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# The Art of Not Quartering Skins

## Techniques Employed for the Subdivision of Bifolia in Byzantine Manuscripts

More than twenty-five years\* have passed since Léon Gilissen proposed, in his *Prolegomènes à la codicologie*, a reconstruction of the manufacturing process used for making quires in Western parchment manuscripts. According to the scholar's hypothesis, quaternions were obtained by folding a skin one or more times along its perpendicular axis. The success enjoyed by this proposition was considerable, so much so that today, extrapolating from Gilissen's postulate, it is commonly supposed that the leaves of *all* manuscripts *always* represent fractions of one skin which has been subdivided in a symmetrical way.

The theory's popularity is certainly due, in large part, to the very natural—indeed, *instinctive*—nature of the steps that it envisages. However, this fundamental plausibility is not the only argument that works in favour of the hypothesis: Gilissen himself, and some other codicologists following in his footsteps, have come up with a body of convergent arguments which, implicitly, can be read as convincing proof of the sound footing of the reconstruction. But what has actually been found? Not the irrefutable evidence presented by bifolia which, over the course of time, have remained materially consubstantial, but rather a series of observations that at best follow the overall direction of the hypothesis, and which ultimately do not contradict it. To be sure, such clues are not lacking in weight, but it is not possible in all instances to reconstruct, based on the 'static' situation one is presented with today, the sequence of manoeuvres performed by the artisan in the past, which obviously remains far out of our view.

In actual fact, Gilissen's hypothesis does not represent an organic whole in which the various elements connect in an almost 'automatic' way. It is appropriate, therefore—and this is particularly important if one is to achieve a better approach to the set of issues addressed in the present contribution—to split up the problem into its constituent parts. Parts taking in-quarto folding as an example.

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\* At present (2020) more than forty years.

According to Gilissen:

- The bifolia are necessarily the result of  $n$  symmetrical subdivisions which *always* produce a number of bifolia equal to  $2^n$  ( $2^0 = 1$ ;  $2^1 = 2$ ;  $2^2 = 4$ , ...). This remains true for all ‘formats’.
- The subdivisions of the sheet were *always* realised by adhering to a pre-stipulated sequence of folds. This remains true for all ‘formats’.
- The succession of folds was *always* the same: the skin was first folded perpendicular to the spine, so that the latter coincides with the bifolium’s fold. This remains true only for in-quarto examples.
- Because the bifolia that are generated from one and the same skin remained materially consubstantial throughout the operation, they necessarily coexist within one and the same quire. This remains true only for in-quarto and in-octavo examples.
- The assembly of folded skins could be carried out either by arranging them on top of each other (formula A2) or by inserting one folded skin inside another (formula C2).

This reconstruction is rather seductive. However, if one gives the matter some thought, there is nothing to prevent the possibility that, whilst leading to the same material configuration, the degree of liberty enjoyed by the artisan may in fact have been greater. For example, it would be perfectly feasible to reverse the order of folds by beginning at the spinal axis. One would obtain, also in this case, two bifolia united along the upper edge, which, when suitably joined, could form a demi-quire. It is true that this demi-quire would not ‘automatically’ obey Gregory’s rule, but one cannot safely deduce that respect for the rule was the automatic consequence of a particular practice and was not dictated by other considerations. Similarly, nothing constrained the artisan to divide bifolia along the short axis (i.e. perpendicular to the spine). Indeed, by dividing them contrarily along the long axis, *landscape* format volumes could be obtained; or perhaps (since this possibility has not been confirmed) a portion of skin could have been cut off and set aside for a different purpose, so as to obtain *portrait* format volumes that no one, at first glance, would be able to distinguish from ‘normal’ volumes. Finally, no one says—and Gilissen certainly never said—that the quaternions of all manuscripts were obtained in the way prescribed by his hypothesis, or that all the quaternions within an individual manuscript were obtained in this way. But above all, no one says that the potential confirmation of one of his theorised series of steps implies, *ipso facto*, the overall validity of the suggested reconstruction.

Apart from Gregory's rule (too wide-ranging to be reduced to a simple by-product of a particular *savoir-faire*) and the unmistakable signs of historic material consubstantiality among bifolia (too seldom observable to represent proof *per se* of the existence of a very widespread practice), the fact that *lisières* appear almost exclusively along the margins of the leaves, which, according to the folding hypothesis, correspond to the edges of the skins, occupies a prime position in Gilissen's reasoning. Yet one can demonstrate that the absence of *lisières* along the top edge of a bifolium is entirely compatible with other procedures.

