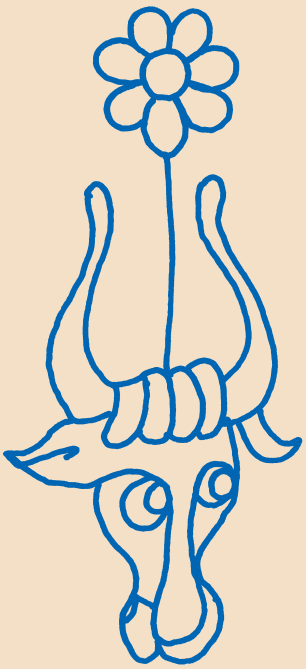
The Bernstein Project

Booklet of the exhibition



Bull's Head and Mermaid

The History of Paper and Watermarks from the Middle Ages to the Modern Period

BERNSTEIN THE MEMORY OF PAPER

LANDESARCHIV
Baden-Württemberg

Bull's Head and Mermaid

The History of Paper and Watermarks from the Middle Ages to the Modern Period

Booklet and catalogue of the exhibiton presented by the Landesarchiv Baden-Württemberg,
Hauptstaatsarchiv Stuttgart and the Austrian Academy of Sciences,
Kommission für Schrift- und Buchwesen des Mittelalters, Vienna

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The cover images are depictions of the watermarks "Bull's Head" and "Mermaid" from the "Piccard" watermark collection at the Hauptstaatsarchiv Stuttgart.

The exhibition was shown in Stuttgart (Hauptstaatsarchiv, December 2006 to February 2007), Vienna (Schottenstift, March to June 2007), Fabriano (Museo della Carta e della Filigrana, July to August 2007), Rom (Istituto per la patologia del libro di Roma, September to October 2007), and Milan (Castello Sforzesco, Biblioteca Trivulziana, October bis December 2008).

The initials in brackets at the end of each contribution following the sigla of the authors indicate the contribution's translator. The complete names can be found in the list of authors and translators (p. 128).

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Preface

The exhibition "Ochsenkopf und Meerjungfrau. Wasserzeichen des Mittelalters" has had an international "carreer". After it was shown at the Hauptstaatsarchiv Stuttgart from December 2006 to February 2007, it was shown from March to June 2007 at the Schottenstift in Vienna. An expanded Italian version under the title "Testa di bue e sirena. La memoria della carta e delle filigrane dal medioevo al seicento" moved to Italy, where it was presented from July to August 2007 at the Museo della Carta e della Filigrana in Fabriano, followed by a show from September to October 2007 at the Istituto centrale per la patologia del libro in Rome. 2008 the exhibition is just presented at the Biblioteca Trivulziana (Castello Sforzesco) in Milan, before it moves 2009 to the Biblioteca Nazionale in Turin and – in an English version – to the Koninklijke Bibliotheek in The Hague.

The exhibit was originally conceived as a joint project between the Landesarchiv Baden-Württemberg and the Commission of Paleography and Codicology of Medieval Manuscripts of the Austrian Academy of Sciences in Vienna. Accordingly, the first edition of the accompanying catalogue focussed on watermarks of the Middle Ages. Nevertheless, the catalogue spanned a wide range of other topics as well, including the history of paper and research on manuscripts, as well as a presentation of the major watermark collections, current watermark databases and digitized images.

After the exhibit was incorporated into the project "Bernstein – The Memory of Paper", the exhibit and the catalogue were expanded, as could already be seen in the Italian version: not only did it contain four prefaces instead of one, the topics being examined were also broadened with regard to the time period, the regions under consideration and the methodology. The incorporation of artistic testimony, drawings and prints, especially from the sixteenth century, went hand in hand with a more comprehensive examination of the history of paper in Italy. In addition, the different technical possibilities for reproducing watermarks were introduced and the presentation of the databases was supplemented with the new material they had incorporated in the interim. Amendments were also made to the general bibliography on the history of paper and watermarks.

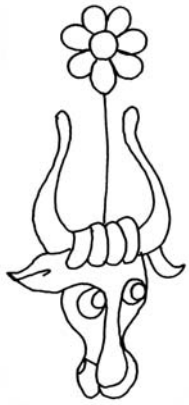
With this third expanded edition, the exhibit catalogue has finally become an independent compendium. It's title, "Bull's Head and Mermaid. The History of Paper and Watermarks from the Middle Ages to the Modern Period", is a direct successor of the previous versions, but expands upon them considerably. In addition to the longer time period, the focus of the previous volumes has been expanded with new articles and consolidated within the framework of the "Bernstein Project". Paper production in the Netherlands during the modern period is examined, as well as the transition to the industrial production of paper. Contributions dealing with methodology examine the relationships found between watermarks, as well as research on manuscripts and incunabulum, and in musicology and cartography. The various means of recording watermarks is also dealt with in a separate article. The original list of watermark collections and collectors has been amended with additional relevant names as well as watermark databases.

A separate chapter is devoted to the Bernstein Project and the groundwork it has laid. This includes an examination of technical standards in watermark reproduction and the "Bernstein Workspace", which includes a newly revised multi-language glossary of watermark terminology and a cartographical and statistical analysis of paper and watermark data. The selected bibliography has been expanded, and has become a solid reference work for research on watermarks.

This volume presents the Bernstein Project, its tasks and goals, its objectives and prospects. It also presents the individual work as well as the mutual efforts of the project's collaborators. Its sincere aim is not only to provide a solid foundation for scholarly work on the history of paper and watermarks by describing the current interdisciplinary state of research, but also to motivate future collaborations with regard to Europe's common cultural heritage. The study of paper and watermarks is a worthy contribution.

Stuttgart, December 2008

Peter Rückert (C.P.-K.)



I Watermarks of the Middle Ages

Introduction

When dealing with paper one deals with watermarks. From the beginning of paper production in Europe, probably as long ago as the twelfth century, watermarks have been used to indicate a paper's origin or quality. They indicate the town and the factory, or at first the paper mill, where the paper was made. In modern terms, one might speak of watermarks quasi as "labels", as a designation of origin or certification of quality. However, watermarks are not immediately visible, but only when paper is held up to light.

The best known contemporary use of watermarks is in paper currency. When backlit, the new Euro banknotes have a watermark that is visible from both sides in the area that is not printed. The bill's architectural motif and its value can be seen. As has always been the case, the watermark is generated directly during the production of the paper through variations in the paper's thickness. It serves here – as for bank notes in general – primarily as proof of the bill's authenticity and to safeguard against counterfeiting.

In the Middle Ages watermarks were typical in the production of paper. They have been preserved for the most part in the paper manuscripts, prints and drawings that are now held and displayed by libraries, archives and museums. After gradually replacing the more expensive parchment as a material to write on – which occurred in Central Europe in the fifteenth century, in the Mediterranean regions earlier, and in northern and eastern Europe later – paper has remained the most important carrier of writing until our time. Of course the way paper is made has changed considerably, especially since the nineteenth century and the development of machine production, and the importance of watermarks – with the exception of banknotes – has become largely negligible. And today, the importance of paper is gradually being reduced by the transformations in communication structures through electronic media. Electronic storage by means of various types of data carriers has already replaced much printing on paper, although its capacity for long-term "durability" cannot yet be foreseen.

Paper from the Middle Ages, together with its watermarks, usually presents no conservation difficulties when stored professionally and handled properly. Correspondingly, the study of paper and watermarks has a long tradition and has been undertaken in many places for centuries. Naturally, contemporaries were already aware of the use and function of watermarks in the production of paper, as can be seen in the early treatise by Bartolus de Saxoferrato.

The interest of modern paper historians and scholars doing research on manuscripts and incunabula who deal with watermarks centres primarily on the methodological possibilities that watermarks provide for dating, apart from the historical economic and technical aspects of paper production as well as its trade and distribution. The watermark collections and research of major scholars like Charles-Moïse Briquet and Gerhard Piccard have demonstrated the special value watermarks hold for dating undated manuscripts and prints. As a rule, by comparing and finding identical watermarks, they can be accurately dated to within a few years. This is of particular scholarly importance especially for early examples from the fourteenth to sixteenth century. A prerequisite for dating by means of watermarks is, accordingly, a large number of dated watermarks. The watermark catalogues published by Briquet and Piccard were the first collections to provide such information. Numerous later watermark collections augment this material, and it is thus likely that now most watermarks of the Middle Ages have been recorded.

In the last few years the large watermark collections have also been digitally recorded. The entire collection of Gerhard Piccard in the Hauptstaatsarchiv Stuttgart, with approximately 92,000 samples of watermarks, is already available on the internet.

It is also planned to fuse the large data banks WZMA (Vienna) and WILC (The Hague), which are currently the main sources for the European Union-funded project "Bernstein – the memory of paper", and to present them as a joint "watermark portal" on the internet. It is clear that common terminology in watermark nomenclature plays an important role here. As the use of many languages is mandatory for

Ill. 1: Banknote with watermark

accessing and describing watermarks, regular international discussions in this field are necessary, as is already done within the framework of the International Association of Paper Historians (IPH) in particular.

"Bull's head" and "Mermaid" are two well-known and widespread watermarks of the Middle Ages. They represent here the early world of paper, the iconology of the Middle Ages, as well as the questions facing current research on paper and watermarks. Thus, they also stand for the relationship between the paper production of the Middle Ages and its presentation and analysis today.

P.R. (C.P.-K.)

Bartolus de Saxoferrato

Bartolus de Saxoferrato (Bartolo da Sassoferrato) (*1313/14 in Sassoferrato [March of Ancona], [u98] 1357 in Perugia), one of the most important representatives of the so-called scholastic jurisprudence, studied law in Bologna, and taught from 1339 in Pisa, and then from 1342 in Perugia. In addition to his commentary on portions of the *Corpus iuris civilis* and the more than four hundred *consilia* that were the result of his activities providing legal advice, he wrote several important monographs (treatises), among them the *Tractatus de fluminibus seu Tyberiadis* on river rights, and the *Tractatus de insignis et armis* (Treatise on insignia and coats of arms), left unfinished by his death, which was the first legal examination of heraldry.

In this treatise he also deals with the signs and marks that craftsmen used to identify their products or show where they came from. In the discussion about these signs, the first recorded mention is made of watermarks, and in this context, of Fabriano, a town not far from Bartolo's birthplace.

Text (Ill. 2) based on the edition:
Quedam vero sunt signa cuiusdam artificii seu peritie. Et hic advertendum, quandoque sunt signa artificii in quo principaliter operatur qualitas loci. Exemplum: in marchia Anchonitana est quoddam castrum nobile cuius nomen est Fabrianum, ubi artificium faciendi cartas de papiro principaliter viget, ibique sunt edificia multa ad hoc et ex quibusdam edificiis meliores carte proveniunt, licet ibi faciat multum bonitas operantis. Et, ut videmus, quodlibet folium carte suum habet signum propter quod significatur cuius edificii est carta. Dico ergo, quod isto casu apud illum remanebit signum apud quem remanebit edificium in quo fit, sive iure proprietatis, sive iure conductionis, sive quovis alio titulo, sive totum, sive in partem, sive etiam mala fide teneat, toto tempore quo tenet non potest prohiberi uti signo ...

(Translation: Some trademarks are proper to a particular craft or skill, and here it should be noted that sometimes they are connected to the nature of the place in which the product is made. For example, in the March of Anchona, there is a certain renowned town named Fabriano, where the manufacture of paper is the main business. Here there are many paper mills, and some of them produce better paper, although even here the skill of the worker is of considerable importance. And here each sheet of paper has its own watermark by which one can recognize the paper mill. Therefore, in this case the watermark should belong to the one to whom the mills itself belongs, no matter whether it remains in his possession by right of ownership or lease, or by any other title, wholly or in part, or even in bad faith. During the entire time in which he has possession of the mill, he cannot be prohibited from using the watermark ...)

