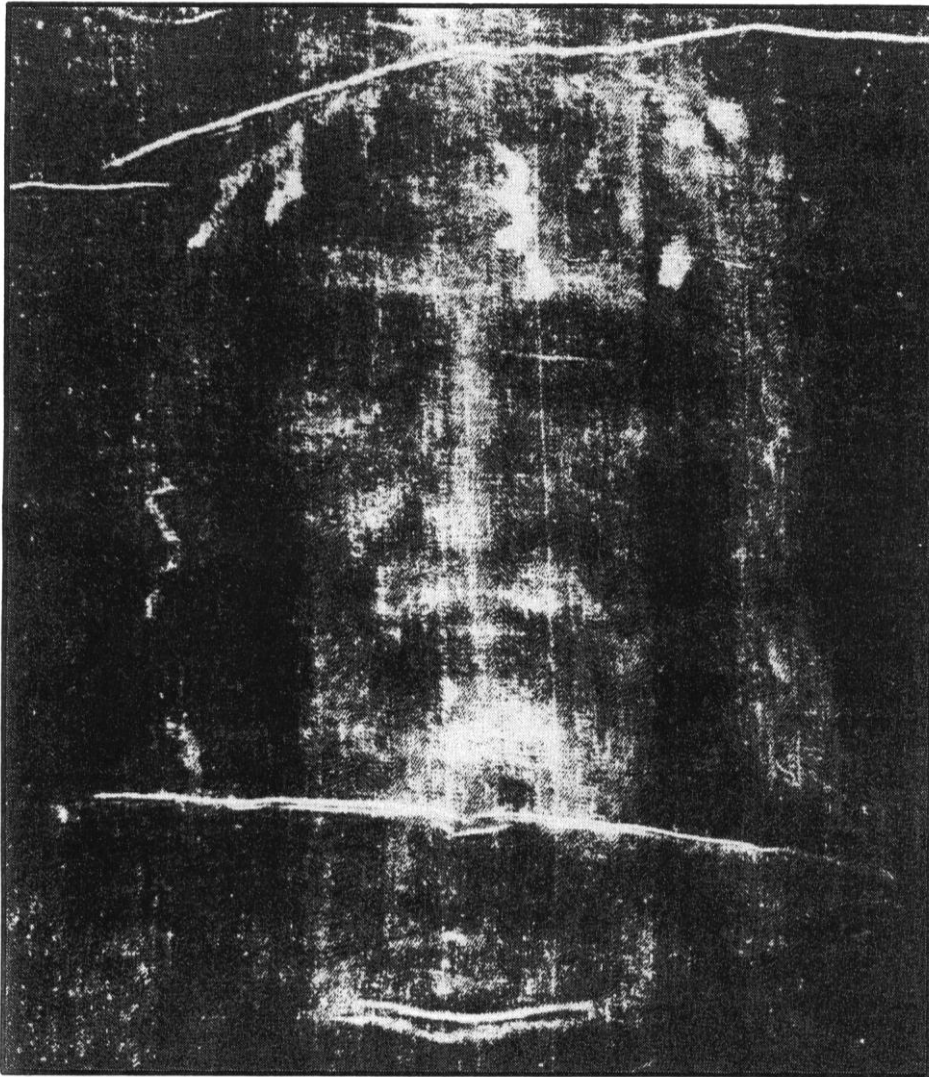
Thorough objective examination of the Shroud is complicated by the fact that it is only rarely removed from its safekeeping. Moreover, the emotions aroused by it can run high, while the sensationalism of the media help to polarize the issues into simplistic slogans which unnervingly many investigators.

Any tests that have been made have had to be non-destructive, although a fragment was analysed by Professor Raes, the Belgian textile expert, in 1973, and surface fibres have been removed together with dust using special adhesive tape.