*Lisières* serve as an irrefutable means of identifying, on a bifolium, the original orientation of the animal skin. Unfortunately, because they represent a nuisance both materially and aesthetically, there was a tendency for them to be eliminated. Nevertheless, as research led by Frank Bischoff has shown,<sup>1</sup> other equally useful reference points on skins exist which, being less bothersome and, above all, further away from the edges of the bifolium, had a much better chance of survival. Known as *brisets* in French, *Flämen* in German, *scalfi* in Italian,<sup>2</sup> these are rounded areas that correspond to the *axillae* (as we will therefore call them), located at the junctions of the four legs of the living animal (Fig. 1). They can be identified thanks to the fact that animal skin has an almost translucent appearance, and because hair follicles are more visible in these areas than elsewhere.

If one accepts Gilissen's hypothesis and imagines the creation of quires taking place without any mishaps occurring and perfectly in line with the canon, the position of the *axillae* on a bifolium makes it possible to reconstruct the type of folding process employed:

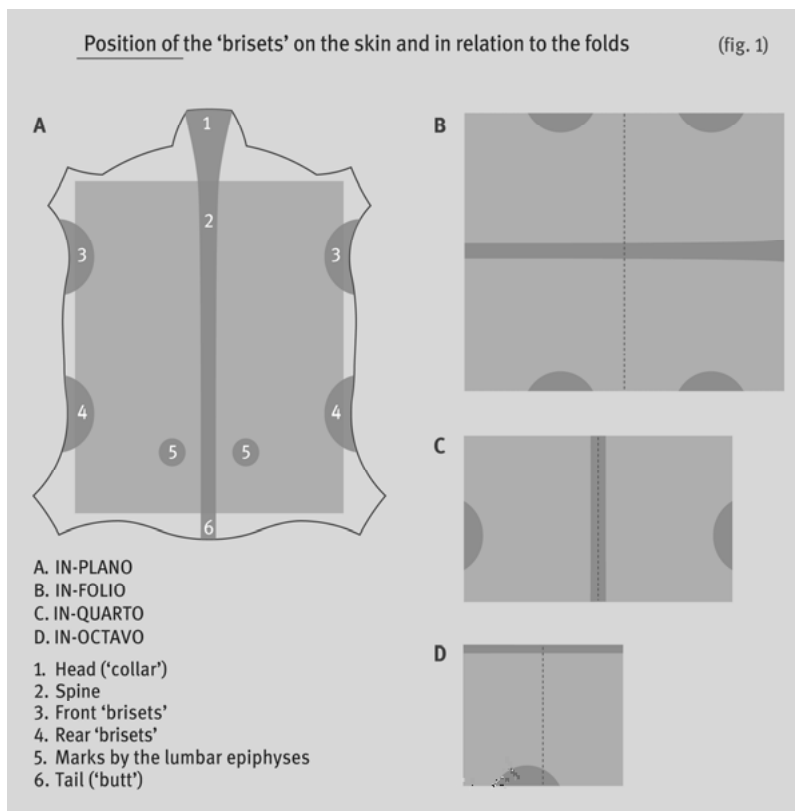
- In an in-folio folding, one should normally observe four *axillae* per bifolium: two on the upper edge, two on the lower.
- In-quarto folding, on the other hand, is characterised by the presence of two *axillae*, namely on each lateral edge of the bifolium.
- In an in-octavo folding, one *axilla* can be seen on the lower edge of each of the four bifolia, straddling the fold.

The observation of *axillae* is not always entirely satisfactory because for various reasons (the nature of the skin, the age of the animal it was obtained from and, above all, the drastic trimming of edges) they are not visible in all instances.

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1 Bischoff 1991 and Bischoff 1993.

