

## Shroud of Turin



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### I. The Birth of the *Problem*

Between the 25th and the 28th of May 1898, the lawyer Secondo Pia took the first photographs of the Shroud kept as a relic in the cathedral of the city of Turin. At the time, the linen was exposed to the public to celebrate the anniversary of the marriage of Vittorio Emanuele (III) of Savoy with Elena of Montenegro. When developing the plates, Pia noticed that in the photographic negative in front of him, was clearly visible a positive image, whilst the signs present on the original shroud and on its positive image turned out to be like a photographic negative of reality (thus inverting the lighter and darker shades of the image).

The discovery provoked very strong emotions. Suddenly the features of the suffering man of the Shroud became ever more recognizable and familiar, above all those of the face. This gave origin to a surge of varied initiatives in the field of scientific research that were never again interrupted. A new atypical discipline called “shroudology” was then born, which was to gather together all scientists interested in the study of this ancient linen.

The new perspectives of scientific research provoked a new awareness of the religious relationship that links the believer to the sheet of the Shroud and to the image impressed upon it, increasing both the enthusiasm and the questioning of the possibility that it could actually be the image of Jesus of Nazareth. At the same time, lively discussions began regarding the so-called “authenticity” of the Shroud, centered

on two problems: a) whether the sheet originated from the outset of the Christian era (a problem of dating) and b) whether the image on the Shroud had been produced by the contact between the sheet and the lifeless body of Jesus after his removal from the cross (the problem of the image's origin).

No ancient discovery concerning Christian origins has ever provoked such interest, because a unique mark is present in the object, one that draws us closer in a very unique way to the "marked" person. Questions instantly arise: is this the sheet that actually touched the body of Jesus of Nazareth after he was taken down from the cross? Does the image that it presents truly reproduce the features of the man so important for Christian life? To be able to respond to these questions is something that appeals to the minds and hearts of every person. The point is to clarify if only a positive answer to that question would legitimize a religious relationship between the believer and this peculiar linen sheet with its image (see below, VII).

The climate in which the discussions and research developed was very animated from the beginning. It witnessed a heightened sensitivity in 1988, when the analysis of the component of C<sup>14</sup> (a radioactive carbon isotope) present in the Shroud's fabric was carried out. The result of this analysis dated the origin of the Shroud's cloth to between 1260 and 1390 (see below, V.1). The controversial tendencies in the discussions gave witness to extreme positions: one side stated that the verdict was definitive and thus one had to consider as sanctioned the illegitimacy of a religious relationship between the believer and the Shroud; the other side referred to the unreliability of the result (frequently claiming that it had been reached using improper procedures), thus defending the "authenticity" of the discovery of the Shroud and the legitimacy of the religious relationship with it.

First of all a correct position concerning the problem needs to be given. The problem arises from, or more precisely it is sharpened by, a scientific announcement, that is the existence of a negative image and its dating. But where exactly does the problem of the science-faith relationship with respect to the Shroud lie? What can or must faith expect from science and what conditions does science impose on faith? First of all one must clarify in which category of religious reality the Shroud is placed: is the image referenced to a fact? Is it the relic of the removal of Jesus from the cross and of his burial (for some also of his resurrection)? An affirmative reply must undoubtedly be given to the first question, since scientific procedures have stated that the image looks not handmade, but linked to a true human corpse; the reply to the second question is categorized as one of possibility. Once again one must ask: what then are the consequences that a specific answer to the preceding questions could have on the relationship of that reality with faith? Where does it put the relationship with faith? Certainly it puts it at the level of the truthfulness of the sign; perhaps also at the level of authenticity of the relic? And therefore, in which way does this act positively in favor of the process which leads to faith?

Where does it place the level of significance? Is it in the expressiveness of the image; or also in the materiality of the relationship with the body of Jesus? Why is the religious emotion stronger when facing the awareness of a "physical" contact: why is the density of memory greater? Does it need that "density" to justify the pastoral proposal of devotion or solemn cult toward the Shroud? Is the sign of the Shroud "truer" if the cloth is certain to have touched the body of Jesus? Does the potential absence of such "density" of meaning constitute only a negative aspect because of the situation of uncertainty that derives from it?

The reply to these huge problems requires a complex journey of research. Its articulation constitutes the summary of our exploration: a) we begin from the reading of the Shroud's reality; b) we compare the finding with the data about the passion and burial of Jesus as reported by the [Gospels](#) [2]; c) we propose a description of the steps (certain, probable, possible) of the journey that the Shroud has completed before

to reaching us; d) to look at the research of the scientists, mathematicians and at the experiments carried out on the Shroud. In conclusion, this enables us to do two things: e) to formulate a judgement on the level of knowledge regarding the reality of the Shroud; f) to offer a religious evaluation of the state of things, with a reply to the questions above.

## II. The Linen Sheet known as the “Shroud of Turin”

The Shroud of Turin is an ancient linen sheet, of good fabric, of a herringbone structure, around 4.36 meters long (a little bit more when it is stretched) and around 110 centimeters wide. The front and back images of a man are visible on the cover of the sheet, a man who died from the tortures of crucifixion (in the traditional position the frontal part is to the left, the back to the right). The image is not visible on the back of the sheet. On the cover the image is caused by darkening (due to oxidization and dehydration) of the surface fibers of the stretched threads of the fabric; an independent color (carmine) and by contrast they have only the bloodstains, scattered a bit everywhere over the body. The blood has penetrated the barrier of the sheet and is clearly visible on the reverse. After the intervening controversy in the 1980's between W. McCrone and the chemists J.H. Heller and A. Adler, and the studies undertaken by these last two and by P. Baima Bollone, today one can no longer doubt the reality of the bloodstains (cf. Baima Bollone and Adler, in Barberis and Zaccone, 1998); the analysis, moreover, identified the blood group as AB (cf. Baima Bollone, 1998, pp. 175-178).

There can be no doubt that the man represented in the image of the shroud is dead. We have several indications of that. The cadaverous rigidity, evident in the position of the head, as it does not lean backwards on the sheet, but, rather, is inclined slightly forwards; the reclined position of the left foot (for those looking at him, and therefore the right foot of the person crucified), that, after the nails were removed from the cross, has not returned completely parallel to the other, and instead was taut; the stiffness of the limb muscles that touch the floor of the tomb and that have lost the elasticity of life without having taken on the softness of the corpse which begins to decompose. It shows moreover the “cadaverous” blood that gushes from the wound in the chest (because of the hemolysis of the blood) and, in the whole, “the existence of a damaging complex of gravity the result being incompatible with life” (Baima Bollone, 2000b, p. 185).