In October 1978, a team of American and Italian scientists carried out a non-destructive examination of the Shroud using optical and infra-red spectroscopy, thermography and X-ray fluorescence measurements and spectrophotometric techniques. Surface fibres removed from different parts of the Shroud have also been examined using optical and electron microscopes. The results published so far have failed to be in agreement, and the way in which the Shroud image was formed is still a matter of controversy.

Much would be resolved if the linen could be dated. However, a radiocarbon-dating test has so far been refused by the Turin authorities responsible for the Shroud, because the handkerchief-sized samples required would be too damaging. By the spring of 1982 the new Radiocarbon Accelerator operated by a team at Oxford University should be ready to work on a fragment of cloth less than the size of a finger nail, and they have already asked for a sample.

Whichever way the dating goes, what the Shroud is as a textile still needs to be clarified, and it was in that spirit that the present notes were compiled.



*The head of a man as appears on the Shroud of Turin.*

Liverpool Museum, with its many colours and shaping and narrowing by dropping warp ends, has only 'S' twist yarns, and a plain lift weave.

However, in *Studies in Ancient Technology: Vol-IV.*, R J Forbes maintains that the high development of spinning and weaving techniques at the dawn of history points to an origin for the production of linen textiles further north. It is known that Neolithic lakedwellers in Switzerland had similar production methods to the Egyptians. There has also been reference to a knowledge of twill weaves by these people.

There is a working model loom exhibited in Norwich Castle Museum, the design of which is based upon archaeological finds that date from the late Bronze Age. It has three healds and has successfully woven twill-based patterns.

Woollen textiles with reversing twill weaves and 'Z' twist yarns have also been found in Northern Europe dating back to the late Bronze Age. They are much coarser sett than the Shroud linen, but a cloak found at Gerumsberg is woven

2/2 herringbone twill with a 'Z' twist warp. The cloak has been shaped like the Rameses Girdle by dropping warp ends and was woven without seam. Here is an interesting link with the New Testament (John 19, v.23). This technique of weaving had clearly reached Palestine by the time of Christ.

It is known that looms with four healds had been developed in China that were capable of producing complex twill weaves before 120 BC. A fragment of a silk shroud from a child's coffin from the Roman period has been found at Holborough in Kent, which has a reversing five-shaft satin weave. The silk trade with China would very likely have passed through Syria.

It seems very doubtful, therefore, that the Turin Shroud was an Ancient Egyptian product but, mindful of the ferment of ideas that was taking place at the advent of the Christian era, and taking into account the high technology in the surrounding Ancient World, it would be reasonable to conclude that linen textiles with 'Z' twist yarns and woven 3/1 reversing twill similar to the Turin Shroud

could have been produced in first-century Syria or Palestine. They were, after all, at the crossroads of world trade routes where cultural ideas would have been mixing for centuries.

Turning from the Ancient World to Mediaeval Europe, although it appears that linen textiles similar to the Shroud have not survived in any number from the early 14th century, flax-was grown and spun, and looms with multiple healds operated by foot pedals were in use. One is shown in a painting by Pinturicchio in the National Gallerv in London.

## Decay effects in the Shroud linen

There would appear to be no reason why the Shroud linen could not have survived from the first century. Much older linen fabrics are available, for example, Tutankhamun's curtains.

Flax fibres are not attacked by moth grubs, which require keratin to feed on, and other insects tend to avoid flax if they can because of its hardness.

When boiled or bleached, flax has a high resistance to bacteriological attack. Under certain conditions of warmth, dampness and contamination, micro-organisms may attack cellulose, notably cotton, but flax fibres will resist damage well if kept dry. The most important factor in the preservation from decay would seem to be the purity of the fibre and the effectiveness of the bleach. Contaminants remaining from the plant would be more likely to be breeding grounds for bacteria than preservatives.