2 Muzerelle 1985, 42; Bischoff 1991; Maniaci 1996 (1998<sup>2</sup>), 31.



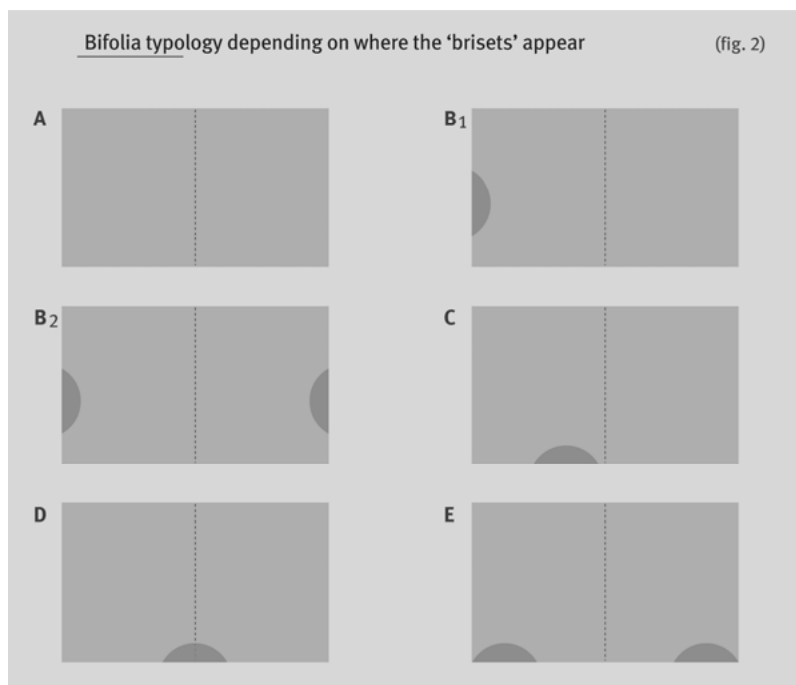
**Fig. 1:** Position of the 'brisets' on the skin and in relation to the folds

Nevertheless, one can still enounce a firm rule: if the constituent quires of a manuscript were created according to the procedure postulated by Gilissen, the visible *axillae* on a bifolium should *necessarily* be located in one of the positions indicated in Fig. 1.

During the course of research recently carried out on a mixed corpus of codices, *Exultet* rolls and archival documents of various origins aimed at establishing the dimensions of skins used for medieval writing,<sup>3</sup> it was noted that certain Byzantine manuscripts do not obey this rule: in fact, the *axillae* are found on the lower edge of each of the two halves of the bifolium. In order to explain this unexpected phenomenon, one has to imagine a lengthwise in-quarto subdivision, thereby making the top margin coincide with the spinal axis. The end result of this approach has been termed

<sup>3</sup> Bischoff / Maniaci 1996.

*Längs-quartformat* (Fig. 3). Nevertheless, because this procedure generates a 'landscape' format volume (i.e. one of greater width than height) which, in order to be reduced to the 'portrait' format, would always necessitate the sacrifice of a portion of the skin, this hypothesis does not seem very convincing to us, since it would be devoid of any functional purpose.