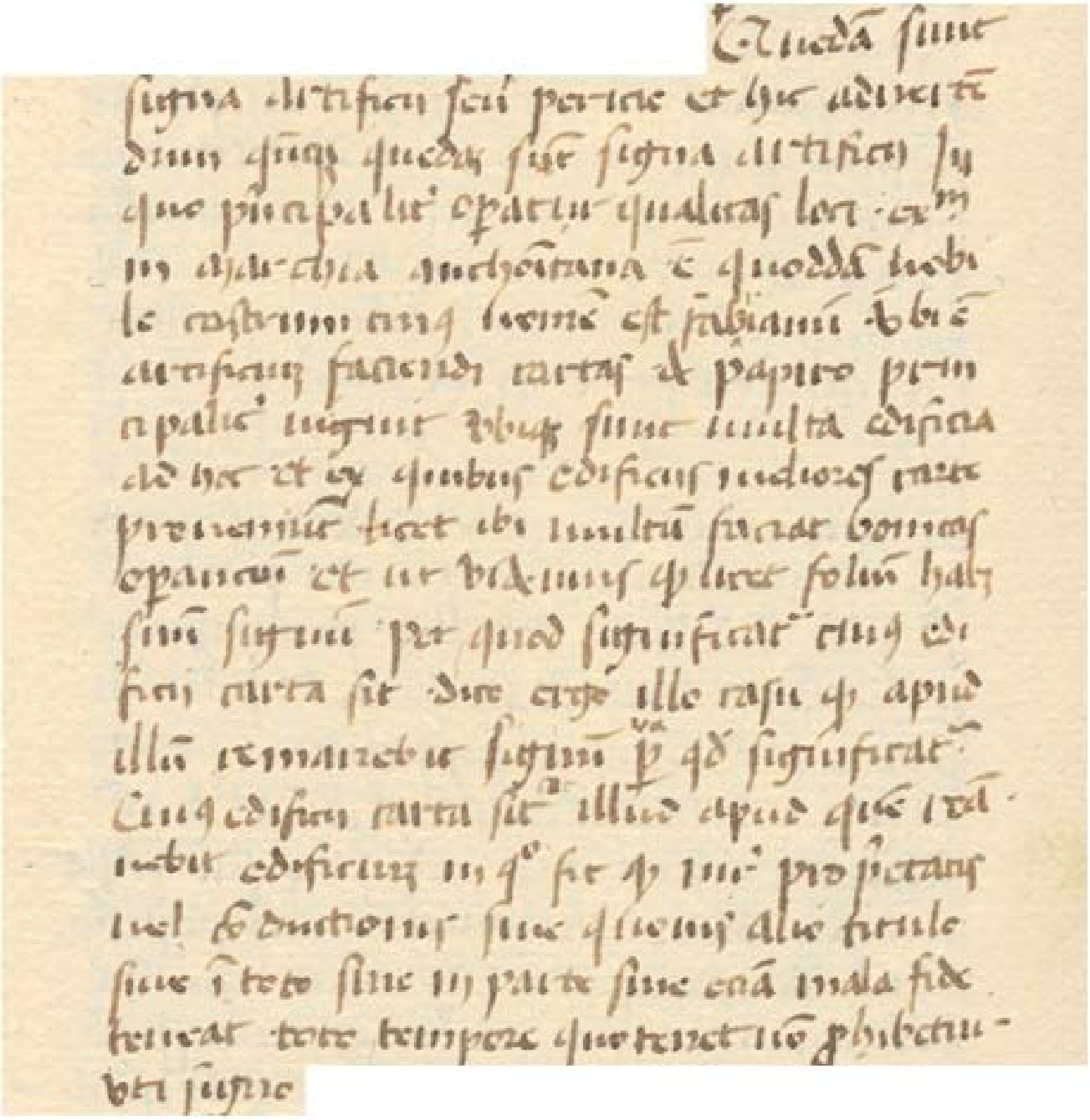
Here Bartolo distinguishes between the marks or signs of craftsmen of whom the quality of their products is primarily dependant on the worker's skill or experience, and those of craftsmen whose products' quality is also dependant on local physical conditions. In using the paper production in Fabriano as an example, he takes the quality of the water, which plays an important role in paper production, for granted. Pure soft water was indispensable for making good paper. According to Bartolo, in cases where, in addition to the skill and experience of the craftsman, the local natural resources are important for a product's quality, for paper the water, the signs or marks are not tied to the producer, but to the site of production, here the paper mill. The user of the mill was allowed to use the sign only as long as he owned the mill, regardless of which type of ownership title he had. In other parts of the treatise Bartolo explains – again using the watermarks of paper mills as an example – that no one else has the right to use this mark.

The rule that Bartolo put forward was universally recognized by the courts of the Middle Ages and never called into question. It is thus not surprising that in the first half of the fifteenth century, the learned jurist Pietro Baldeschi, the grand-nephew of Bartolo's student Baldo degli Ubaldi, when discussing watermarks and citing the Bartolo passage *Marchia Anconitana ... operetur bonitas operantis*, does not comment on the words of the great jurist. His intention has been merely to express that this is the unanimous viewpoint of the jurists in Italy.

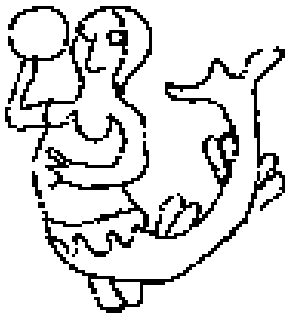
Edition of Tractatus de insignis et armis: O. Cavallar, S. Degenring, J. Kirshner, A Grammar of Signs. Bartolo da Sassoferrato's "Tract on Insignia and Coats of Arms" (Studies in comparative legal history), Berkeley 1994, 109–121 (further prints are listed on p. 108), the cited text cf. p. 113, l. 171–183; translation: p. 149; comment of the editors to Bartolus remarks about watermarks cf. p. 69.

Literature: Henkelmann, Bartolus de Saxoferrato; Weiß, Papiergeschichte und Wasserzeichenkunde, ad Tractatus cf. 298; Weiß, Handbuch der Wasserzeichenkunde; Renker, Das Buch vom Papier, 113 (ad Bartolus) and 74–76 (importance of water for paper making); Gasparinetti, Bartolo da Sassoferrato und Pietro Baldeschi; Ornato et al., La carta occidentale nel tardo medioevo I. Tomo 1, 110 (ad Bartolus) and 155 and n. 99 (ad Fabriano), including further literature.

F.L. (C.P.-K.)



Ill. 2: Bartolus de Saxoferrato: Tractatus de insignis et armis, passage on the watermarks of Fabriano, from: Vienna, Archiepiscopal Diocese Archives, Kirnberger Bibliothek der Wiener Dompropstei, E-2, 156vb; Italy, middle 15th cent. (detail)

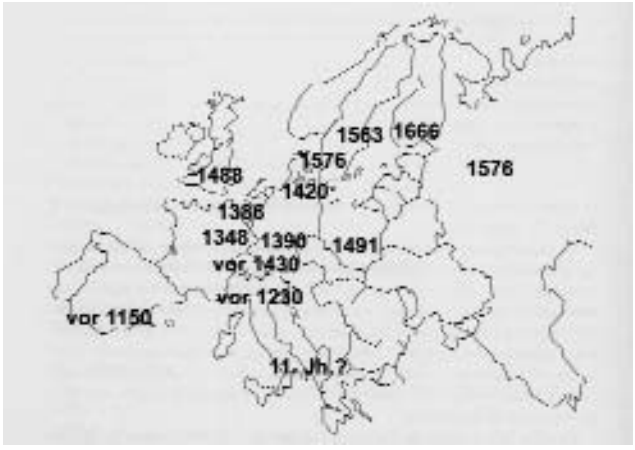


II The History of Paper und Paper Production from the Middle Ages to Modern Times

The History of Paper and Paper Production

The inventor of paper is purported to be the Chinese court official Ts' ai Lun, who, as reported in the Chinese royal chronicles (*Hou Hanshu*), began to produce paper out of rags and plant fibres in the year 105 C.E. The secret of making paper was guarded in the Middle Kingdom for over seven hundred years, before the process became known in Germany by way of Arabia, Egypt, Spain and southern Italy. The oldest European manuscript on paper was produced in Spain earlier than 1036, a *Breviarium et Missale mozarabicum*, which was composed at the monastery of Santo Domingo de Silos near Burgos on Arabian paper. Arabian paper was already used in Sicily in 1061. The oldest paper manuscript from the German-speaking realm is considered to be the register of Albert Behaim from the Bavarian monastery of Aldersbach, most of which is written on paper from Italy, but which was begun in 1246 on Spanish-Arabian paper.

It was no longer a particularly large step from using imported paper to producing it in one's own country. In Spain, paper probably began to be produced before 1150 and in Italy, before 1230 (Tschudin 2002) (Ill. 1). Documents record the first paper producer in Fabriano as early as 1283. Fabriano's rival was Amalfi, where, however, the independent production of paper is verifiable only from 1289.

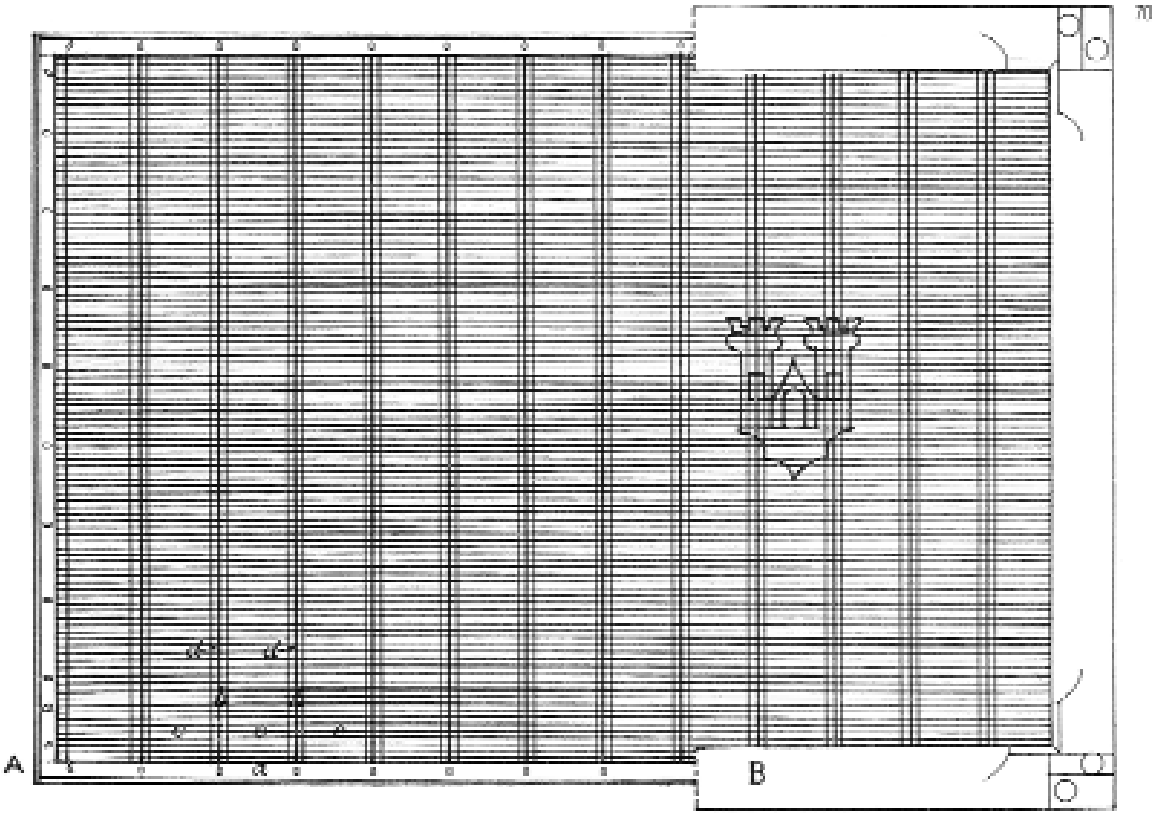


Ill. 1: Chronological spread of papermaking in Europe (based on Tschudin)

From the thirteenth century, the spread of paper production in Europe resulted in parchment, the material that had generally been used for writing until that time, to be slowly replaced. This development was helped considerably by the founding of paper mills. In the German-speaking regions, the "Gleismühl" paper mill of Ulman Stromer in Nuremberg, founded in 1390, is considered the first of its kind. Other
paper mills were established in Ravensburg (1391), Augsburg (1468), Kempten (1477), Memmingen (1481), Ettlingen (1482), Reutlingen (1486) and Landshut (1489) (Schweizer). It is remarkable that in the German-speaking areas, papermakers did not organize themselves into guilds. This was based on the understanding that papermaking was a free trade and thus its practitioners did not have to be part of a guild.