The causes of death are characterized by the torture suffered by the man and visible in the image, particularly the marks of nails in the hands and feet. In addition to these signs, which point directly and unequivocally to crucifixion, the shroud preserves the memory of many other tortures: the face is swollen and covered by a veil of blood (which was also revealed by the electronic scanning of the reverse of the Shroud's cloth, where images are not visible, while every presence of blood is revealed); it shows swellings, a probable fracture of the nasal septum and a split lip; the hair falls rigidly to the side of the face because of the clotted blood and the beard is also rigid; the forehead is furrowed by a stream of blood, that stops at the eyebrow and, coming over the wrinkles, assumes the figure of an upside down “3” or of a Greek *epsilon* (?). Also on the head, the hairs are soaked in blood and one can detect the presence of a multiplicity of small wounds that have damaged the scalp and have caused widespread haemorrhaging, that flows to the nape of the neck (a place of high hematic density). On the posterior part of the body (back and legs) numerous indications of strokes probably produced by a whip (the presence of it also on the anterior part shows the winding effect impressed by ropes or leather straps) are particularly visible. Again on the posterior part, at shoulder height, two dark stains are noticeable, probably from the rubbing of the trunk of the body over the cross, the *patibulum* (gibbet), as it was carried by the condemned man (except that which deals with “cadaverous bruising,” cf. Zacà, in Baima Bollone, 2000b, p. 178). On the front part of the human figure, in the fifth intercostal position, a large wound is present (4.5 x 1.5 cm)

from which that cadaverous blood came, the blood that during the transport of the body has formed a belt across the back. Returning to the wrist wounds, from the left (the only one discovered, as the other is hidden under the left hand) a double flow of blood can be seen, due to the diverse positions assumed on the cross of the condemned man in the effort of making inhalation from the thorax possible. The man of the Shroud thus died from the torture of crucifixion. What it is more difficult to say, is who this man was.

### **III. The Information displayed by the Linen and the Information given by the Gospels about the Crucifixion and the Burial of Jesus of Nazareth**

The Shroud owes its name and its interest to the Gospels; nevertheless one has the impression that, of all the sciences that are involved with the Shroud, biblical exegesis has the least to say about it. It is very clear that the Gospels are not able to give an indication that will lead us to conclude that the sheet conserved at Turin is 2000 years old and covered the body of Jesus Christ. Nevertheless, when looking at the Shroud one cannot also avoid looking at the Gospels. The fact that for centuries multitudes of the faithful have instinctively connected what they have observed on the sheet with what the Gospels narrate of the Passion of Jesus, can only provoke the scientist's curiosity. Other secular remnants have in themselves a very weak symbolism and arouse interest almost exclusively because of a long tradition of popular devotion to them. The Shroud, on the other hand, has an original message of its own, provoking a religious sentiment that transcends the sheet, and becomes a living relationship with Him to whom the sheet seems to refer.

The image of the Shroud is a "story," whoever reads it discovers the truth of an event and also manages to follow its development. The fact that another story exists, this time a literary one, that narrates an analogous event—and analogous in a unique way—the protagonist of which we know as well as the facts that preceded his death, obliges the researcher to perform a first check. Biblical exegesis is competent on this second story. It is responsible for clarifying all of that which corresponds and that which is incompatible within the two "stories". By reading the Gospels, can we consider—with grounds for truth—the hypothesis that the actual "Turin Shroud" corresponds to the funeral sheet that wrapped the body of Jesus? Or is such a correspondence incompatible with the data recorded by the Scriptures?

The setting for the Gospel story regarding the Shroud is that of the Passion and burial of Jesus of Nazareth (cf. *Mk* chs. 26-27; *Lk* chs. 22-23; *Jn* chs. 18-19) and of the discovery of the empty tomb (cf. *Jn* 20:3-10; *Lk* 24:12) (cf. Ghiberti, 1982). The verification of the possible convergences can begin with the very name given to the linen sheet. The "find" preserved at Turin has more than one, according to language: *Turin Shroud* or also *Holy Shroud*, *Sindone de Torino*, *Linceul de Turin* or *Saint Suaire*, *Sábana Santa*, *Heiliges Gratuch* or *Turiner Grabtuch*. The Latin name that has accompanied the presence in the West of this sheet is that of *Sacrosancta Sindon Domini Nostri Jesu Christi*, from which the Italian "Sindone" is derived. This is a technical term, because it is not usually applied to other sheets or covers.

This term is one of those present in the three synoptic Gospels (Mt, Mk and Lk) to indicate the sheet (or a sheet) used for the burial of Jesus. Exegesis looks to see whether originally the name indicated the Shroud that we know. The answer could be given only if one keeps in mind both the semantic potentiality of the term and the verbs that indicate the use made of this cloth. The semantic spectrum of the Greek *sindón* leads us to a cloth or sheet that could be found in an unbleached state or already prepared for a specific use (for example, as a tunic, that could be used for burial purposes). The possibilities of meaning are therefore wide and leave open the questions on the forms, on the type of material (most likely linen) and on its size, because the documentation of the use is numerous and imprecise. It is in a *sindón* that the body of Jesus is wrapped. "Wrap" could also be understood as placing the cloth that lies under the corpse

over the front part of the body, making it turn behind the head, just as was thought happened with the sheet of Turin. Certainly, if the Shroud of Turin did not exist, we would perhaps not be drawn instinctively to interpret the verb “to wrap” in this sense, but it is important that such a meaning is not excluded by the semantic capacity of the term.