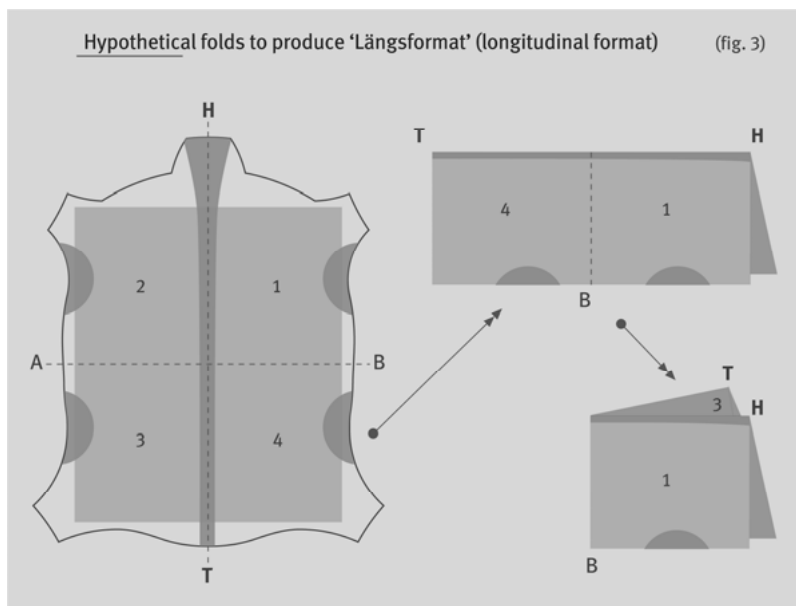


**Fig. 2:** Bifolia typology depending on where the 'brisets' appear

Given that the phenomenon has been observed in Byzantine production, it seemed like an interesting proposition to analyse, bifolium-by-bifolium, a certain number of Greek manuscripts in the group under examination, with the aim of determining where the *axillae* are found. Accordingly, almost 500 quaternions from 20 pre-13<sup>th</sup>-century volumes were meticulously scrutinised (corpus A). It should be emphasised that this small corpus is not intended to be seen as a faithful representation of Byzantine production from a chrono-geographical standpoint, nor from a dimensional one: in fact, on account of the difficulty of identifying the positions of *axillae*, the small manuscripts (< 400 mm) were excluded from the investigation, at least for the time being.

The data collected through this operation made it possible to arrange the bifolia into five different categories. Each category was assigned a letter (Fig. 2):

- A:** ‘Silent’ bifolia, which is to say those without *axillae*.
- B:** Bifolia in which at least one lateral edge presents with an *axilla*.
- C:** Bifolia with an *axilla* on the lower edge, positioned off-centre to the left or right of the fold.
- D:** Bifolia with an *axilla* on the lower edge, centred on the fold.
- E:** Bifolia with two *axillae* on the lower edge; specifically, one on each half.



**Fig. 3:** Hypothetical folds to produce ‘Längsformat’ (longitudinal format)

Alongside the main corpus, a larger population (327 manuscripts, corpus B) underwent a less detailed and non-quantitative study. The manuscripts were divided into just two categories: those which present with *axillae* on the lower edge, and all the rest.

The results of the investigation carried out on corpus A as a whole are as follows:

- The ‘silent’ bifolia (A-type) represent practically half of the total corpus; their frequency varies from one volume to another.
- The B-type bifolia, which are compatible with Gilissen’s in-quarto formulae, constitute approximately a third of the corpus.

- The D-type bifolia, which conform to the in-octavo formulae, are not numerous, but are far from being absent. This result is surprising if one considers the large size of the volumes included in the corpus.
- The E-type bifolia represent a very small minority.

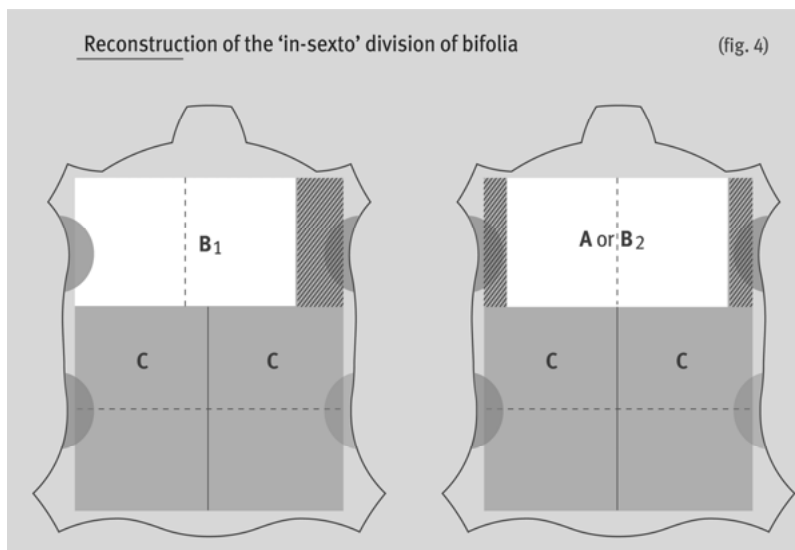
As regards the C-type bifolia, which are incompatible with Gilissen's formulae, their numbers are far from insignificant, given that they represent around 20% of the total population. We shall take a further look at these later on.

The variety of forms observed in one and the same volume is the most surprising thing that one notices when taking a first look at the results. Indeed, only six volumes present with very homogeneous arrangements: these, in all cases, are composed of B-type bifolia, characteristic of the in-quarto format, which can be considered 'traditional'. This type of subdivision is therefore very representative of Byzantine artisanal practice.