How was paper made? The production of paper in the Middle Ages had two steps: First, plant fibres were broken down and dissolved. The second step involved binding these dissolved fibres into a new material. In the Middle Ages linen rags furnished the basic raw material for making paper. Collecting rags and fabric scraps was the responsibility of rag collectors, who gathered used clothing, linens and rags from the populace. The rag collecting trade was often tied to bartering. Silk and wool was sorted out from the discarded fabric as unsuitable for making paper. The rag collectors offered their fabric scraps to the paper mills, the first customer having the advantage of being able to pick out the best pieces for finer paper. It can be shown that official regulations limited the trade in rags geographically already early, and therefore it is possible to closely determine where the rags used by a particular paper mill came from.

After the rags had been collected, sorted and soaked, and the retting (rotting process) had broken down the woven fibres, the complete separation of the fabric was carried out by machinery that hammered and beat the pulp. In the second step of the papermaking process, a paper mould was needed in order to form paper out of the fibre pulp (Ill. 2). The main parts of such a mould are a wooden frame (deckle) and a screen. The latter is formed of laid-lines (ribbing wires) running closely parallel to each other, and perpendicular chain-lines (warp wires). This wire grid is so tightly arranged that when scooping the paper pulp out of the vat, the water runs off but the fibres remain as a thin film on the screen.



Ill. 2: Schematized rendering of a papermaking mould (based on Piccard)

Less paper pulp accumulates on the wires than in the free spaces between them. Likewise, the paper is more transparent where wire figures have been attached to the screen's grid to create a watermark. It was noted by Piccard that strictly speaking two watermarks are produced when making paper: on one hand he is referring to the prints of the screen's laid and chain-lines, which are a technical feature as well as the main characteristic of handmade paper, and on the other hand, the transparent forms created by the deliberate fastening of wire figures to the screen, producing watermarks (Piccard spoke of 'paper marks') in the usual sense of the word.

When the mould is lifted out of the watery paper pulp in the dipping vat, the water flows off through suction and the linen pulp (rag pulp) remains on the screen, forming a new material: a piece of paper (Ill. 3). It contains the watermark as well as a print of the chain-lines (warp wires), seen in the warp lines, and the laid-lines (ribbing wires), seen in the ribbed lines (Bannasch). Usually two workers are involved in the process of making paper: One is the vatman, who is responsible for dipping the mould into the vat filled with water and fibre pulp (the 'slurry') and who carefully shakes the contents so that the pulp is spread evenly over the screen. The other is the couchman, who then takes the mould containing the paper pulp from the vatman. While the vatman repeats the first step with a new screen, the couchman lays a sheet of felt over the fibres in the mould and couches the fibres on the screen onto a ready piece of felt by turning the mould over. A second sheet of felt is laid over the wet sheet of paper so that the next piece of paper can be couched directly on top of it.

Thus, for reasons of efficiency, two screens were used to work at one dipping vat, and consequently there were two wire figures forming watermarks. Sheets of paper that were made in this way therefore show two variants of a single watermark, a watermark pair. It was possible for two workers at one vat to make up to five thousand sheets of paper during a twelve-hour workday (Jaffé). As soon as a taller stack of fresh sheets of paper and the felt separating them had piled up, this 'post' was pressed. In this way the weight could be reduced by nearly half. In a second pressing, after the felt was removed and the correspondingly smaller post of paper sheets was laid in the press, the dipping water was pressed out nearly completely. The paper was then brought to a drying attic to dry completely. There the sheets were hung on lines with the help of a wooden cross. In a final step, each sheet of paper was coated with a layer of starch paste, smoothed out again and packed for transporting.

Tschudin has estimated that a mould had a work life of maximum two years; larger moulds were considered more

Ill. 3: Papermaking with a paper mould, woodblock print from 1698

delicate. The relevance of watermark pairs was not taken into account by Briquet (1907) in his watermark collection, and thus he referred to the large number of variants of individual watermarks.

The fact that one finds watermark pairs is, however, very important: based on the number of extant pairs of forms it is possible, for instance, to estimate the number of vats in a particular paper mill and thus the size of the business (Weiß 1955). Detecting several different pairs of watermark forms from one paper mill verifies that various motifs were used at one and the same place.

The production of wire figures for watermarks requires special skill. When paper first began to be produced, they were made by the papermakers themselves, but later they were made by specialized craftsmen who were often gold or silversmiths (Spoer). The craft of forming wire figures withstood the invention of the electroforming process around 1830. Not least, handmade paper that contains watermarks offers valuable dating possibilities because of the "independent existence" of the watermarks' wire forms. Since the act of couching was hard on both the mould and the attached wire forms, on occasion such figures worked themselves loose. Soldering points, which can still be seen in the watermarks, are a sign of later repairs. Such repairs could result in the shifting or deformation of a watermark. The wire figures were also sometimes damaged when scrubbing the mould clean with brushes. Changes in the wire figure, visible in the watermark, offers a key to the production chronology of a particular type of paper. In addition, it can be surmised that wire figures were sometimes transferred to new screens, which also presents dating possibilities (Tschudin 1996).

The paper produced in Europe reached its best quality in the fifteenth to sixteenth century. Its export led to the spread of book printing. Technical improvements were developed in the early modern period in the production of handmade paper, which as mentioned above is characterized by visible warp and woof wires in addition to watermarks. This "new" paper, vellum paper (Lat. *Vellum* = skin), was first produced in England in the middle of the eighteenth century. In Germany, widespread production only began at the beginning of the nineteenth century (Spoer). Watermarks finally stopped playing such a major role when paper began to be manufactured industrially, which resulted in an increase in production, a multitude of formats, and, especially, paper being stored for longer periods of time.

The oldest European paper format (Bologna about 1308, after Tschudin 2002)
• Imperiale 500 mm x 740 mm • Reale 450 mm x 620 mm • Mezzane 350 mm x 520 mm • Reçute 320 mm x 450 mm

Literature: Bannasch, Wasserzeichen als Datierungshilfe; Hößle, Württembergische Papiergeschichte; Jaffé, Zur Geschichte des Papiers; Piccard, Die Wasserzeichenforschung als historische Hilfswissenschaft; Piccard, Datierung des Missale speciale; Schweizer, Frühes Papier; Spoer, Drahtgeschichten; Tschudin, Grundzüge der Papiergeschichte; Tschudin, Methodik der Papierdatierung; Weiß, Bedeutung der Wasserzeichenkunde; Weiß, Geschichte des Papiers; Weiß, Zeittafel zur Papiergeschichte.

C.K. (C.P.-K.)

Paper: from Fabriano to Europe

How and when paper and papermaking was introduced to Italy has yet to be studied. The only clear pieces of evidence we have date to the thirteenth century. A notarized document issued in 1235 in Genoa states that two Ligurians, one from Lucca and both owners of paper mills, had employed a papermaker for their workshops. Twenty years later (1255), a notarized certificate documents the founding of a company by a Milanese and a Genoese papermaker to begin paper production in the vicinity of Milan.

But to the south of the peninsula in Sicily paper already existed from the twelfth century. It seems that here at least two Arabian paper mills were in operation, one near Catania, the other in the vicinity of Palermo. It is certain, however, that Sicilian paper was, like the Spanish paper produced

in the Iberian regions under Moorish rule, *Arabian* paper and thus made according to Arabian methods. It used a binding agent based on starch, which was good for countries with hot and dry climates such as in Arabia, but less suitable for more temperate and damper regions such as central and northern Italy. Here the humidity encouraged the starch's fermentation and thus processes that led to the paper's disintegration, this to such an extent that for important documents it remained essential to use parchment, which though more expensive was more durable.

A further characteristic of Arabian paper was the method of processing the rags, which was done by hand with wooden pestles (similar to large clubs) in large stone mortars. This limited production. Although it seems that hydraulic machines were in fact used in Cordoba and Xativa, as can be deduced from reports by Arabian chroniclers, it is not possible to reconstruct their exact purpose.

In the second half of the thirteenth century, a "new" type of paper appeared on the market, a paper that was much different than the other papers; it had finer fibres, a special texture, and it also absorbed ink better. The traders who offered it at the market places of Foligno, Perugia, Florence and Bologna came from Fabriano or were in contact with traders from Fabriano. As is clear from various documents, papermaking was already flourishing in this small town in the borderlands at the foot of the Apennines in the second half of the thirteenth century. Since paper from this area was at that time already preferred both at home and abroad, it thus seems that its quality must have been quite high and therefore it is reasonable to assume that paper production must have begun here many years earlier. The exceptional popularity of Fabriano paper was the result of three innovations distinguishing it from other products and contributing to its great success:

First, the breaking down of the fabric fibres was no longer done by hand, but mechanically with a machine (called a *pila a magli multipli*) that had originally been used for processing wool, also a common trade in Fabriano. This machine, the so-called *gualchiera* (felt machine), which was used for milling wool to process it into woollen fabric, was modified and used for breaking down the linen and hemp rags. This freed the workers of a lengthy and tiring task. The quality of the final paper pulp was improved and it was also possible to increase production.

A further difference was the binding agent, which in Fabriano was made of animal gelatine, in contrast to substances containing starch, which, as already mentioned, were responsible for the rapid disintegration of Arabian paper. It is unknown how this binding agent came into use, but if one considers that in the early period, wool and paper were processed and manufactured – possibly – at the same place if at different times, it may have been a chance discovery. Even if one accepts that this was simply an accident, it is to the credit of the papermakers of Fabriano that they recognized its advantage in papermaking and used it.

And the papermakers of Fabriano introduced a third technical innovation, an innovation that at first glance was not obvious, but from an economic viewpoint very important: the watermark (*filigrana*, *marca d'acqua*), which identified every single sheet of paper that they made.

A watermark is a sign (a letter, the outline of a figure, etc.) (Ill. 4) that is in the paper and that on first sight is nearly imperceptible; if one looks at the sheet against a light, however, the watermark can be seen very clearly. The watermark is visible because of a very fine difference in the paper's thickness, this caused by a bent wire figure in the shape of the desired watermark being attached to the screen of the papermaking mould. When the papermaker dips the mould into the pulpy mass in the vat and pulls it up to form a piece of paper, the water drains off quickly and the fibres remain on the screen. Quickly and skilfully the papermaker spreads the fibres evenly over the whole screen. As a result of the thickness of the figure's wire, the paper is thinner where it has been attached.