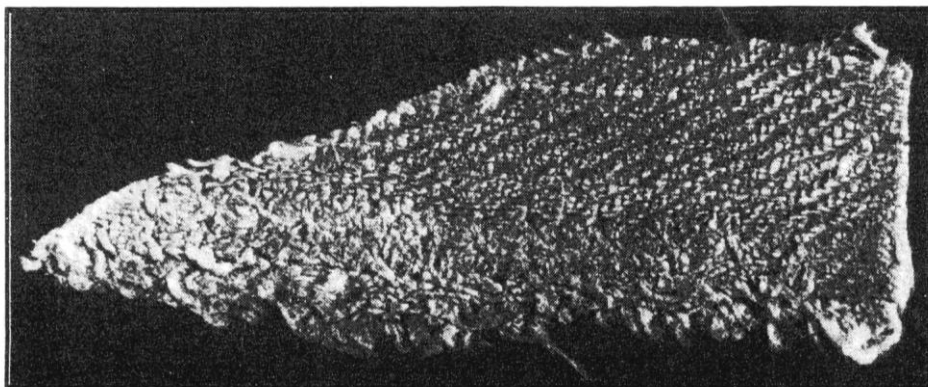
It has been conjectured that the Shroud may have been washed since it was first used. The water stains from the Chambery fire indicate that it has not been washed since 1532. Earlier washing would have removed most of the blood and other contaminants such as faeces which would have been breeding grounds for bacteria. But, if so, what is it that we see as 'blood' stains? The fire at Chambery would also have sterilized the Shroud and helped with its preservation.

## The 'herringbone' weave of the Shroud

From a close study of photographs, it would appear that where the opposing lines of the 3/1 twill meet the reversal is a true mirror image, whereas in others, the twill drops out of true correspondence to give a herringbone effect. These changes may be faults in the weave because of incorrect drawing-in through the healds which could suggest a primitive loom. In fact a study of the spinning and weaving defects in the Shroud might throw light on the method of production.

No more than four healds would be required to weave the linen and, even though the image appears upon the long, warp floats on the 3/1 face, the cloth would almost certainly have been woven back-up as a 1/3 lift to reduce strain upon the warp

# The Turin Shroud



Fragment of the Shroud removed for study by Prof Raes (approx 3× actual size).

and reduce thread breaks. The Shroud might therefore have been a less formidable task for a handloom weaver than may be thought at first sight.

The question could be asked: 'Why bother with a reversing twill weave at all; why not a cheaper plain woven cloth?' A reversing twill weave to some extent resembles the pleated linen skirts worn in Ancient Egypt, and such fabrics may have been developed partly for this reason. Certainly cloths with reversing twill weaves are less likely to curl than plain weaves and they drape and shed soiling and creases better. It may be, therefore, that the Shroud linen was originally intended as an expensive apparel fabric that was hastily pressed into service for funerary purposes (Luke 23, v.53). On the other hand, the smooth surface of a twill would probably be an ideal base upon which a forger could paint.

Another interesting feature is the presence of numerous dark (pale in the photographic negative) warp threads that run for some distance through the Shroud and cross from image to non-image areas. A good example runs through one eye. Their appearance would indicate that even though the cloth was piece bleached, the yarns must also have been at least part bleached before weaving, probably in hank form. Moreover, the difference in shade between adjacent individual yarns appears to be as great as between image and non-image areas of the cloth. This must complicate comparative radiation reflectance measurements. Perhaps a closer study of these yarns might help in the investigation of the image-forming process, since they seem to vary in shade as they cross from image to nonimage areas.

## The textile analysis of the Shroud linen and edging strip

Photographs of the Shroud and descriptions in the literature indicate that there is a narrow strip of material along the whole length of the one of the long sides that is divided from the main area by a seam-like thickening. It differs from other patches in the Shroud in that it is similar in tone and hue to

the main area and just what is involved is by no means clear.

Professor Raes has given different textile constructional particulars for what he describes as 'Piece I', the main Shroud, and 'Piece II'. He also gives some details of the sewing thread that he found joining these pieces together. It has been assumed that 'Piece II' is part of the edging strip which was therefore stitched to the main body. It has also been conjectured that the addition was made to centre the image better.