In the Gospel according to John (cf. *Jn* 19:38-42, to be completed with vv. 20:3-10) the details are provided, but they are not easily reconcilable with those of the synoptic Gospels. It no longer speaks of the “Shroud”, instead it refers to a “cloth” (Gr. *othónia*) and then a “towel” (Gr. *soudáron*), while in the case of the burial of Lazarus (cf. *Jn* 11:38-44) it speaks, more than that of a towel, also of “burial bands” (Gr. *keiríai*). These bands or strips (that were not used for the burial of Jesus) served to firmly bind the hands and the feet, so that during the journey towards the sepulcher the limbs of the body would not come away, given that the body is buried a short time after [death](#) [3] (and therefore would not have totally succumbed to cadaverous rigidity). The “cloths” are indicated in the plural and are therefore this is a sign that more than one of them was seen, whilst the “towel” (that of Lazarus “covered” the face: cf. *Jn* 11:44) for Jesus “had covered his head” (cf. *Jn* 20:7). Now, the Shroud of Turin is the a single cloth and, moreover, does not suggest the presence of a towel over the head, given that the intensity of the Shroud’s image is homogeneous on all of the body’s surface, with no less intensity on the face. A possible suggestion comes from the way in which the cloths appeared to those who found them “lying” in the tomb: if Jesus would have been wrapped (in reality John says “rolled”) in the way that is foreseen in the Shroud, then after the [resurrection](#) [4] the visitor would have seen the cloth in its upper and lower parts, as an apparent plurality. The towel could also have been folded, or rolled, and used around the face under the chin, and so it would not have been interposed between the face and the Shroud.

It holds true that in the synoptic Gospels and in John there are elements to favor a certain wrapping of the body of Jesus for the burial, though it is not easy to imagine in concrete terms how it was carried out. This excludes the possibility that the *sindón* can be considered a death tunic, because it would not be practical to speak of wrapping in a tunic (the unexpected circumstances of the death of Jesus and the haste in placing the body also make the recourse to a tunic improbable); instead two possibilities remain: either the body was placed in a large cloth, and upon this were gathered the items of cloth (which were then fixed with bindings), or it was placed on the lower half of the cloth (long and stretched), that was then wrapped behind the head and then brought down to the front part (this is the way suggested by the vision of the image on the shroud). On the basis of John’s data we can neither negate nor affirm the addition of some item of fabric omitted by the synoptic Gospels: we cannot exclude the possibility that for transporting the body on the brief journey to the sepulcher something analogous to the bindings or *keiríai* were used to keep the feet and hands together. One could conclude that the use of the expression “wrap in a shroud” could also be used to explain that which we see today in the shroud sheet: a cloth of that form, used in that way.

Due to the particularities of the tortures suffered by the two protagonists of the two stories, Jesus of Nazareth and the man of the Shroud, the consistencies between them are quite suggestive. There is an exceptional coincidence between the tortures described in the Gospels and those visible on the image of the Shroud: the crown of thorns, facial harassment, flagellation, nailing of hands and feet, wound on the side. Some of these features are not so usual in the old descriptions —generally quite sparing of details— of crucifixions (i.e. the crowning with thorns, the spear that pierced the man after his death): to find them both in the Gospel and on the Shroud is a clear indication of correlation between the two “stories.” The most natural explanation of the presence of such features, suggests that they came about from the contact between the shroud and the body of Jesus once he was taken down from the cross; were it not Jesus, it would then be normal to ask ourselves whether those tortures were inflicted on a different person in exactly the same way. This remains, however, a gratuitous conjecture.



There are some difficulties though in admitting the compatibility between the Shroud and the Gospels (cf. Ghiberti, in Scannerini and Savarino, 2000, pp. 273-284). First of all the image on the shroud seems to be the outcome of an almost perfectly perpendicular projection. The differences in the intensity of the colors seem only to be a consequence of the distance between the different points of the body from the shroud, and not due to the presence of other kind of linen cloths. Is all that compatible with the verbs used by the Gospels? Concerning the “plurality” of the cloths and the towel “over his head”, a probable answer has already been given above. Regarding the verbs which indicate the wrapping of the corpse (Gr. *entylíso*, *eneiléo*, *déo*) it is not clear whether or not they mean a kind of wrapping which includes all parts of the body. The procedure with which the ointments were used (Gr. *arómata*, *myron*, *smyrna*, *alóe*) is perhaps less important for our research. Besides, the grave (gr. *mnemeíon*, *mnêma*, *táphos*) does not represent a problem. Maybe a “trough grave” (hollow in the shape of a bath) could better explain the orthogonal projection on a new shroud, stretched and kept in a half-rigid position on the corpse.

We still do not know precisely how the Jews of Jesus’ time used to prepare the corpse before the burial (Gr. *entaphiázei*, in *Jn* 19:40). We presume that in such a big occasion as the *parasceve* of that “great sabbath” the rituals of the preparation of the corpse would have been shorter than usual. The fact then that the corpse was that of a sentenced man, implies other possible prescriptions. What interests us is the conclusion of the very probable omission of the washing of the corpse. The man of the Shroud has a beard and long hair; some suggest that he might have had a kind of pony-tail plaît. Does this coincide with the Jewish customs for men’s hair at the time of Jesus? The objections regarding the hair do not seem to be convincing, neither for the “pony-tail” (whose presence is disputable) nor concerning the alleged impossibility of having long hair: it is not to be excluded that Jesus lived at least a period of his life as “Nazirite” (a Jewish vow which included the prohibition of shaving the head); moreover, the prohibition of having long hair cannot be shown as a practised law. Methodologically though, it will be necessary to consider the question of the historiographical intentions of the evangelists when they (or their sources) chose to adopt a specific terminology. It is possible that the narrative intentions of those stories do not include single episodes, especially in John. From all the particularities that we have mentioned here, we can equally reach the conclusion that between the “Shroud” and the pages of the Gospels there is no incompatibility.

## IV. Main Historical Steps of the Path of the Shroud

The most ancient story about the “Shroud” is linked to a very uncertain event: the date of its origin. The report of the analysis of C<sup>14</sup> present in the cloth, made public on the 13th of October 1988, dates it between 1260 and 1390: if it is to be believed, the story of the Shroud coincides with its known European period; if it is not, then it is possible to think of an earlier origin.