Ill. 4

From the time papermakers put watermarks into each piece of paper they made, the markets knew which paper came from Fabriano. Since paper from Fabriano was of such high quality, it became ever more popular and the watermarks became not only a sign of origin, but also a mark of quality. Already in the fourteenth century the great jurist Bartolo da Sassoferrato was aware of this, and in his treatise *De insignis et armis* mentioned it to introduce the concept of exclusive rights to a trademark's use.

Watermarks became the sign of the papermakers and the paper mills. In some cases the papermakers were required to incorporate watermarks by traders in order to guard against forgery. Ludovico di Ambrogio, a trader from Fabriano, carefully noted every sale of his wares in his registers; in addition to the paper, he also noted the watermark of not only his own production but also all that he bought or sold:

"Today, 23 November 1365, we bought *charte reali* with an axe (*mannara*), 2 bales; *charta reale* with a horse (*cavallo*), 2 bales; *charte reali* with a pinecone (*pinnocchio*), 3 bales; *charte* with a flower (*fioretto*), 3 bales; *charte* with a pomegranate (*melograno*), 5 bales; round *charte* with a lily (*gillio*), 5 bales; in sum 20 bales with a weight of 4000 pounds". In these notes, *reale* indicates a paper format (a *charta* is a sheet of paper), while *mannara*, *cavallo*, *pinnocchio* etc. indicate the watermark. In his entries are found references to approximately sixty different watermarks,

which gives an idea of how many paper mills there were in this period, 1363 to 1411, in Fabriano and its vicinity.

As already mentioned, the paper from Fabriano was a success not only at nearby markets, but also further away, as in Genoa, Bologna, Venice, etc., and it was even found on the other side of the Alps. It is known, for instance, that the papal court in Avignon regularly purchased paper from Fabriano, which was shipped there from Talamone by way of the port of Aigues-Mortes.

Paper export made Fabriano famous, but also another phenomenon was clearly linked to the name of this town and its product: the export of the new papermaking process to all of Europe through the migration of papermakers. Why papermakers were forced to leave the Apennines can be easily explained: in very few years the number of paper mills increased so quickly that the competition became too great. Probably in order to avert bankruptcy many craftsmen (*mastri*) decided to try their luck elsewhere, since they had mastered the techniques and the markets were interested in paper of Fabriano quality. The know-how first spread to the area surrounding Fabriano (Foligno, Urbino, Ascoli Piceno, etc.), but later spread beyond the Apennines and the Alps. Thus papermakers from Fabriano could be found everywhere that paper was produced: in the Abruzzi and Campania, in Bologna as well as in Treviso.

Evidence of how the paper from Fabriano had developed into a standard of quality can be seen by the fact that when concluding contracts it was often clearly stated that the paper be made in the Fabriano method (*facere cartam ad usum fabrianensem*).

F.M. / G.P. (C.P.-K.)

Ill. 5: Unicorn watermark, printer: Johann Veldener, Utrecht, 1480 (WM I 00063, KB)

Dutch Paper Making

The beginning

The use of paper was known in the Netherlands in the 14th century (Ill. 5). The oldest paper in the archives has been dated 1346 and is preserved in the Royal Library in The Hague. In the Middle Ages most paper used in the Netherlands was bought in Brugge, Keulen en Antwerpen and was coming from Troyes in France and on a smaller scale from Lombardy in Italy and from southern Germany.

The first paper mill was built in 1428 in Gennep, Limburg. Founder was Willem Boije, member of a prosperous family of merchants in Nijmegen. But in fact this was such an exception that in general Dutch paper industry is considered to have been started in 1586. In that year Hans van Aelst and Jean Lupaert founded a paper mill in Zwijndrecht, near Dordrecht, in South-Holland. Probably this has to do with the fall of Antwerp to the Spaniards a year earlier. Due to this fall the Netherlands was cut off from the traditional sources of supply in Antwerp – at that time the centre of the paper trade – and the production centres in Germany and Liège. A paper shortage was the result. Moreover, many southern people emigrated to the northern Netherlands for religious and political reasons, among them many paper-makers including van Aelst en Lupaert mentioned above. The combination of paper shortage and the availability of knowledge concerning papermaking implied the beginning of the Dutch paper industry. In addition to Zwijndrecht other mills were founded – most of them by southern immigrants – in e.g. Arnhem, Alkmaar, Schiedam (Ill. 6) and Middelburg. Most of them were short-lived enterprises. Early in the 17th century Dutch paper industry concentrated in that part of Guelderland called the Veluwe, in the Zaan region near Amsterdam, and later in Waddinxveen.

The Veluwe

Most of the paper mills in Gelderland were water-driven mills. Only one out of every twenty were windmills. The first mill in Gelderland was founded by Hans van Aelst, who also founded the first Dutch paper mill as we have seen above. Thereafter, more paper mills were built, most of them on the Veluwe. At first it was going rather slow. The military threats that continued to hang over the region until the Twelve Year's Truce (1609–21) discouraged investments. Once the truce was signed, the industry embarked on more than a century of expansion: 25 paper mills in 1625, around 50 in 1650, 75 by 1670, 125 in 1700. The peak was in 1740 with 171 paper mills with 188 waterwheels. Thereafter the overproduction of white paper became a problem, and after 1740 the number of Veluwe paper mills declined slowly but steadily to 135 in 1815.

The circumstances on the Veluwe were very attractive given its natural endowments of pure water and the numerous locations for water mills. The clear water was the result of a natural filtering process by the sandy soil, which was coming to the surface on the east of the Veluwe in the form of springs. The water was used for both powering the waterwheels and for cleaning the rags, the basic material for the paper production.

Most of the brooks in the Veluwe region, where the paper mills were located, were in fact artificial water courses.

They had all been dug and were fed by groundwater. In fact it was an example of ingenious hydraulic engineering, or water management as we would call it today.

Often there was a number of mills situated along the same brook. As a matter of fact, sometimes this lead to conflicts. Especially the paper-makers at the end of the brooks complained that they did not received sufficient water. Many negotiations and agreements were needed and already at an early stage there were rules stipulating each paper-maker's rights and duties.

The material used in the paper mills were linen rags. Printed cotton was only used on a large scale after the invention of bleaching methods. In the 17th and 18th centuries also waste paper was used. Many rags were imported from France, but particularly from Germany. Rag merchants played an important role in the paper industry. Sometimes they even become owners of the paper mills if the paper-makers were unable to pay their debts to the rag merchant.

Most water mills were operating with stampers and not with beaters. They were only used in some mills at the Veluwe from around 1770. Usually the mills had only a single vat, since the capacity of pulp preparation was limited. That also implied that the enterprises were rather small; 3–5 workers for each paper mill. The total production was 125.000 to 150.000 reams in the mid-eighteenth century. The Veluwe mills produced white writing and printing paper as well as grey packing paper and the blue paper in which traditionally the cone-shaped sugar loafs were packed. When in the 17th century the paper-makers of the Zaan region began to specialize in fine white writing paper and blue paper, the Veluwe paper-makers concentrated more on white printing paper, less fine writing paper and packing paper. Most of the paper was for inland usage. But Veluwe paper was also exported to Russia, the Baltic States, Scandinavia, Germany and England.

Ill. 6: The oldest picture of a Dutch paper mill. The paper mill of Schiedam on a map by Jacques de Gheyn, 1598

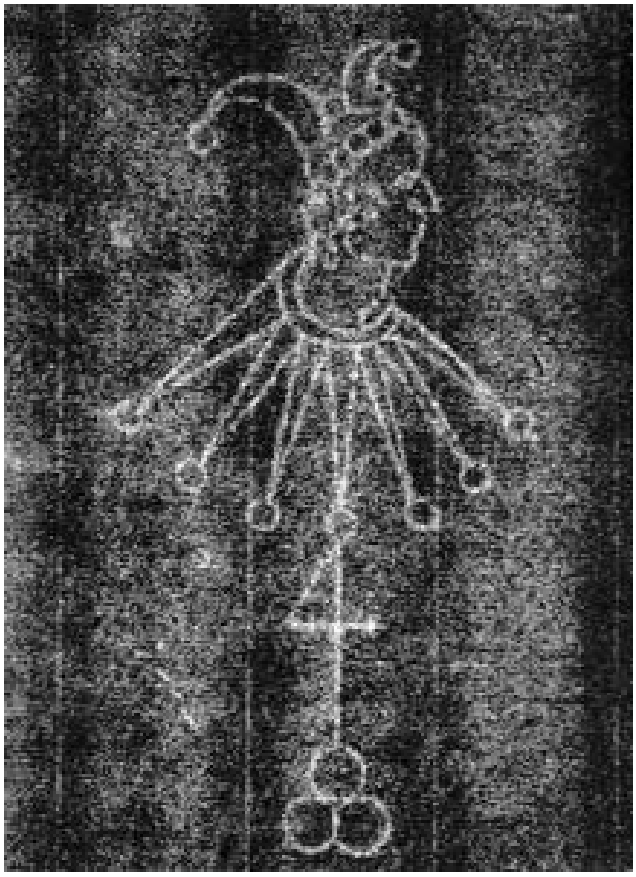
Watermarks

In general no early Guelders watermarks are known. The first paper-makers used international watermarks like a lily, foolscap (Ill. 7) or post-horn. That makes it difficult to determine the origin of this paper. The paper trade with its international connections didn't like to use unfamiliar Guelders watermarks. Only in later periods specific Guelders watermarks were applied. More common was the use of the initials of the paper-maker in the paper. E.g. H.B. for Hendrik Brouwer and L.V.G. for Lubbert van Gerrevink. The latter one also used his full name in the paper, but that was an exception. Lubbert van Gerrevink was a paper-maker in Vaassen, a small village at the Veluwe. There was also a paper-maker in Egmond op de Hoef in North-Holland with exactly the same name and who also used the initials L.V.G. He had even a patent for using these initials. His heirs-at-law instituted legal proceedings against the namesake in Vaassen. The final result was that Lubbert van Gerrevink in Vaassen should add to L.V.G. the letters D.Z., i.e. Dirk's son. For the rest the quality of the paper of Van Gerrevink was high. It is known that for that reason in England paper was produced with the initials L.V.G. Thus paper with Dutch watermarks does not guarantee that it is Dutch paper. Furthermore, this also holds for paper with Dutch watermarks like the coat of arms of Amsterdam or Pro Patria. Amsterdam paper merchants who imported paper from France often required that Dutch watermarks were used.

The Veluwe paper-makers

At the Veluwe papermaking was a family affair. It is interesting to remark that where in the beginning of Dutch paper making most mills were founded by foreign people, once that the paper making was rising they were not welcome. In order to protect the technical lead that the Netherlands had with respect to paper making the government prohibited the recruitment of foreign craftsman in 1751 and the export of mills and equipment in 1781. In general the trade of paper making was going from father to son and also marriages were solemnized with the paper-maker families. Giving an example Lambert Jans Mulder (ca. 1720–1776) was a paper-maker at the 'Zuidelijke Dorpermolen' in Vaassen. At least two of his daughters married with paper-makers on one of the other 15 paper mills in Vaassen. One of his daughters married with Lubbert van Gerrevink, who we already met above and who was also coming from a famous family of papermakers. One of his sons, Jannes Mulder (1761–1826), succeeded his father on the 'Zuidelijke Dorpermolen". And the son of Jannes Mulder named Lambert Mulder (1802–1862) succeeded again his father. The daughters married again other paper-makers. Et cetera.