### Raes results

(as published by Ian Wilson in 'the Turin Shroud')

		Piece I	Piece II
Threads cm	Warp	38.6	—
	Weft	25.7	25.7
Linear density (count) of the yarn (tex)	Warp	16.3	18
	Weft	53.6	73.1
Direction of twist	Warp	Z	Z
	Weft	Z	Z

Raes also describes the sample he obtained as carrying a selvedge. The photograph of Raes' triangular sample does show a narrow warpway band of different structure on the longest side. The ends of the weft yarns protrude at this edge and appear to have been cut through.

It appears, however, that a lady (seamstress) observer at the American tests in 1978 was of the opinion that the weft threads in the main area of the Shroud were continuous across the so-called seam into the edging strip. I have concurrence of this opinion from Vernon D Miller of the Shroud of Turin Research Project (STURP). This is important for it would indicate that the 'seam' is some kind of anomaly in the fabric structure and not a join. Nevertheless, Raes was clearly dealing with a seam and its sewing thread and with fabrics of different quality particulars on either side. If, however, one examines large photographs of the Shroud, the place where Raes' sample was taken can be seen

between the main area of the Shroud and a rectangular patch. (This is close to the lower right foot of the frontal image.) This patch is below the 'edging strip' and appears in photographs as different in tone and hue to the main area. There is therefore some doubt as to whether the sample described by Professor Raes as 'Piece II' is the edging strip or part of a patch.

It is important that this matter be resolved if it is intended that the forthcoming carbon dating tests are to be made on Raes' sample. The patch is probably mediaeval.

But why such an anomaly in the Shroud linen? Is the so-called seam really a 'cord' of warp threads woven into the cloth? Is it perhaps a handloom weaver's aid to finding the shed when using a very primitive shuttle? We may be looking at evidence about the production method which is historically important.

## The absorbency and draping properties of the Shroud

It is a fact of textile technology that the performance properties of a fabric are associated with the quality particulars of the cloth structure. Hence any experiments that are made in an attempt to replicate, for example, the absorbency and draping effects that might be seen in the Shroud must be carried out upon linen fabrics woven from similar yarns in the same construction and in the same state of finish.

So far as the Shroud is concerned, the comparatively closely sett structure of the linen may not be immediately absorbent of water let alone the more viscous liquids draining from a corpse. The water stains from the Chambery fire do not suggest a high rate of absorbency for they do not seem to have penetrated far and there are tidemarks where absorbency ceased. Similarly, flax is not as easy to dye as other cellulosic fibres and this would have complicated the problems of a forger, and would suggest the use of pigments rather than dyes. An interesting question that cannot be answered by the study of photographs is whether the image varies at all as it passes around crease marks like the one under the chin of the image. The answer may be relevant to the image-forming process.

In considering the possibility that the Shroud image is a contact print, either from a corpse or a sculpted form, the draping properties of the fabric would be important. Because of the fabric structure, the linen may be stiffer warpway than weftway and therefore drape more easily across the figure. The Shroud photographs appear to suggest that the material has supported itself stiffly across the hollows between chin, chest, abdomen, hands and knees, but that there was more tendency for it to hang widthway into hollows. It would be a remarkable achievement for a painter to anticipate such draping in a negative image.

The development of contact images as defects in

textiles that may not be evident when first formed has been investigated by Best-Gordon, where uneven distribution of urea-formaldehyde resins and variations in effective polymerization were involved, and he has drawn attention to the Shroud image from that point of view.

The arguments against the Shroud image being a contact print are that it would suffer lateral distortion due to the fabric draping around the sides and that the imprint would only be in two tones, like a brass rubbing. There is no lateral distortion in the Shroud image and it has remarkable gradations and subtleties in shade. It has to be remembered that in 1350 it would still be at least a generation before the introduction of printing, woodcuts and engravings into Europe.