In 1353 in Lirey, in the diocese of Troyes in France, a church was completed in honor of the Annunciation of Mary by Geoffroy de Charny, who entrusted the Shroud to the canons of the church itself (cf. Zaccone, 1997). The Shroud soon became an object of veneration and attracted crowds of pilgrims. This fact arouses many controversies that lasted for decades and involved many figures of authority such as Bishop Pierre d’Arcy, King Charles VI and the anti-pope Clement VII. First, accusations were made that the Shroud was a false relic, ending with permission being given for its exhibition, though with some cautions. From that time on, we are able to read the history of the Shroud in an uninterrupted fashion. In 1418 the Shroud was removed from the church of Lirey by the last Charny, Margaret, wife of Humbert de La Roche; in 1453 she handed it over to Louis of Savoy. The Savoyes kept it as a precious relic and always carried it with them wherever they went until 1502 when they placed it in

the chapel of their palace in Chambéry, which, in 1506, received its own liturgy (the feast is the 4th of May) from Pope Julius II (1503-1513), and where it suffered the disastrous fire of the 4th of December 1532. The effects of the damage were carefully repaired by the Poor Clare nuns of Chambéry in 1534. In 1578 Emanuel Philibert ordered the cloth to be brought to Turin, the new capital of his duchy and in 1694 it was placed in the Guarini Chapel, built on the dividing line between the cathedral and the Royal Palace of Turin. The Shroud again went with the Royal family to Liguria in 1706 and left the city for one more, and final, time between 1939 and 1946, going to the Benedictine Abbey of Montevergine, in Campania, to escape the dangers of the bombings of World War II. The exhibitions during the Savoyard and Torinese periods were initially very frequent, but from 1700 became considerably more rare. They were common when the feasts of the dynasty were celebrated: for example for the marriage of Vittorio Emanuele (II) in 1842, of Umberto (I) in 1868, of Vittorio Emanuele (III) in 1898, of Umberto (II) in 1931 (the last two were delayed). There were successive exhibitions in 1933 (for the “Jubilee of Redemption”), in 1978 (for the 400 anniversary of its arrival in Turin), in 1998 (for the centenary of the first photograph, the 500th anniversary of the cathedral and the 1600th anniversary of the Council of Turin) and in 2000 (for the Jubilee to mark the end of the Second Millennium). In 1973 a televised exhibition was permitted. On various occasions there were private exhibitions, for example, in 1804 when Pius VII passed through Turin on the way to France; in 1980 for Pope John Paul II; and on 14th April 1997, after the fire on the night of 11th/12th (from which the Shroud escaped undamaged). How the Shroud reached Lirey is not clearly known: some say it was a gift or a “conquest”. The latter is hypothetical and is reconstructed on the basis of information whose interpretation is uncertain (cfr. Dubarle, 1985; Dubarle and Leynen, 1998). The year 1204 is crucial for the news that the Latin crusades had reached the city of Constantinople. One of them, Robert de Clari, describes the relics that he venerated in the Christian Capital of the Orient: among them a Shroud on which the image of Christ is visible. After the sacking of Constantinople its presence there can no longer be recalled and one assumes that it reached the West or ended up in the hands of the Templars or, after a stay in Athens, ended up in the hands of French knights who had resided there.

The assertion that the Shroud of Turin is identical to the shroud venerated in Constantinople is less easy to make than maintaining it was certainly the same appeared in Lirey. In awaiting a sure response to such a question, how can we fail to ask what happened to *that* shroud before it arrived in Constantinople? It is fairly probable that it was preserved in the capital of the Eastern Empire since 944, when the emperor Roman I Lecapenus (920-944) managed to come into possession of the *Mandylion* of Edessa. This obviously presupposes accepting the identification of the two finds as one and the same reality. The principal source of information is the homily of Gregory the Referendary on the arrival of the image on the 16th August 944. He speaks of the bloodied face and the side from which blood and water pours. In Edessa (today Urfa) such an image was present at the beginning of the 7th century. There is a reference to that in the legend connected to the King of Edessa Abgar V (9-46 A.D.), as reported by Eusebius of Cesarea (260-339). According to Eusebius, the king, who had fallen gravely ill, had an image sent to him by Jesus himself. For the presence of the *Mandylion* in Edessa and the hypothesis of its relationship with the Shroud we refer to Wilson (1978 and 1998), Dubarle (1985), Dubarle and Leynen (1998), Zaninotto in Zaccone (1997).

The historical core in this complex mass of information is obscure and to solve its difficulties many possible responses have been put forward. The *Mandylion* showed only the face of Jesus, but they speak of a *tetradiplon* cloth (i.e. doubled in four), probably because the long sheet, folded twice and then in four, left only one eighth of the total area visible, i.e., that of the face (on this question cf. Dietz, in Scannerini and Savarino, 2000, pp. 330-357, who correct and complete the hypothesis). This face was contemplated by the artists who followed Emperor Justinian I, a pious devotee to the relic of Edessa. He had introduced a “model” for the face of Jesus (testified by the ancient icons of Saint Catherine in Sinai)

that seem to have had constant features: a bearded face with long hair, parted from the crown of the head, perhaps completed by a curl left free on the center of the forehead; the face was asymmetrical, due to a swelling in the left cheek. From a certain moment onward, it was spread the so-called depiction of the "body taken down from the cross" and laid on a linen cloth placed on the ground. For a long time it seems that the Shroud was looked at only for that part that showed the face. For some of the people of Edessa, the Mandylion constituted a relic, for others a reason for scandal, especially in the iconoclast period. This would also explain its periodic appearances in the form of copies produced time by time (the *mandilia*): noteworthy are those of Genoa and the Vatican, but they were also to be displayed in Constantinople. Whoever accepts this hypothesis, links the movement of the Shroud from Jerusalem to Edessa to one of the phases of the tradition of Abgar V, and places the date somewhere in the middle of the Second Century.

The state of things briefly described here is judged in a different way by scholars: the lack of sure information over a period of thirteen centuries is held by some to be an insurmountable difficulty, one of the weakest points in the scientific discussion about the Shroud. Others hold that the absence of reliable data for such an object is not exceptional at all, when compared with other ancient finds, which often carry no other message than their own reality. It is true, however, that the reconstruction of the story of the Shroud requires recourse to other information that can only be offered by the scientific study of the object itself.

## V. Analysis of the Experimental Sciences on the Shroud

When was the Shroud with its image made? How was the image itself formed? History could answer the first question, while historical data are certainly not enough to answer the second. Indeed they are lacking in both and require a systematic recourse to experimental sciences. "The Turin Shroud is undoubtedly a medical-legal record that must be studied using criteria and techniques which are proper to disciplines belonging to that area, one located in the middle between clinical anatomy and human sciences" (Baima Bollone 2000c, p. 4). The 20th century has seen a great number of sciences involved with the Shroud; here we shall only look at those that focus on our two problems.

*1. The Dating of the Shroud.* In demonstrating the age of the Shroud, it is not controversial to say that it dates back to at least the middle of the 14th Century (Lirey): later attributions, for example to the life of Leonardo da Vinci (1452-1519), are a scientific absurdity. Here we will mention some elements favorable to its dating back to ancient times and some others which make this hypothesis questionable.