A large number of the Veluwe paper-makers were also the owner of their mills, but they had to lease the water. Water was valuable. In general you had to apply for the water rights from local landowners. They leased the water and



Ill. 7: Watermark foolscap on the Ink-drawing 'The Ruin of Brederode', by Jan Lievens (ca. 1650–60)

sometimes also some land to the paper-makers. The right was granted against payment of an annual charge. Although the owner of the water rights had to pay a little fee for these rights to the government, the annual rent for the paper-maker was rather high. Some landowners tried to posses the mills by refusing to extend the land and water leases and forcing the paper-makers to sell the buildings.

The paper-makers had a high reputation, since they were the only industrialists in the Veluwe villages and they generated work. Most of them were well educated and illiteracy was rare among them. They often also fulfilled social functions. In general the paper-makers were selfsupporting. They grew their own food and owned some cattle. However, the work was heavy. The working conditions were far from ideal in damp and cold surroundings. The working hours were long about 12 hours a day. One started at 6 a.m. and stopped in the evening at 6 p.m. And also child labour was not an exception. About one third of the labourers were children of eight years and older.

It was custom for some of the workers to live with the master, who was responsible for the paper production, and having a joint meal. Hunter (1947) mentioned an anecdote concerning the latter. According to him it was proper for the workers to cease eating when the master laid down his spoon as a sign that the meal had finished. And that sometimes in order to prevent that the workers eat too much, the dishes were served steaming hot and that before they had had time to cool sufficiently, the master laid down his spoon ... But whether this is true or is only a myth is the question.

The Zaan region and Waddinxveen

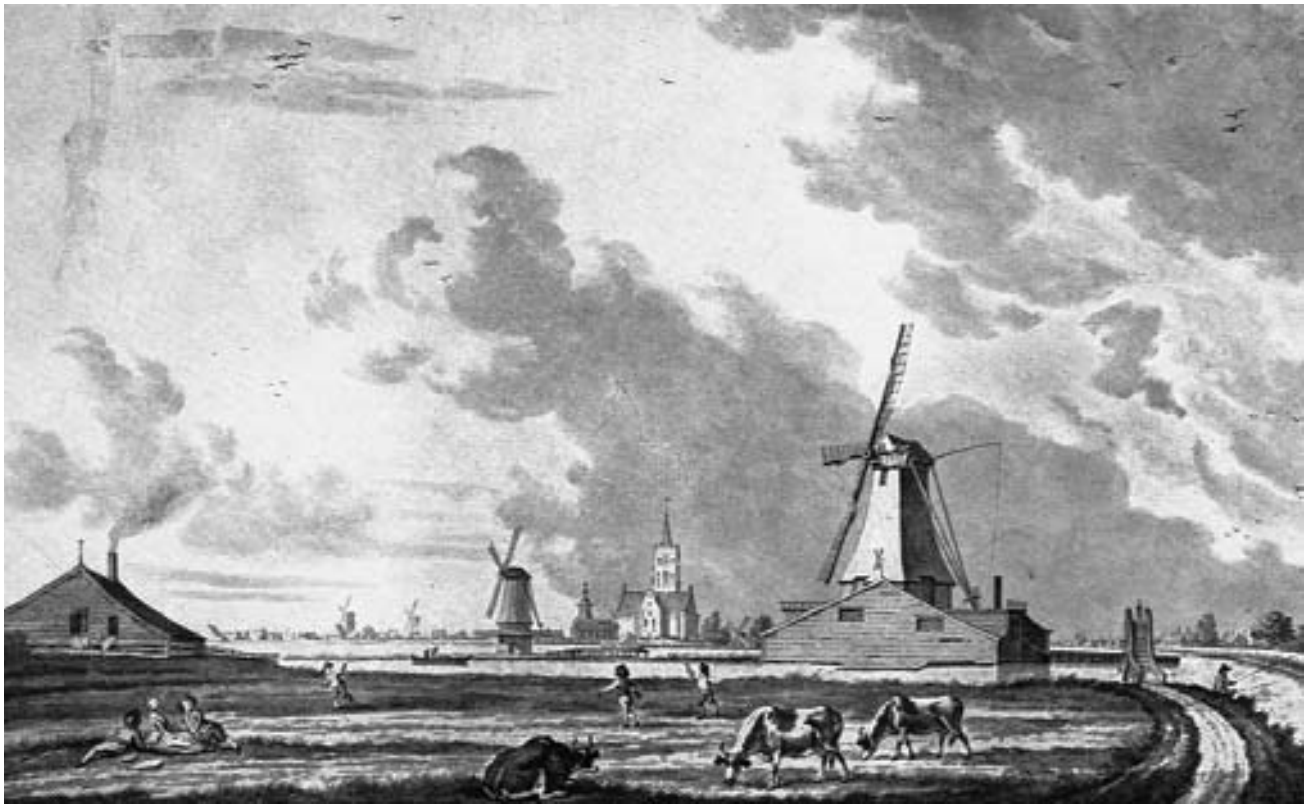
The other region in the Netherlands that played an important role in the paper industry is the Zaan region near Amsterdam. There are large differences with the papermaking on the Veluwe. As said the sandy soil Veluwe region possessed naturally pure water. Not so for the Zaan region. There ingenuity was necessary to overcome the handicap of low-quality water. However, advantage was the proximity of Amsterdam as a new centre of international trade including paper. The Veluwe paper mills, driven by water power, were small operations with three or five, primarily family members. The Zaan region mills were driven by wind power (Ill. 8) and ranked among the largest industrial installations of that time, employing 40–50 workers. They supplied far less energy than the watermills, but the building of a windmill required two or three times the cost of a water mill. The large capital investment required caused investors to reduce their exposure to risk by forming 'partenrederijen' (managed partnership, a form of limited partnership originally confined to ocean shipping and fishing. On the Veluwe the mill owners were often the landlords, who leased them to the paper-makers.

The Zaan region's first wind-driven paper mill dates from shortly after 1600, and by 1630 there were 5 of them. All of Holland then counted 14 or 15. However, after 1650 this dispersion gave way to concentration, as the number of mills in the Zaan region grew to 12 in 1660, 21 in 1680 and 36 in 1700. The number of large Zaan paper mills reached about 40 by the 18th century, while the smaller Veluwe paper mills totalled about 171 at the peak in 1740.

There was also a third centre of Dutch paper industry; Waddinxveen in South-Holland. Also there it concerned wind-powered paper-making (Ill. 9). But the scale there was limited. At the peak in 1775 there were 16 paper mills. They employed about 10 workers each and produced mainly gray and blue paper.

The Hollander

There is one Dutch major technological innovation that stood behind the rapid expansion of the paper industry after 1650. One tried to develop a method for macerating rags that would require less power than the stamping method and at the same time be more productive by making a much finer and more even distribution of the fibres. This machine is known as the "Hollander" (Ill. 10). It was invented in 1673–4 by a Dutchman, whose name is unknown unfortunately. Instead of stampers cylinder beaters were used. The Hollander is an oblong wooden vat, round-



Ill. 8: Paper mill "de schoolmeester" in Westzaan, built in 1768, watercolour by Jan Bulthuis (1750–1801)

ed at both ends. The vat was divided in the length into two parts. The dividing screen does not touch the walls of the vat, so that the liquid with the rags can circulate. On the one side of the screen is a cylinder with iron knives. Usually the bottom of the vat under the cylinder is adapted such that it follows the contours of the cylinder.

On the bottom there are also iron knives. The rags come between the iron ribs and are cut and broken. Finally, the result will be a finer, but also stronger paper. The oldest illustration of the Hollander dates from 1718, nota bene in a German book. In the Netherlands itself the first illustration appears in 1734. Giving an impression of its capacity; it furnishes in one day as much pulp as with stampers in eight days. It was in fact also this innovation that allowed the wind-driven mills to produce white paper, the standard for writing and printing. Until then the wind-powered mills were restricted almost exclusively to the production of the crudest types, gray paper and cardboard. The Hollander was the most important innovation in paper making between the Middle Ages and the 19th-century introduction of mechanized paper making. It accounts for the rapid expansion of the Zaan's region's white paper-producing capacity to some 80.000 reams per year between 1675 and 1700. Gray and blue paper production rose about 10.000 reams in 1650, 30.000 in 1670, 50.000 in 1700, 65.000 to 75.000 between 1740 and 1790. But then the progress stopped, also at the Veluwe.

Elsewhere in Europe further industrialization of the paper making industry took place. In the Netherlands it started rather late. Partly due to the fact that during the French occupation in the Napoleonic era the Netherlands were rather isolated. Moreover, the investments which should be done in order to install new equipment were rather high, especially for small paper-makers as at the Veluwe. And sometimes they also had not the knowledge how to handle the machinery. Steam was introduced firstly in the 1830s. In the water mills it was often combined with water power. In the windmills steam was a must since the modern machinery could not be operated with wind energy. In fact only a part of the Dutch paper industry followed the new developments. Many watermills were transformed to laundry and bleaching installations.

At this moment only a few paper mills in the Netherlands have remained. Among them the one in the Openluchtmuseum in Arnhem (Ill. 11). In fact it is not just one paper mill. It has been constructed from parts of the former "Achterste molen" from Loenen at the Veluwe, supplemented by parts of other mills in the surroundings. It is run occasionally. Another still running mill is the "Middelste Molen" in Loenen, which is still on its site and stood next to the mill in the Openluchtmuseum.

Ill. 9: Wind paper mill, 17th century

Ill. 10: The Hollander

Ill. 11: The paper mill in het Openluchtmuseum, Arnhem. Originally located at Loenen, founded in 1654

Literature: Hunter, Papermaking; Menke, Veluwse beken; Voorn, De papiermolens 1960; Voorn, De papiermolens 1973; Voorn, De papiermolens 1985; Vries / Woude, The first modern economy.

J.C.A.v.d.L.

Paper Production in the Transition to the Industrial Revolution

A period of a dramatic transition in the field of paper making took place in the late 18th century at whose end in the middle of the 19th century most of the paper mills manufacturing in the traditional manner had been relinquished because industrial large-scale production prevailed as the more efficient production method. A series of pioneering innovations made contributions to this effect.

Wove Paper

First mould-made papers which longer featured the ribbed structure that had been typical for centuries emerged in the middle of the 18th century. The by then used chain and laid-lines of the mould had been replaced by woven wires in order to produce this almost untextured paper showing a much smoother surface.

James Whatman Junior realised at the latest in 1786 that wove paper would be 'infinitely better for copper plates' (Balston, James Whatman, p. 27). This paper grade got the acceptance of the copper plate printers indeed because it allowed to copy graphics reproduced by *intaglio* printing with a high quality due its consistent surface. Therefore the new form of paper moulds was adopted in the following decades by paper makers on the continent, too. For example in France – incited by Benjamin Franklin – one dealt intensively with the new paper grade from 1777 onwards, and a few years later first prints on wove paper appeared. The papermakers Montgolfier, Johannot and Réveillon raised corresponding claims of priority. Bodoni in Italy had done a print on a *carta d'Annonay* for the first time in 1781. In 1796 Pietro Miliani started the production of wove paper in his paper mill in Fabriano after he had been trying to buy corresponding moulds from France since 1788. For Germany the year 1795 is mentioned in which Johann Gottlieb Ebart (1746–1805) fabricated successfully

first wove papers in the Spechthausen paper mill. Friedrich Schiller loved wove paper for the formulation of his letters and manuscripts but also for his private print copies. Paper with watermarks from Adrian Rogge's paper mill 'De Walvis' was used for the *Musenalmanach* from 1796. The novel paper grade gained friends in Poland, too, whose own production is documented for the first time around 1823.