Given that one does not observe a large presence of E-type bifolia, it must also be concluded that the hypothetical *Längs-quartformat* was not favoured in the Byzantine world. This is understandable, since not only would volumes made in this way be, as we have already said, of greater width than height, they would also have a rather stumpy appearance: in fact, their height could not exceed half the width of the skin.

This being so, an effort was made to explain the number of C-type bifolia with one *axilla* positioned on the lower edge in corpus A. What characterises the manuscripts that contain these is the fact that C-type bifolia never appear alone: even where they are in the majority, they are always mixed with B-type bifolia. The necessity to account for this coexistence gave rise to a new hypothesis which not only explains the results obtained but also perfectly fits the size and proportion canons that characterise Byzantine manuscript production. However, the hypothesis presupposes that one is prepared to renounce the dogma that insists on the symmetrical subdivision of a skin into an even number of bifolia, and postulates that the artisan was able to obtain not two or four, but *three* bifolia starting out from the original skin (*in-sexto* division).

In applying this method, the skin would have been divided into a T-form. One would obtain in this way two 'Siamese' (i.e. conjoined) C-type bifolia, which is to say bifolia united with the spine of the skin, and one B-type bifolium, perpendicular to the former, whose fold does not necessarily coincide with the remaining part of the spine (Fig. 4).



**Fig. 4:** Reconstruction of the 'in-sexto' division of bifolia

In theory, in an entirely in-sexto volume one should find  $2/3$  C-type bifolia and  $1/3$  B-type bifolia. In practice, however, one observes a greater difference: in fact, in the B-type bifolium, the position of the *axillae* coincides with the portion that should have been cut off in order to obtain the same width of the other two bifolia. It follows, then, that the only in-sexto compatible volumes are those in which by adding to the percentage of B-type bifolia a sufficient number of 'silent' bifolia one can achieve a level of 33%.

Corpus A contains just three volumes in which the frequency of different bifolia types is compatible with these criteria. However, it is very likely that the in-sexto option was used partially, if not predominantly, in other manuscripts—indeed, in all volumes, C-type bifolia are distributed in equal numbers among those in which the *axilla* is situated on the right half and those in which it is situated on the left half. This distribution fits very well with the coexistence of 'Siamese' bifolia originating from the same skin placed symmetrically in relation to the spine.

Needless to say, when one resorts to an in-sexto subdivision, some of the raw material will be wasted, owing to the fact that the B-type bifolium is larger than the other two, and therefore has to be trimmed. However, it should be pointed out that all the skin subdivision options result in the sacrifice of a certain amount of raw material whenever cultural imperatives required that leaves should be endowed with proportions that do not naturally result from the division of skins, which there-



fore had to be trimmed in a systematic way. (It is not possible to expand on this issue in the present contribution.)

In the case of a traditional in-quarto format, each leaf replicates the original proportions of the skin: hence there is no sacrifice of material when those proportions coincide with the canonical criteria imposed on the leaf. What of the in-sexto format, then? In order for there to be no sacrifice of raw material, the three bifolia must be contained within the usable rectangle. It can be shown that this will only happen when the proportion of the skin is  $2/3$  and the leaves of the manuscript are square. These are conditions that neither correspond to the reality of animal skins nor to the working practice of artisans.

In the absence of such conditions, the minimum loss (approximately 10%) can be achieved when the skin's proportion is  $4/5$  and that of the leaves  $3/4$ . Now, these proportions represent, respectively, the average proportion of skins and the predominant trend observed in the proportion of leaves in the Byzantine world, irrespective of the size of manuscripts. It should be noted that, under such conditions, the loss amounts to 6% for the in-quarto format and 17% for the in-octavo. One can see, then, that an in-sexto subdivision yields the best results precisely in routine artisanal practice, and that in this context it holds a position which can almost compete with the traditional in-quarto solution. However, since this does not represent a decisive advantage, it is insufficient to exert a serious impact on the latter option.

Most of the 20 volumes examined (a detailed analysis of which cannot be provided here) were made using a range of different methods. Nevertheless, one is not necessarily dealing with a chaotic jumble: in two of the manuscripts, extensive homogeneous portions are plain to see. In order to propose a plausible explanation for this concomitance of different practices, it is necessary to address the question concerning the sizes of volumes and skins in the Byzantine world.