Palynology, or science of pollen, started to have a role in dating the Shroud when professor Max Frei, an expert from the criminal police of Zurich, obtained material preserved in the interstices between the threads by applying adhesive bands to the surface of the Shroud (between November 1973 and October 1978). Among these residues he found the spores of various plants. By studying such material by means of an ordinary optical microscope and later by an electronic scanning microscope, Frei identified the pollens of 58 different plant species by comparing them with pictures of known pollens. At the time of his untimely death he was working on the identification of another 15 species. Frei himself travelled to Israel to deepen his knowledge of the botany in that area; later on, Israeli botanical experts (Avinoam Danin and Uri Baruch) were to intervene. None of the species discovered were extinct, all of them were known. From the spores found on the Shroud, the criminologist went back to the different localities in which the linen sheet had to have been. The discoveries of Frei and the studies of Danin and Baruch allowed one to say that the Shroud had been in the Mediterranean area. Moreover, some species are proper only to areas which correspond to the place of Edessa or to present day Israel. The most interesting observation



concerns the fact that three species (*Cistus creticus*, *Gundelia Tournefortii*, *Zygophyllum dumosum*) survive together in some areas of Palestine. All of this allow us to hypothesize about the trajectory of the movements of the Shroud. It also favors the idea that the sheet laid open in a certain season of the year, that is in Spring. Does it also lead to any conclusions about the date of the Shroud? Only the story of botany would permit a response, if one of the species found within the Shroud tissue were to be extinct for example, exactly 2000 years ago. The fact that that branch of botany is still underdeveloped, and that all the species found up to this point are still living, removes the point of this argument. The trail is correct, but the research is not yet conclusive.

Numismatics (cataloging and historical dating of coins) is a notoriously recent instrument of dating archaeological finds. The findings of Filas (from 1954) and those of P. Baima Bollone and N. Balossino (1997), who detected on the eyes of the crucified man of the Shroud the signs of the presence of various low-value coins (of the *lepton* family) coined by Pilate in the years 29 and 30 of the Common Christian Era, are of great interest in that respect. In fact they would allow us to date the time of the burial of the crucified man of the Shroud to those same years. Nevertheless the findings are not sure and this research also is not conclusive (cf. Balossino, in Barberis and Zaccone, 1998).

The method of historical dating by measuring  $C^{14}$  chemical abundance is able to estimate the years that have passed from the time in which organisms, that were present in some particular finding, have ceased to live. This takes advantage of the carbon cycle existing in nature, based on the following fundamental fact. In organic matter three carbon isotopes exist,  $C^{12}$ ,  $C^{13}$  and  $C^{14}$ , having an increasing mass number (whose nuclei are formed by six protons and, respectively, by six, seven and eight neutrons). Of these isotopes,  $C^{14}$  is present in a minimal amount. It is unstable and radioactive. It undergoes neutron decay ( $n \rightarrow p$ ) emitting  $\beta$  particles (electrons), and transforming itself, as time goes on, into the Nitrogen isotope  $N^{14}$ . While the organism remains alive, the total amount of  $C^{14}$  remains in a state of equilibrium with the other Carbon isotopes through the metabolic exchange with external environment. From the moment in which life stops, the amount of the radioisotope is no longer renewed and gradually begins to diminish in a constant fashion, having reduced to 50% of its mass after a period of approximately 5,730 years.

The research by this method was applied to our case, supposing that the fabric of the Shroud was made just after the cessation of the plant's life from which the fibers were extracted and thus used, after a short time, for the burial purpose that we know. From the measurement of the chemical abundance of  $C^{14}$  present on the Shroud today, the age of the Shroud can be measured. In order to carry out this examination on some samples of the linen cloth, it was decided to use a mass accelerator spectrometer. The analysis was entrusted to the laboratories of Zurich, Oxford and Tucson. The sampling was carried out on the 21th of April 1988. A sample of 50 mg weight was sent to each laboratory. Along with the sample of the Shroud, they were delivered other three samples of ancient fabrics whose age were known (ranging from the Roman to the Late Medieval period). The examination would have to be carried out blindly, but the sample of the Shroud was identified immediately. The result the examination was communicated to Cardinal Anastasio Ballestrero, the papal custodian of the Shroud, on the 28th of September of that year. He made it public on the 13th of October. According to the three laboratories, the Shroud was dated back to a period between 1260 and 1390 of the Christian Era.

The intensity of the controversy that followed this news is easily understandable considering what was at stake, but it was also caused by the report of some improper aspects which would have occurred during the development of the procedure. We do not want to list them here; certainly, the refusal to accept both the presence of scientific representatives of the owner of the Shroud and the collaboration of scholars of the Shroud, prevented the researches from taking advantage of a wider knowledge, for instance in order to enable the samples to be freed from pollution. Against the results obtained during the 1988 analysis two

kinds of objections were made, firstly by A. Kouznetsov and secondly by L.A. Garza Valdes. The Russian scholar Kouznetsov took a sample of cloth, which dated back certainly to the Roman period, and exposed it to a simulation of fire in conditions similar to that which happened in Chambéry in 1532 (including contact with water and the presence of silver ions), finding out a radiocarbon “rejuvenation” of the analyzed tissue. The Texan scholar Valdes Gauze instead made the hypothesis that living micro-organisms of the *liconothelia* type have been present for a long time on the sheet, thus altering the radiodating. The results of these tests are not sufficient for overturning the radiocarbon report of 1988. The experiments carried out by Kouznetsov’s showed a retro-dating that is still not sufficient, and those made by Garza Valdes were performed on material that was not definitely from the Shroud. Nevertheless, these researches indicate the possibility that the 1988 measurements could not have taken into account all the conditionings on the Shroud in the course of its history. Today it seems reasonable to affirm that “the problem of the radio-carbon dating of the Shroud is still open; although the results obtained in the 1988 measurements are a step forward in solving that complex scientific and historical puzzle which is the Turin Shroud, they cannot be considered conclusive” (Savarino, in Barberis and Zaccone 1998, p. 205).

In addition to direct tests, “indirect tests” could also be indicative of the age of the Shroud, in particular those that lead one to exclude any falsifying or deceit about its origin. The knowledge gained by the discovery of photography, and, with photography, by computer analysis that showed the characteristic of tri-dimensionality, is unfavorable in classing the Shroud as a medieval artefact, because the product easily goes far beyond all the projectual possibilities of that age. A “negative” test could be considered the same quality of the fabric, once held to be too refined and complex for a hypothesis of Palestine origin from the era of Christ. Today, however, both the presence of linen fabrics and the binding technique known as “fish spine” are well documented in the area of Egypt and Syria from the centuries preceding the pre-Christian era (cfr. Baima Bollone, 2000c, pp. 13-17).