The first-time use of such a wove paper is documented at least by parts of the Latin edition of Vergil published in 1757 by the type founder and printer John Baskerville (1706–1775) in Birmingham. Although Baskerville claimed that this 'wove paper' was his invention and he was rightly famous for his prints shining due to the hot pressing method, it is assumed that James Whatman Senior (1702–1759), England's most important papermaker of the 18th century, or his homonymous son (1741–1798) had produced this paper. The English paper historian Richard L. Hills commented to the development of the wove papers of Whatman: "His wove paper, while being very high quality, distinctly shows shadow zones caused by ribs under the wire covering. Presumably the wire covering must have been placed directly on top of the wooden frame and the ribs of the papermaker's mould without any backing wires." Neither the ripped paper nor the one without ribs of the Vergil edition had been watermarked. In the year 1759 Baskerville used for his print 'Paradise regained' a wove paper which didn't show any shadow ranges. The presumption that it was produced by James Whatman Senior is supported by the fact that he verifiably delivered the wove papers for the 'Prolusions' edition from 1759 and the 'Aesop' edition from 1761, both printed by Baskerville. A subsequent break in the production of wove paper gives according to Hills further evidence to the assumption that the older James Whatman was the one who had produced all those papers before he died on June 29th, 1759.

One observes different facts with respect to the watermarks: "In wove paper the watermarks set themselves apart very clearly, the pictures come into one's own, the impression is neither influenced by ribs nor by chain lines. Paper without ribs co-exists at the same time and parallel to tabbed paper; from a general point of view the innovation did not prevail completely."

Some paper mills completely dispensed with the production of wove paper, some produced only such paper grades, and others produced both kinds. The modified mould technology created novel forms of watermarks, e.g. the so-called *Vollwasserzeichen* (Ill. 12). No contour shapes formed by bent wire but complete letters cut from metal sheets and fixed on the woven sieve were used instead. Full-area, light-shaded watermarks are generated by this approach. Additionally, so-called 'dark watermarks' as well as 'light-and-dark watermarks' could be made in wove as well as in normal paper using another improvement of the watermark technology starting from the middle of the 18th century (e.g. 1787 by Johann Gottlieb Ebart in Spechthausen). Thus, paper got many new faces but one of the main problems blocking further developments, viz lack of raw materials, persisted.

Ill. 12: Watermark from a wove paper of the Mindelheim paper mill. The lettering 'LUDWIG. I. KOENIG VON. BAIERN' is done in the form of a so-called 'Vollwasserzeichen'. Papermaker Joseph Hundegger (1835)

From Schäffer to Keller – the Search for Alternative Paper Raw Materials to Counter the Lack of Resources

Complaints about the lack of raw materials can be traced back nearly to the beginning of European papermaking. The reason for the small-scale production structure in papermaking until the decline of the manual paper making may be caused not in the last place by the difficult raw material supply. Rags being not directly available from nature were a secondary raw material. That means they were at disposal only to a limited extent. At the beginning of the 19th century one reckoned with an approximate rag crop of three pounds per inhabitant and year. In the course of time their quality was subject to considerable changes. The use of pure linen fabric was declining, blended fabrics like barracan (linen as chaining thread and cotton as filling thread) and increasingly pure cotton fabrics took over which, with the production means of the time, could be processed to paper by far worse than linen or hemp fibres. Besides, each paper mill was eager to get from the authority the privilege for collecting rags within a specific territory in which no other paper maker was allowed to send his ragman on acquisition tour. So it was inevitable that the local population living in those assigned districts didn't get better prices for the sale of rags. So it does not astonish that in boarder districts and especially the better rags which were worth the transport expenses found their way to the nearby or distant foreign countries despite all kinds of prohibitions and smuggle flourished. Under such circumstances it was obvious

Ill. 13: Title Page of J. Chr. Schäffer's 'Versuche und Muster ohne alle Lumpen oder doch mit einem geringen Zusatze derselben Papier zu machen' aus dem Jahre 1765.

that other fibre materials appropriate for paper making had to be sought after.

René-Antoine Ferchault de Réaumur (1673–1757) and Jacob Christian Schäffer (1718–1790), superintendent in Regensburg, are to be mentioned as pioneers in this field. The careful examination of wasps' nests caused Réaumur in 1719 already to reflect on alternative papermaking methods. It was wasp nests too, that influenced Schäffer to conduct extensive experiments for decomposing plant fibres with a self-construed small hand-driven stamp mill in such a way that they could be used – at least in combination with a certain portion of rags – for papermaking. Schäffer published in six volumes a total of 81 different paper samples which he had produced nearly without addition of rags amongst other things from the fibres of cottonwood, herbs, potatoes, sawdust, planning chips, osier and aspen wood, hops, cirrus, and grape-wine as well as moss (lichen), etc. (Ill. 13). All this was already announced by him in another article in 1761.

Even though his experiments were not suitable for a large-scale production, he became rewarded by Emperor Joseph II therefore with a golden chain of grace, while in contrast the tradition-conscious papermakers ridiculed him because of his improvements.

The idea to utilize already used paper once again in a recycling process emerged in that time, too. The jurist Justus Claproth (1728–1805) made in 1774 the proposal to de-ink print products no longer needed by means of turpentine oil and fuller's earth. Markgrave Karl Friedrich (1728–1811) from Badenia ordered a test of this method in the paper mills in Niefern and in Ettlingen but it proved inefficient.

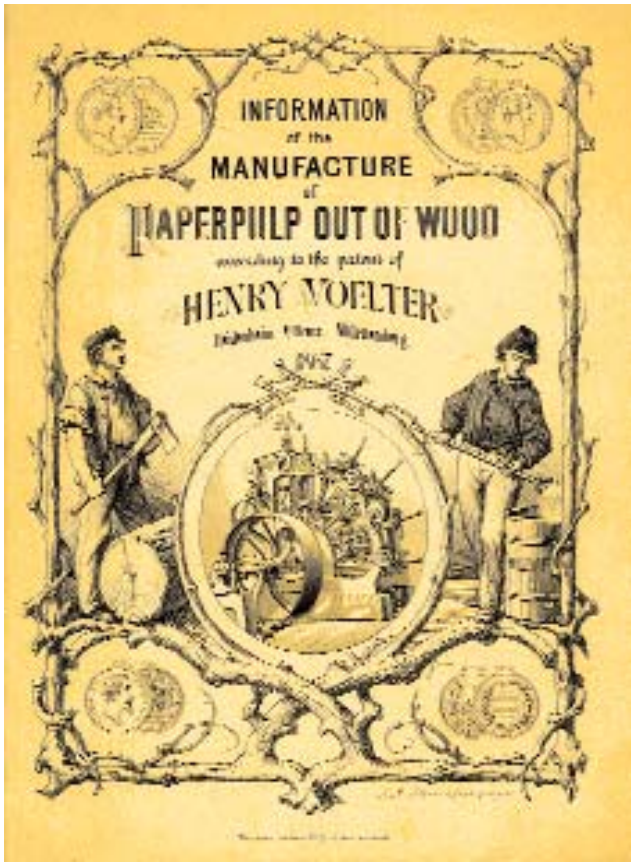
More success in the fight against the scarceness of raw materials was given in France to a method which following the example of the textile industries was soon employed in papermaking, too. The chemist Claude Louis de Berthollet (1748–1822) applied elementary chlorine discovered in 1774 and described according to the theory existing at that time as 'dephlogisticized salt acid' and made in 1785/86 for the first time bleaching experiments on a larger scale. A short time afterwards papermakers, too, picked up the method of chlorine bleaching according to which the gas was piped on the rags enclosed in bleaching chambers. Until then paper fibres had exclusively been bleached by boiling with potash lye or by exposing to sunlight but by the new method dyed textiles, too, could be treated as strongly as necessary for the production of white paper. First patent applications for that bleaching method go back to Taylor (1792) and Cunningham (1794). It arrived to the German-speaking world in 1793 through a publication of Johann Gottlob Tenner and was already implemented in 1803 in the Dombach paper mill near Bergisch Gladbach. But chlo-

rine bleaching needed control and was not easy to dose. The printers were particularly afraid of the chemically active residual chlorine, because of the damages caused by aggressive halogen which could also effect corrosion. In the first half of the 19th century there existed a series of further approaches for the industrial bleaching of papermaker's raw materials. Hypochlorite liquids and bleaching powder became accepted for the treatment of raw materials step by step until the middle of the 19th century, but they were not able to solve finally the problem of the shortage of raw materials.

Gottlob Friedrich Keller from Hainichen who became interested in the raw materials problem of the papermakers through publications of the years 1839/40 wrote down in his 'Poecketbook of Ideas' in 1841/42: "To produce paper by wooden fibres, which are manufactured by friction." Presumably without knowledge of Schäffer's studies, he started his wood grinding experiments in December 1843. Adding 20 percent rags in the paper Mill of Carl Friedrich Gottlob Kühn at Alt-Chemnitz 5–6 reams of paper from mechanically processed wood pulp were produced. Afterwards calendered in a cotton mill at Hainichen and on October 11th, 1845 printed at the print shop of Carl Gottlob Rossberg in Frankenberg for the number 41 of the '*Intelligenz- und Wochenblattes für Frankenberg mit Sachsenburg und Umgebung*', published at November 1st, 1845 as the first print product worldwide on mechanical wood pulp paper.

Subsequently, Keller signed a contract with Heinrich Voelter (1817–1887) to the effect of the economic exploitation of the process. Voelter had to go systematically after applications for Patens in the German countries and abroad, which due to the multitude of the German countries and their own patent laws which caused a lot of costs and which were not in a well balanced relation to the attainable profit, since the duration of the protection often lasted only for five years. The invention did not pay off for Keller and so additional two decades passed, during which the machine manufacturer Heinrich Voelter began first alone later on together with the engine builder Johann Matthäus Voith (1803–1874) from Heidenheim to make efforts concerning technological development and commercialisation. Voith build 21 wood grinders in the period 1852–1860, which Voelter supplied to buyers at home and abroad. The world exhibition of 1867 in Paris alone brought the breakthrough (Ill. 14). Voelter exhibited there a complete furnished wood grinding mill inclusively all auxiliary machines and samples of the finished paper. From that time on the raw materials shortage for the developing paper industry was solved and one not depend any more alone on textile remains, which till then the ragmen could get hold of in towns and in the countryside.

While Keller had cleared the way for making paper of wood by mechanical means, others tried to use chemical dissolving methods. The English chemists Hugh Burgess (1825–1892) and Charles Watt produced sodium pulp from cottonwood and hemlock wood in 1851. According to this method at first in America pulp has been produced in industrial scale since 1863, but without any commercial success. Already before Mellier in France invented a method to produce straw pulp in 1854. Benjamin Chew Tilghman (1821–1903) tested the influence of sulphur dioxide on fats



Ill. 14: Title page of Voelter's advertising brochure from 1867 on the world exhibition in Paris. In the cartouche Voelter's wood grinder is reproduced.

in 1857 and observed on this occasion how it affected and softened wood. Tilghman had experimented with that sulphur method for two years, but in spite investing a lot of money he was not able to avoid the failures in sealing the digester and resigned at the end. It was not until 1871 the Swede Carl Daniel Ekman (1845–1904) succeeded to boil a usable sulphite pulp using magnesium bisulphite. A Swedish mill produced using this process starting in 1874.

Concurrently with Ekman the German chemist Alexander Mitscherlich (1836–1918) conducted long test series in order to find usable digester materials for preparing sulphite pulp. Only an acid resistant stone coating proved to be a sustainable solution for the problem which Tilghman fought with. Alexander Mitscherlich and his brother Richard received a series of domestic and international patents within the years 1874 to 1878, e.g. the first German patent dated February 5th, 1875. Alexander Mitscherlich was able already in the year 1877 to supply by wagonloads the paper industry with his chemically prepared pulp. The sulphite process needed wood with low resin content and was very well applicable to the digestion of spruce wood. The pulp prepared herefrom had already after the digestion a high degree of whiteness and was well bleachable.