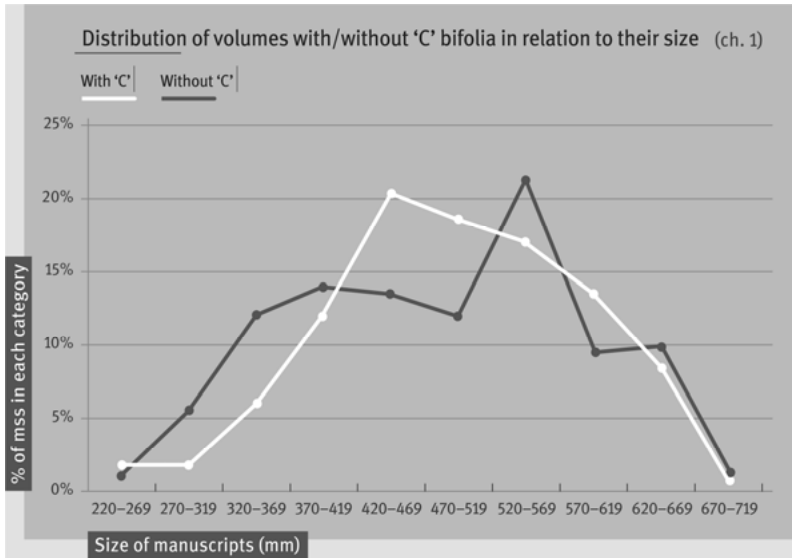
The size (*taille*) of the manuscripts in corpus A range between 436 and 715 mm. If the lower limit is due to a limitation being deliberately pre-imposed on the sample (see below), the upper limit represents a ceiling that is typical of Byzantine production as a whole. On the other hand, it is astonishing to see that, in contrast to what happens in other countries and in other eras, even the largest volumes never present with in-folio folding.

Given that the large manuscripts in corpus A are in-quarto, it is easy to confirm that the 'useful' size of the skins used to make them ranged from 1250 to 1450 mm. These are certainly large skins, but this should come as no surprise: skins of such dimensions are well documented in medieval production, and even more so among today's parchments. That being said, it is very likely that skins of these dimensions were not used exclusively for the largest volumes. Subdivided in-octavo, the same

skins could have yielded leaves measuring between 400 and 470 mm in size. Indeed, D-type bifolia are present in the smallest volumes of corpus A, but the sample was not sufficient to carry out a deeper analysis of this finding. Subdivided in-sexto, the skins could have produced sizes ranging from 485 to 560 mm. Now, two of three presumed in-sexto manuscripts fit precisely within this range.

One will observe that the in-quarto or in-octavo subdivision of large skins produces manuscripts of very different sizes. However, such a gap does not exist in the size distribution of Byzantine manuscripts. This void could certainly have been filled by using skins of different sizes, but also through the adoption of different subdivision techniques, such as, indeed, the in-sexto option. The filling of this size gap could therefore represent one of the incentives that encouraged the development of this technique. However, some other advantages arising from this approach can also be considered:

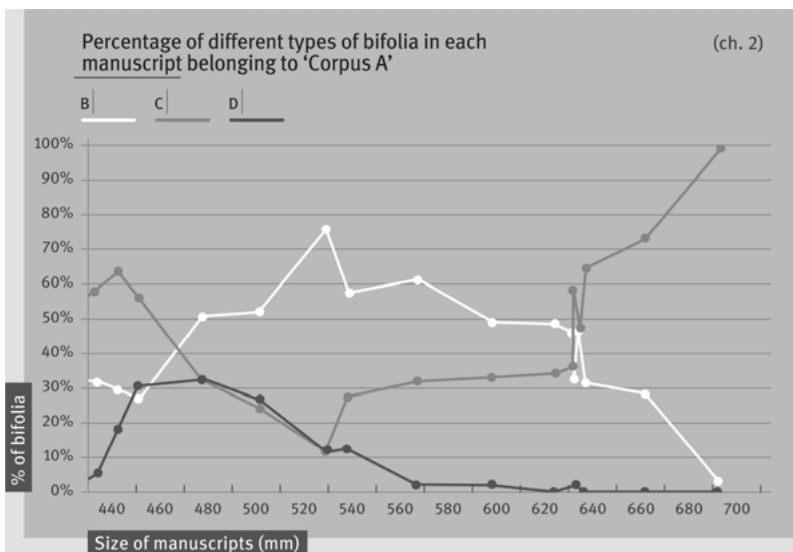
- Avoidance, as far as possible, of resorting to an in-octavo subdivision. Poorly suited to leaves of wide proportion, this solution always involves a not negligible sacrifice of raw material in Byzantine manuscripts.
- The standardisation of the leaves in one and same volume when the available batches of skins are of very mixed sizes. This would explain why one encounters a considerable number of volumes containing a medley of different techniques. Chart 1—in which the percentage of different types of bifolium in relation to the size of volumes is shown—demonstrates very clearly a sort of ‘no man’s land’ around the average sizes, a kind of ‘crossroads’ where the various possibilities vis-à-vis the subdivision of skins would intersect. In large volumes, there are longer skins that are large enough to make in-sexto books, and in small ones, where the in-sexto format would produce books that are too large, the in-octavo format takes up the baton.
- The possibility of better exploiting the raw material by obtaining three bifolia from a skin which is a little larger, rather than two bifolia from a slightly smaller skin. It can be demonstrated that skins measuring 1450 and 1250 mm in size, subdivided in-quarto and in-octavo respectively, produce pages of very similar dimensions, with a significant gain of usable surface (an absolute value) in the in-sexto format. In general, from the economic standpoint, artisans preferred to divide a large skin into a greater number of smaller rectangles, rather than to divide a small skin into fewer larger rectangles. Could this be the justification for the use of larger skins in the period preceding the 13<sup>th</sup> century? The idea is rather attractive, but at present there is nothing to prove it.



**Chart 1:** Distribution of volumes with/without 'C' bifolia in relation to their size

A close look at corpus B supports the hypothesis of 'the filling of a size gap', as formulated above. In fact, Chart 2 shows that the maximum concentration of C-type bifolia is found precisely in a space less occupied by manuscripts in which this type of bifolium is absent. One also notes, as in Chart 1, that the frequency of C-type bifolia decreases in correspondence with size—the data are therefore consistent. On the other end of the curve, the decrease in correspondence with small sizes hints towards the adoption of other solutions (i.e. in-octavo and in-quarto treatment of small skins) that the insufficient sample in corpus A makes impossible to discern.

In conclusion, the existence of an in-sexto subdivision rests on the rigorous and irrefutable observation of certain irregularities in parchment whose position on the bifolium is totally incompatible as much with the 'traditional' formulae proposed by Gilissen as with a hypothetical 'oblong' orientation of the skin. The consistent coexistence of B-type and C-type bifolia in one and the same volume, as predicted by our reconstruction, further substantiates the existence of such a subdivision.



**Chart 2:** Percentage of different types of bifolia in each manuscript belonging to 'Corpus A'

Furthermore, this method appears to be well suited to the material and artisanal context typical of the Byzantine manuscript. When one wishes in all cases to obtain wide bifolia without taking into account the 'natural inclination' of the animal skin, the in-sexto option, thanks to its geometrical characteristics (which we cannot elaborate on here), is easy to achieve and allows for a greater exploitation, relatively speaking, of the usable area of the skin. Additionally, inasmuch as it represents an intermediate size solution lying between the in-quarto and in-octavo solutions, this kind of subdivision makes it possible to vary the size of volumes when starting out from typologically uniform skins, usually of large size. Finally—and this does not represent a contradiction—the method could just as easily play a role in the opposite way, namely by contributing to the regularisation of bifolia when the abovementioned large skins do not form sufficiently uniform batches.

These considerations presuppose a civilisation in which the slaughter of livestock was never carried out with a view to producing parchment, at least in the pre-13<sup>th</sup>-century Byzantine world: in other words, the artisans had to make do with what was at hand. Such an agro-technological background is not at all unlikely, but it certainly ought to be corroborated through further observations. At the same time, a new question automatically arises: given that the artisanal circumstances and technical *savoir-faire* were not the same, can it be said that

the practice of in-sexto subdivision did not take place in the Western Middle Age? On this matter we shall have to reserve judgement, given that up to the present nobody has set out to examine Latin manuscripts from this perspective. A well-targeted investigation would therefore be welcome.<sup>4</sup>

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<sup>4</sup> For a more detailed analysis of these phenomena, the interested reader can refer to Maniaci 1999.