2. *The Formation of the Image on the Shroud.* Today no procedure is yet known that could explain the way in which the human image on the Shroud was formed. Photographic and computer research have lead us to exclude presence of signs of pictorial tampering. Experiments of every kind have been carried out in accordance with the details of the Gospel accounts, especially using ointments as reported by John 19,39-40. Images and marks have been produced in several ways, but none of them having the resolution and accuracy shown by the signs on the Shroud (cf. Baima Bollone, 2000b, p. 161; Milanesio, Siracusa and Zacà, 1997; Balossino and Siracusa, in Ghiberti and Casale, 1998). Three classes of explanations have now been proposed, resulting from more or less in-depth experiments: image formation through contact, through vapor (vaporigraphy), or image formation by radiating energy. Scientists are convinced that these kinds of explanations, however, can only give a partial account of how the image was actually produced. Two main streams of thought are in evidence today: some suggest that the image was obtained thanks to the heating of a statue or cast in bronze on which the Shroud was placed, others suggest that it was produced by the emission of light (or other forms of energy) that occurred at the time of Jesus’ resurrection. The first resulted unsustainable by simply comparing the Shroud with a number of attempts made following the above procedure. In contrast to the image on the Shroud, the image formed in the simulations is visible also on the back of the cloth, and it disappears within a few months. The second suggestion, instead, has the limit of being untestable, as the resurrection is an unrepeatable event which goes beyond the field of experimental sciences (for a suggestive proposal by Sebastiano Rodante see Scannerini and Savarino, 2000, pp. 167-168). From the scientific viewpoint, nobody can say what will happen in the future: for the time being the only objective attitude is that of the *nescimus*, i.e., we do not know.

At this point at least some partial results need to be stated. The correspondence between the Gospel accounts and the “account” of the Shroud allow us to hypothesize that there was a relationship between

the event of Jesus' Passion and the formation of the image of the Shroud. The possibility still remains, as already pointed out, that the image is that of a man who experienced the same crucifixion and death as Jesus of Nazareth, and who was then wrapped in the cloth that we know as the Shroud today. But this hypothesis, though not impossible, is not supported by any argument and, looked at closely, is also highly improbable. If, instead, the Shroud was the funeral cloth used in the burial of Jesus himself, even without needing to endorse any of the theories proposed to explain the image's formation (all insufficient), it is inevitable to admit a "contact", that is, a fairly close connection, between the corpse and the sheet. The latter shows up, in this respect, several different marks: the signs due to the blood must have preceded the formation of the image of the whole body, and affected the fabric deeper with respect to what caused the complete image. The blood is visible on the back, the image is not. We cannot say if the intensity of the image has varied in time: whether at the beginning it was immediately fairly visible, whether with time, it has diminished. The intensity of the contrast between the image and the background has certainly diminished, and therefore it has become difficult to see the complete image with its distinguishing marks.

## VI. Critical Evaluation of our knowledge of the Shroud of Turin

The steps taken up to this stage, demand a careful conclusion. Starting from the similarity existing between the account in the New Testament of the passion and death of Jesus of Nazareth and the data that can be observed on the Shroud, we have carried out an initial attempt to verify whether the account of Jesus' burial is compatible with the image of the Shroud. The conclusion is that "there is no incompatibility" between them. Focusing our attention on the possibility that the Shroud (sheet and image) is the cloth or one of the clothes used for burying Jesus (we usually would call this fact "historical authenticity"), we have looked for clues, in the fields of historical and experimental sciences, that could confirm or contradict the authenticity of the Shroud. It was possible to say with certainty that the origin of the image is not the work of a painter. The discovery of the negative-positive photographic effect and of the three-dimensional character of the Shroud's image, leads us to exclude any intentional falsification. In fact, until quite recently, the knowledge of those effects was unknown not only to the common people but also to scientists. The same can be said of all possible artificial interventions that have been tried so far, which have shown themselves to be incapable of supporting the hypothesis of planned interference to produce the result that we have. Except for the  $C^{14}$  analysis, the various sciences applied to the study of the Shroud of Turin show that this linen sheet is an *unicum*: it is an object that can be explained only if we suppose that its origin lies in its use when burying Jesus. None of the results provide a judgement of historical or experimental certainty, capable of demonstrating that the Shroud was the burial sheet of Jesus, but their convergence is highly significant. The nature of such a conclusion is not mathematical in character: the only "mathematical" result is the one concerning the carbonium analysis, which seems to deny that the origin of the Shroud dates back to Jesus. Actually, the method by measuring the  $C^{14}$  isotope would provide mathematical certainty, only when a complete thorough knowledge of all the situations and circumstances of each single case or find is definitely available. However, this certainty is far from being acknowledged. We still have many cases of divergence between the dates indicated by archaeologists or botanists (for example, starting from the rings of a tree trunk) and those indicated by radiocarbon measurements. It is right therefore to continue the research along all the avenues open to us.

In the difficulty of evaluating this mass of data, the method of computing the probabilities can be of some help (cf. Barberis, in Barberis and Savarino, 1997 and in Barberis and Zaccone 1998; cf. also Fanti and Marinelli, 1999). It is an attempt to provide a quantitative, not merely a qualitative, evaluation of how probable is a conjecture or the happening of a specific event. The method is very suggestive, but must be applied with scientific correctness. The computation of the degree of probability for a statement or an event depends on the correctness of our archaeological and historical knowledge, which needs to be based

on a precise amount of information. Unfortunately, the information we have is often approximate and incomplete. For this reason calculations can change a great deal depending on the operators. For instance, a statement such as «the Shroud of Turin is authentic because it has all the characteristics of a Hebrew burial sheet of the 1st century» can be refused from all viewpoints when one acknowledges the fact that we do not know anything about Hebrew funeral sheets of the 1st century, simply because the relevant documentation is missing. The accuracy of the level of probability of each single statement is also variable: if, for instance, the abrasions on the shoulder and shoulder blade of the man in the Shroud had not been caused by the *patibulum* carried by the convicted man before reaching the place of torture, but had only been “corpse-like bruises,” the probability that such signs can be attributed to crucifixion would be significantly reduced.