On the other hand the sulphate method developed by Card F. Dahl in Danzig in 1879 was well applicable to all

types of wood as well as to one year old plants. And highly resinous pinewood could be processed well, too. The result of the digestion with the caustic sodium lye, with an additional of sodium sulphate was a dark coloured kraft pulp, which was not easy to bleach, but showed high strength values, because of which it was well appropriated for packing papers and for linerboards. Concurrently to it, Oswald Meyh invented the brown mechanical pulp in Zwickau in 1872.

A new base of material supply for paper manufacturing could be organised and the scarceness of resources lasted centuries could be eliminated due to all the processes listed above which became what they are today, by many additional improvements.

The First Papermaking Machines

Rags were used exclusively as a raw material for papermaking till the beginning of the 19th century. One hundred years later paper industry started using yellow straw pulp, bleached straw pulp, ground wood pulp, chemical wood pulp and waste paper in large quantities. In the late 19th century the paper production in Germany had grown about fifty times, while the number of its employees had increased about four and a half times. A considered use of technology and a significant change of the base material had modified the relations in the papermaking completely.

The single processing steps of the manual paper productions can be found even by modern paper machines but in heavily changed form. The paper pulp suspension is drained through an endless wire sieve. A press section follows where the new paper is further dewatered by various presses between felts or similar fabrics. The dry section is positioned at the end of the paper machine where the new paper is dried by heat and is rolled into an endless roll.

Ill. 15: Model of Robert's papermaking machine in the Papermuseum Duszniki / Poland

Although in the context of the construction of the first paper machine other names are mentioned among others, e.g. the Austrian Ignaz Theodor Pachner Edler von Eggenstorf, still the Frenchman Nicolas-Louis Robert (1761–1828) is considered generally the inventor of the first Fourdrinier wire paper machine (Ill. 15). He constructed a prototype machine between 1796 and 1798. Using this prototype the first paper machine was built in a large scale a few months later. This allowed the production of up to five meters long and sixty centimetres wide paper.

His first paper machine had already an endless wire sieve but no press and dry section. Neither Robert nor the later buyers of his patent L. Didot and the brothers Fourdrinier had any financial success because of the significant shortcomings of his construction. Only the mechanic Bryan Donkin (1768–1855) in England succeeded to set in motion a paper machine built after Robert's idea in 1808.

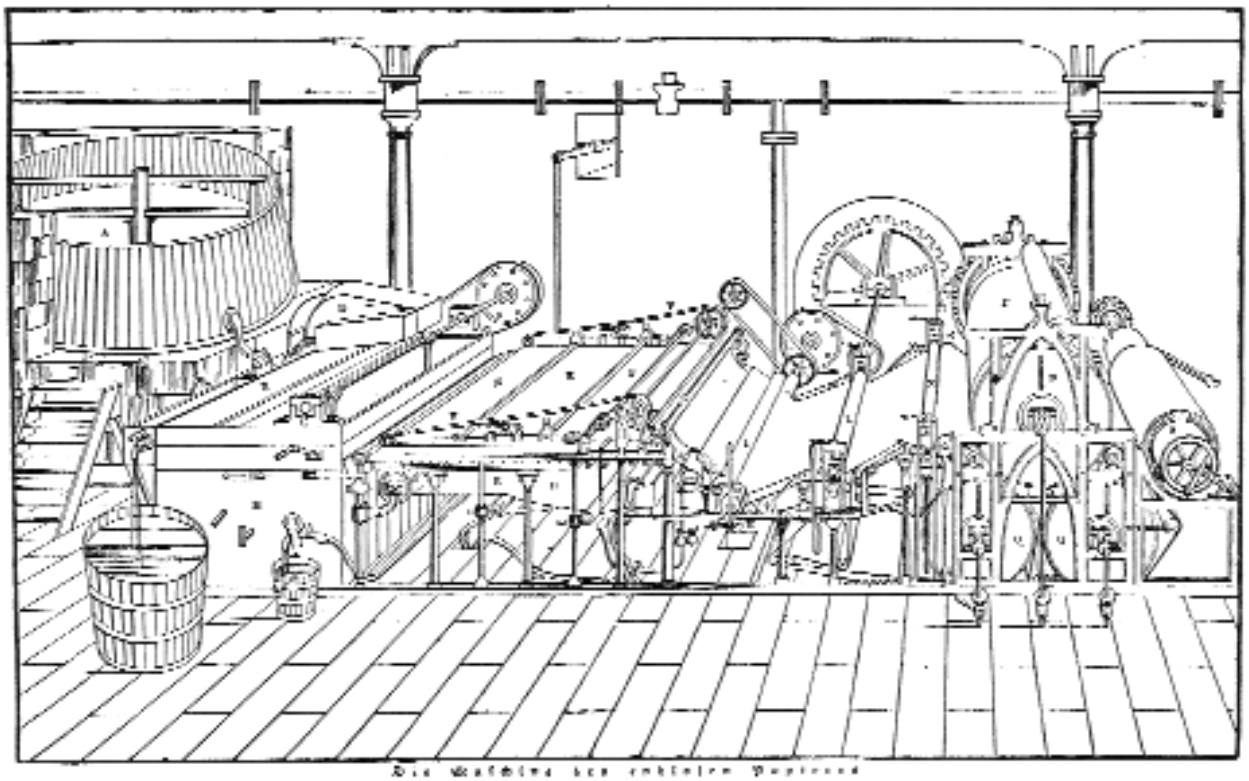
Donkin had already built thirteen more machines until 1809. Thus the Fourdrinier wire paper machine was successfully introduced to the industrial paper production. It was his engineering company, the Donkin & Co, which in the years 1818/19 set up the first paper machine in Germany for the '*Patentpapierfabrik der Königlich Preußischen Seehandlung*'. The *Allgemeine Handlungs-Zeitung* reported in 1820 about these products: '... the force, regularity, equality, with which the machinery works, is not possible for the human hand, the 'machine works, continuously every day like the others, and her paper is consistently the same, and it produces from less qualitative rags paper of better quality than usual for traditional paper mills'.

At this time, the cylinder paper machine presented the only technological alternative to Fourdrinier's wire paper machine. The mechanic Joseph Bramah (1748–1814), an all-round inventor, received an English patent in 1805. Adolf Keferstein (1773–1853) from Weida (Saxony) built an own cylinder paper machine with a steam heated drying cylinder in 1819. It was used for the production of 60 cubits of endless paper. Thomas Crompton got a patent for a drying cylinder in England in the same year following a report by Keferstein about his invention in a newspaper.

Only by this and Illig's pioneering invention (to get the watery pulp already glued, instead of sizing the finished sheets) a continuous production of paper became possible (Ill. 16).

Paper Sizing According to Moritz Illig

Unsized papers are inappropriate to write on with ink or similar water-based writing materials. Such papers are imbrued and the script runs. The paper became ink-resistant only by gluing. We have knowledge about sizing of papyrus by dipping it in glue made of fine flour and wine vinegar or of acidified bread crumbs already from antiquity. Later – up to the 14th century – starch alone was used for sizing paper. Since that time and probably for the first time in Fabriano or Nuremberg, paper has been sized by animal glue. For the preparation of such a glue, sheep feet or leather waste were cooked under addition of alum. The paper sheets were pulled through this glue, pressed again, dried and



Ill. 16: This illustration of a paper machine shows the state of the art around 1830. From the vat (A) the pulp reaches the flow box (B) through the rotating Fourdrinier wire (E) and is transferred between two felts from the sieve section to the press section by couching (H). Until the invention of heated drying cylinders (P) over two press rollers (O and Q) a winch was usual. Source: Das Pfennig-Magazin der Gesellschaft zur Verbreitung gemeinnütziger Kenntnisse, No. 73, 20 Sept. 1834, p. 584.

then smoothed by rubbing with an agate stone or later batchwise in a hammer mill. One distinguished between full-, three-, quarter-, semi- and unglued papers, where the sizing degree determined the use of the paper. While blotting or filter papers are totally unglued, printing papers are usually only soft-sized because of the better absorbency. Writing papers again are strongly glued. With the mechanical production of endless paper, the animal sizing of single sheets was not feasible anymore. A new paper sizing method described in 1807 by Moritz Friedrich Illig established itself in the following decades. The usual subsequent surface sizing was substituted by sizing the paper pulp achieved by adding alum and resin during the pulp processing in the colander.

Industrial Watermark Production

The paper manufacturer John Phipps and Christopher Phipps 1825 received a patent for "An improvement in machinery for making paper by employing a cylindrical roller the part of which is formed of 'laid' wire. The effect produced by the said cylindrical roller is that of making impressions upon the sheet of paper, or pulp, upon which the said roller passes and thus the paper has made it the appearance of 'laid' paper (like that manufactured by hand)." (Smith, Watermarks). The London industrialist John Marshall delivered a metal-fabric covered roller (Ill. 17) to the paper manufacturers Towgood in January 1827. This roller should make the paper on the Fourdrinier wire smoother. Shortly afterwards he delivered a roller with a ribbed covering to J. and C. Phipps.

Watermarks could be initially affixed to these rollers but only as outline watermarks. The first industrially produced papers with shaded portrait watermarks of Napoleon which were shown at the Industrial Exhibition in Paris in 1849 can be attributed probably to the English paper maker W.H. Smith. Such shadow watermarks are, for example, still a widespread security feature of banknotes.

The paper industry used further methods for making watermarks in paper sheets. One of these is the Molette technology. A different technology was used for the so-called 'false' watermarks where watermark patterns are faked by pressing in dry paper or printed with special colours.

Unlike the watermark of handmade papers, the dandy roller of the industrial production (Ill. 18) of watermarked paper could last significantly longer than the two-year-usage period of watermarks from a mould. For this reason watermarks in machine made paper are only restrictedly us-

Ill 17: Advertisement of T.J. Marshall & Co, the inventor of the Dandyroll/Egoutteur, with which watermarks can be made in industrially produced paper. (Advertisement from the Wochenblatt für Papierfabrikation, Vol 36 (1905), p. 3232)

able for dating. Sometimes in quests of authenticity these characters can still make their contribution. However, it is to bear in mind that 12, 16 or 24 similar watermarks are often installed on one Dandy roller and each of them can have-not intentionally! – individual peculiarities.

Literature: Audin, De l'origine du papier vélin; Balston, The Whatmans; Balston, James Whatman; Blechschmidt / Strunz, Der Beginn; Bockwitz, Wer war der Erfinder; Clapperton, The papermaking machine; Doizy / Fulacher, Papiers et moulins; Feyerabend, Über die Stellung von Wasserzeichen; Hößle, Alte Papiermühlen; Hössle, Bayerische Papiergeschichte; Hills, The early use; Killermann, Jakob Christian Schaeffers Papierversuche; Hoyer, Die Entwicklung der Papiermaschine; Hunter, Porträt-Wasserzeichen; Klein, Chemie und Papierfabrikation; Loeber, Paper mould and mouldmaker; Meltzer, Die Entwicklung der Papierfabrikation; Postl, Herstellung von Wasserzeichen; Postl, Oberflächenleimung; Postl, Faber in amne cudit; Schlieder, Über Anfänge der Verwendung; Schmidt, Geschichte der Papierherstellung; Schulte, Ueber die erste Papiermaschine; Sembritzki, Ueber die erste Papiermaschine; Siniarska-Czaplicka, La production; Smith, Watermarks; Strachan, Die Geschichte; Weiß, Handbuch der Wasserzeichenkunde; Weiß, Vom Velin- und Kupferdruckpapier; Weiß, Schiller-Manuskripte; Weiß, Schiller und das Papier; Wintermeyer, Die Entwicklung der Holzschleiferei.