## The formation of the Shroud image

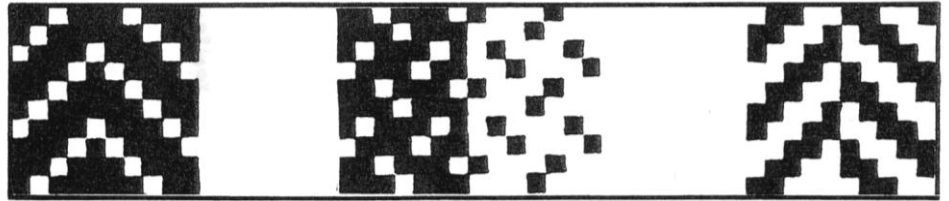
The examination of the Shroud in 1978 convinced all the observers that the image was an effect only present on the outermost flax fibres of the yarns that formed the cloth surface. The 'blood' stains, however, penetrated the interstices of the weave. There therefore appear to be at least two different effects involved. The body image is apparently creamy/sepia in colour whereas the 'bloodstains' show up red, even carmine. Human blood dries brown and even black in only a few days, whereas the Shroud is known to be at least 600 years old.

Dr Walter McCrone, an expert American microscopist and microchemist, claims that he has found pigments adhering to the fibres in the image. He is convinced the image is a painting, done in negative by an artist using his finger to avoid brush marks. He says that an iron oxide suspension in tempera was used, and that there are carmine and other red colourings in the 'blood' stains.

The American STURP team, however, say that the image is not a painting, the 'blood' stains do have the character of human blood, and there is evidence of a deposit of human skin oil. The reflectance spectra of the body image are similar to the scorch areas of the 1532 fire. The Americans and other scientific observers are unconvinced by McCrone's evidence and explanation. Indeed, an iron oxide tempera suspension as weak as that McCrone says was used to make the faint image would be very difficult to manipulate, even if an artist was painting a positive image.

It has also been pointed out that the Shroud could very well have been 'retouched' during its long career of public exhibitions. It has certainly been in artists' studios during its history when it was being copied. It even (incredibly) seems to have had the attention of Italian television make-up people when it was shown on the European network in 1973. Dr McCrone does not appear to have dated the pigments he has found.

A view that was put forward by Vignon and Delage at the turn of the century, and which has since been presented in modified forms, is that the



Left: Turin Shroud 3/1 reversing twill (linen); Centre: Holborough Shroud 3/1 and 1/3 damask (silk); Right: Gerumsberg 2/2 twill broken to reverse (wool).

image is a 'vaporograph' produced by ammonia and other gases from a corpse acting upon oils, myrrh and aloes on the linen. It has also been argued that Jesus was still alive when placed in the tomb and that, as He revived, His body heat contributed to the natural chemical action. The difficulty here is that images formed by vapours and warmth are diffuse and lack the clarity of the Shroud image.

Attention has also been drawn to the images that can be produced by certain plants upon the cellulose of the paper between which they have been sandwiched for botanical collection. These effects do bear some resemblance to the clarity of the Shroud but the plant images take several decades to develop.

The most surprising idea to which the Americans and Italian scientific workers keep returning is that the Shroud image must be some kind of 'photograph' produced by the body itself upon the linen, this being the explanation which most satisfactorily accords with the subtlety and

clarity of the image and with all their findings.

But how? By the emission of some kind of radiation from the body? An energy-heatscorch has been discarded as too violent.

A 'Geller' effect? Perhaps the stepping up of the normal human electromagnetic field? From the textile point of view, it is known that cellulosic fibres can be chemically modified by corona discharge. At this point speculation really takes off, and the sceptic looks for refuge in Dr McCrone's ideas of an incredibly knowledgeable Leonardo da Vinci a hundred years before his time!

Yet, whatever the verdict of the now inevitable carbon-dating of the Turin Shroud, so much is known about it now that this particular textile technologist has to acknowledge it as probably the most remarkable 'Standard Sample' for the interpretation of the history of textiles that has come down to us. No Christian would expect it to be otherwise.

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