Although we hesitate to use the probabilistic method, which may have been viewed with excessive enthusiasm, its suggestive strength remains. The cumulative convergence of many probabilities, of various degrees, increases the truthfulness of the affirmation of the direct origin of the Shroud from the event of the death and burial of Jesus of Nazareth. According to similar considerations made by Y. Delage, P. de Gail and T. Zeuli, Barberis concludes his calculations claiming that «within a sample of 200 billion crucified men only one would have all the seven relevant characteristics owned by the man of the Shroud» (Barberis, in Barberis and Zaccone, 1998, p. 275). Fanti and Marinelli (1999), with a more complex calculation of probabilities (but in numerous points not spared by criticism), set forth that the authenticity of the Shroud can be demonstrated with the highest level of confidence, near to 100%, thus claiming for the Shroud the qualification of a true religious relic (cf. p. 188). However, I consider it impossible to share this last conclusion, since these authors do not take into account enough the prudential limits set by the response of the C<sup>14</sup> analysis, which so far has been put into debate, but not cancelled. Neither do they seem to give enough weight to the uncertainties that remain in the field of historical reconstruction. Nevertheless, the probability method is of some relevance, although it does not allow one to acknowledge in a demonstrative way the authenticity of the Shroud, not even in a “moral” sense. The sum of the probabilities increases, maybe, the degree of the global probability, but it does not produce absolute certainty; this is particularly true when the case is questionable (at times very questionable, as in the case of supposed writings on the fabric or for the coins over the eyes) or when the research that supports this has not yet reached a conclusion (as in the case of the pollens or, above all, in the recognizing of the coins).

## VII. The Shroud between Science and Faith: Relic, Icon and Message

The path here summarized allows us to say that it is possible that the Shroud of Turin belongs to the first century of the Christian era; it is also possible that the body of Jesus, once taken down from the cross, was wrapped in it. It is reasonable to acknowledge that these assertions carry a degree of serious probability. To go beyond this, affirming that we have a complete certainty of that, seems to us to be unjustified. We have also to add that it would be unjustified to assert that the Shroud is definitely an object of the Late Medieval or Modern ages; completely less legitimate is to state that the Shroud is a deliberate fake. There are reasons in favor of the Later Medieval period, but they are not definitive. At the same time, there is no absolute certainty that the Shroud is from the Roman era and that it was in contact with the body of the crucified Jesus: the reasons and proofs we have still do not solve the problem in a satisfactory manner.

The question arises whether the previous conclusions lead to consequences for the Christian faith in the Son of God, crucified and risen from the dead. The reality of the Shroud seems to point us towards two things: to recognize the obscurity in which our knowledge is debated (only for the time being? or perhaps



it will always be so?); to value all the aspects contained in this “mystery,” as the Shroud is an image undoubtedly related to the passion and death of Jesus, a sheet that could have wrapped his body. The believer can be brought to think that, at least for the moment, God has decided that for the fundamental issues aroused by the Shroud—that are a suitable object for scientific research, but also lead one to “suspect” the existence of a dimension that transcends that research—it is not possible to give a unambiguous, decisive answer.

*1. The Origin of the Religious Relationship.* Having recognized what belongs to the mere facts, one can then look at the consequences there involved. Past and present history has always noted that the faith of believers had a specific interest in the Shroud. In order to characterize such a religious relationship, we must start from what is more typical of the Shroud itself: that is, the image it contains and the exceptional correspondence between this image and a very special event as recorded by the Gospels. The Shroud gives a particularly evocative testimony of the event of the passion and death of Jesus, expressing with visual language what the Gospels express, much more concisely, with literary language. It follows that, for those who are acquainted with the history of Jesus, the vision of the Shroud becomes a spontaneous reference to the Gospels and the Shroud itself becomes a witness, a silent yet eloquent echo of the voice of the Gospel.

All of this happens in the believer’s feeling before the questions on the “why” of the Shroud are asked, and before answers are looked for by means of scientific investigation. The relationship between the believer and the Shroud is, in its spontaneous phase, pre-scientific in nature. One can indeed say that, before the dialogue with science begins, a direct relationship between the history of Jesus and the origin of the Shroud has already been postulated, because of the exceptional nature of the connection between the two narrations. Science is called into play for the verification of this “suspicion” and for the reply to every other question regarding the cloth, its conservation, and the origin of the image. The “religious” relationship, which involves at some level the believer’s faith, has already begun, and this is quite legitimate. The presence of such an immediate and original relationship is what explains and justifies the corresponding pastoral initiatives undertaken by the Church, having the Shroud as its object.

The characteristics of the relationship of faith are set out on a wide range. First of all the veneration for an object that, by the nature of its mark, refers back to the person who is the direct object of believer’s faith and love, that is to Jesus Christ. It is obvious that the sign, the Shroud in itself, is not directly the target of any act of faith, but it is undeniable that it is placed in the “economy” of faith, developing an auxiliary function. Nor it is, in itself, the object of the believer’s love, though it reflects something which brings the beloved person of Jesus closer to us, and therefore it is looked upon with a feeling of reverence and devotion. The sign here involved is not conventional, but natural. It is an image that carries a direct representation of the event, a representation that is, moreover, particularly alive. In the period of history known to us, it is not known if a reflection developed on the function of the image of the Shroud comparable to the Eastern theology of the icon. As known, the sensitivity of Western culture is characterized by a [realism](#) [5] that often prevails over a reflection that would value the symbolic element. Nevertheless, the theology of the icon, even if in a way all of its own, is not extraneous from the context of the Shroud (see Schönborn, 1988, and Mondzain, 1996, who reach at different conclusions on this respect).

Given the certainty—that seems to be completely consolidated—that in the reality of the Shroud one can exclude any pictorial intervention, the use of the concept of “icon” assumes here some exceptional aspects. Different from the painting of icons, there is no “technique” in the Shroud, but in spite of this the “functionality” and the “message” of the image is not absent. The reference must be acknowledged at a superior level. It is an icon of the unknown, an icon that implements the wealth of its mystery, placing it

in the depth of God's silence.

*2. The Dynamics of the Relationship.* The problem of the Shroud affects many fields of knowledge and belief. Since it is an image, and many also call it a relic, one is immediately confronted with the problem of the relationship that images and relics would have with faith. But concerning the Shroud, this relationship is quite unique. In fact, whoever denies the relevance of the image-relic relationship within the path of one's faith, willingly resorts to the scientific analysis of the Shroud in order to show whether the qualification of a true relic would not be correct. Calvin, for example, resorted to exegesis and to history in order to claim that deceit was being committed; another group of contemporary evangelicals resorts to scientific arguments in order to put forward the same interpretation (cf. Papini, 1982 and 1998), meaning that the eventual admission of the authenticity of the Shroud would create a certain uneasiness.

There is then a set of problems that we could group under the name of "the question of the Shroud" and that concern the claim that science would have the role of conditioning the believer's faith. However, such a claim does not seem to be reasonable. If the religious relationship with the Shroud is born in a pre-scientific phase (without becoming neither anti-scientific, nor unscientific), it follows that scientific research cannot condition it. It is important to maintain this vision, because it enables even those, who are convinced that science has unsurpassable objections against the authenticity of the find, to welcome the special message that comes from the image of the Shroud.

The possibility that this sheet truly wrapped the lifeless body of Jesus has a great strength of involvement, but adds nothing to the intelligence of Christian faith. More than the mind, it would be the "heart" to be affected by the response. The fundamental reason for believing and acting as Christians comes from what Jesus did and said. The image of the Shroud, on the other hand, represents and testifies, in an unsurpassable way, precisely Jesus' life and death. It is even possible to see an educational function in the margin of uncertainty associated with our studies on the Shroud. By giving this "aid" to our faith, without freeing us completely from scientific uncertainty, the God who has resurrected His Son seems to want to invite us to focus only on the essential part of the message. The weakness of the instrument does not make us love it less. Indeed it reconciles it with our weakness: the little that we know invites us to love more. This is nothing other than the "style" of Jesus, who insisted on giving value to weak things.

*3. The Message.* The Shroud is a humble and weak reality. It must be accepted as such. But it is also an extremely expressive, effective, demanding sign. It is so "humble" that we do not have the last word on its place of origin, on the era in which it originates, on the process of formation of the image it shows. It must be accepted with its own level of truth, without forcing it towards degrees of certainty that we may wish to have, but don't. The Shroud is "weak," because it does not have at all the sacramental efficacy of the Eucharist, as it is only a reference to it. What is more, the Shroud is by no means necessary in order to reach salvation. For many it is not important, for very many it was not and it is not known, and this has not diminished in the believers their awareness and their commitment in answering Christ's call to follow him. For many non-Christians or Christians of other non-Catholic confessions, the Shroud is not accepted as being a legitimate companion in the path towards God. It is therefore a very poor sign and, when conceptualized it also becomes a fairly complicated thing. It is difficult to respect the poverty of the Shroud, a sign of expectancy, a sign of the silence of the tomb.

However, the Shroud exists and it says the same things as the Gospel regarding the death and burial of Jesus. Indeed it becomes a distinctive sign only through the Gospel. It says these things in a way that no other does, and it says them today, in the so-called "civilization of the image." It could be said that this sign has waited until our time in order to show itself to a great number of people, in order to become an even greater resonance chamber of that message. Since the Shroud speaks the same words as the Gospels,

it is justifiable that some believers do as much as possible so that these words are also heard by others. This image is a meaningful call to the most neglected passage of the St. Paul's "creed": "and he was buried" (*1Cor 15:4*), that is also in need of being restored in our time.

The conclusion of this article is the one suggested by the reflections that John Paul II proposed at the time of his pilgrimage to the Shroud, on May 24, 1998 (cf. ORWE 27.5.1998, pp. 1 and 4). "The Shroud is a challenge to our intelligence. It first of all requires of every person, particularly the researcher, that he humbly grasp the profound message it sends to his reason and his life. The mysterious fascination of the Shroud forces questions to be raised about the sacred Linen and the historical life of Jesus. Since it is not a matter of faith, the Church has no specific competence to pronounce on these questions. She entrusts to scientists the task of continuing to investigate, so that satisfactory answers may be found to the questions connected with this Sheet, which, according to tradition, wrapped the body of our Redeemer after he had been taken down from the cross. The Church urges that the Shroud be studied without pre-established positions that take for granted results that are not such; she invites them to act with interior freedom and attentive respect for both scientific methodology and the sensibilities of believers."

Then the Pope continues to point out that the contemplation of this image can assist contemporary evangelization. "The Shroud is *a mirror of the Gospel* [...] and invites us to pattern our lives on the life of the One who gave himself to us." "The *image of human suffering* is reflected in the Shroud. [...] The Shroud not only spurs us to abandon our selfishness but leads us to discover the mystery of suffering, which, sanctified by Christ's sacrifice, achieves salvation for all humanity." "The Shroud is also an *image of God's love as well as of human sin*. [...]. Echoing the word of God and centuries of Christian consciousness, the Shroud whispers: believe in God's love, the greatest treasure given to humanity, and flee from sin, the greatest misfortune in history." "The Shroud is also an *image of powerless* [...]. It is the experience of Holy Saturday, an important stage on Jesus' path to Glory, from which a ray of light shines on the sorrow and death of every person." "The Shroud is an *image of silence* [...]. The Shroud expresses not only the silence of death but also the courageous and fruitful silence of triumph over the transitory, through total immersion in God's eternal present."

To approach the Shroud, John Paul II concludes, "is precisely a 'coming to see' this tragic and enlightening sign of the passion which proclaims the Redeemer's love. This icon of Christ abandoned in the dramatic and solemn state of death [...] urges us to go to the heart of the mystery of life and death, to discover the great and consoling message it has left us. The Shroud shows us Jesus in the moment of his greatest helplessness and reminds us that in the abasement of that death lies the salvation of the whole world. The Shroud thus becomes an invitation to face every experience, including that of suffering and extreme helplessness, with the attitude of those who believe that God's merciful love overcomes every poverty, every limitation, every temptation to despair."

**Read also:** [Gospels](#) [2]

[Resurrection](#) [4]

**Documents of the Catholic Church related to the subject:**

[Abbreviations and complete titles of the documents](#) [6]

John Paul II, ["The Shroud whispers". Discourse during the visit to the Shroud of Turin, Turin 24.5.1998](#) [7], ORWE 27.5.1998, pp. 1 and 4.

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We present here only a selection of books, without any reference to the many articles published on the subject. Bibliographies can be found in Dervieux (1929 and 19362) and Fossati (1978). E. DERVIEUX,

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