G.D. / F.S. (G.D / F.S. / L.D.)

Moulds and Wires

In Europe, paper is typically made with a metal mould fitted into a wooden frame. The mould is usually made of copper or bronze. The frame is stiffened and supported by wooden ribs, tapering towards the mould, that are parallel to the frame's shorter sides. The mould itself is made of horizontal laid or ribbing wires (laid-lines) that run parallel to one another, and thinner so-called chain or warp wires (chain-lines) that run perpendicular to the laid line and parallel to the cross pieces. These chain-lines lie directly on the wood of the cross pieces and are stitched to the laid-lines. When making the paper, the pulp mass sinks into the spaces between the wires and thus the paper is thinner over the laid-lines. The structure of the mould, seen as light and dark stripes, is readily apparent when the paper is backlit or photographed by means of beta-radiography. The print of the mould in the paper mirrors more or less exactly the diameter of the laid-lines and the distance between them. However, such mould prints are quite difficult to see in early paper, as for example from the first third of the 14th century. Above all, the cross pieces are very difficult to see in paper from this period, even with the help of beta-radiography.

The diameter of wire depends on the technique with which it was produced. Wire can be either forged or drawn. In the latter technique, wire was gradually made thinner by pulling it (in the beginning, manually using muscle strength) through the progressively smaller holes of a drawing die.

According to research done by Hills, in very early Italian paper the clearly irregular wire lines in the mould prints indicate that the wire was hammered and not drawn. He found mould prints with irregularly running laid wires and

Il 18: Image of a Dandy roller for an light-dark watermark. It is a vellum Dandy roller from the year 1923 showing the words 'REPUBLICA PERUANA'. The paper appears dark there because the dents of the writing can accumulate more mass. Exactly the opposite is the case in the foreground where the higher wire parts are. The wire displaces more pulp and the paper appears in these places brighter. Such a watermark is called light-dark watermark. Manufacturer of this Dandy roller was the Dürener Metalltuch and Egoutteurfabrik, J. W. Andreas Kufferath & Co., Düren. The Dandy roller comes from the paper mill Weissenborn close to Freiberg.

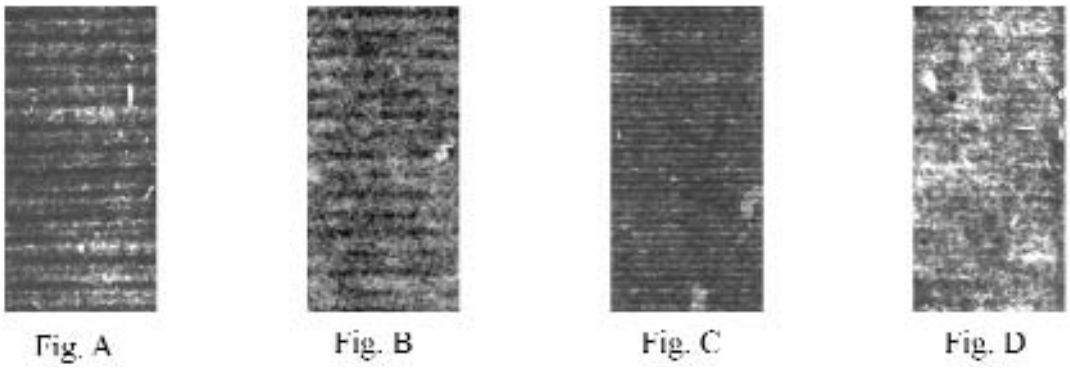
uneven diameter in paper from as late as 1343/44. Here, the chain-lines are hardly visible. In paper from 1347, he was then able to distinguish prints of straight, quite thick laid-lines running about 3 mm from each other. From this point in time, paper moulds continued to be of this type. About 1385 paper moulds with finer laid-lines running only 1.2 mm from each other were already in use. It is also possible to clearly see the stitches used to attach the chain-lines to the cross pieces from around this time. This new type of mould, with closer laid-lines, resulted in less fibre pulp being needed and thus, among other things, the paper being thinner. Paper historians have concluded that these significant changes in the moulds are an outcome of new techniques being used for making wire (Hills 90–91; for wire pulling, Wolters 207–210).

Gerardy (Gerardy 64–65) has identified a special type of mould used for Italian paper during the 14th century that was made with alternating thick and thin laid line. Such alternating laid-lines can also be seen, for instance, in Codex 168 (dated 1390/91) of the Klosterneuburg Stiftsbibliothek. Twenty alternating thick and thin laid-lines are about 29 mm in width (Ill. 293; Fig. A), whereas twenty thick laid-lines themselves, with thin lines between, is 58 mm. Within this Klosterneuburger codex, however, one also finds paper showing prints of only thin laid-lines (cf. the various watermarks in the above-mentioned signature under http://www.ksbm.oeaw.ac.at/wz/wzma.htm), and thus paper with "mixed laid-lines" may have been a transitional form.

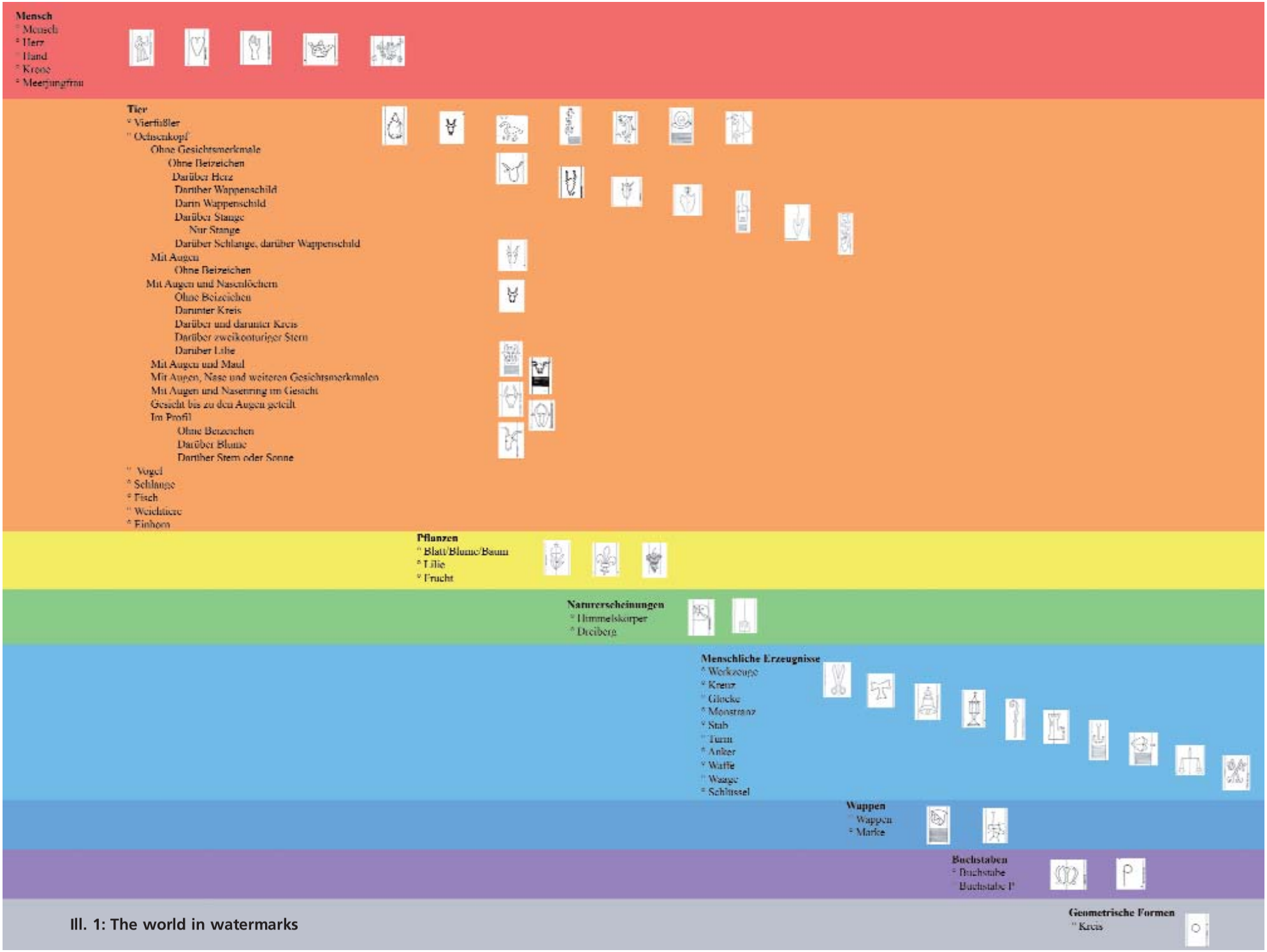
According to Weiß, twenty laid-lines had a width of between 16 and 80 mm depending on region and period. For dated paper in the WZMA from the period between approximately 1350 and 1380, for "thick" laid-llines this width (based on random samples) was between 45 and 55 mm (Fig. B). In contrast, in paper with "thin" laid-lines, seen from the 1390s, this was reduced to less than 30 mm. More research needs to be done on early paper, whose laid line is generally difficult to see, in order to reconcile this generally-held opinion of paper historians with Codex 1251, f. 6 (Fig. D) of the Klosterneuburg Stiftsbibliothek, dated 1330, where twenty rather thin laid-lines have a width of about 28 mm, and the Rechnungsbuch Rb 7/1, Sheet 6 of the Klosterneuburg Stiftsarchiv dated 1321, where the same number measure about 25 mm. According to an examination undertaken by Ezio Ornato (Ornato, II 347) of Piccard's collection, in the seven examples from the 1360s only "thick" wire was used. The percentage of paper with "thick" laid-lines in comparison to paper where the mould prints show "normal" wire had already sunk to 11.54% by the 1390s and then to 0.71% in the first decade of the 15th century, rising again later to about 1.40%. According to Ornato (II 74), the width of twenty laid-lines in paper of folio format (*rezzute*) varied between 25/26 mm at the beginning of the 15th century and below 20 mm by the end of the century (Fig. C).

Literature: Weiß, Handbuch der Wasserzeichenkunde; Gerardy, Einige Besonderheiten von italienischen Papieren des 14. Jahrhunderts; Hills, Early Italian Papermaking; Wolters, Drahtherstellung im Mittelalter; Ornato et al., La carta occidentale nel tardo medioevo I. Tomo II (Addenda 4).

F.L. (C.P.-K.)



Ill. 19:
Fig. A: Klosterneuburg, Stiftsbibliothek, Cod. 168, Bl. 293 (1390/91).
Fig. B: Klosterneuburg, Stiftsarchiv, Rechnungsbuch 7/1, Bl. 27 (1343).
Fig. C: Klosterneuburg, Stiftsbibliothek, Cod. 69, Bl. 297 (Ende 15. Jahrhundert).
Fig. D: Klosterneuburg, Stiftsbibliothek, Cod. 1251, Bl. 6 (1330).
Illustrations reproduced 1:1



Ill. 1: The world in watermarks

III The World in Watermarks

The watermarks in paper of the Middle Ages can be considered a symbol, a fragment of that world and how it was understood at the time. To start with, they are a European invention: they are not found in old Chinese or Arabian paper. This can be explained by the fact that papermakers in Europe began to use rigid paper moulds to which wire figures could be attached. In the history of papermaking, the rise of watermarks in the European Middle Ages was quite late on the scene.

In addition to early texts documenting the use of watermarks from the middle of the 14th century such as the treatise by Bartolus de Saxoferrato described above, there are also sources that refer to watermark forgery. For instance, in 1398 Louis de Tignonville (Bailli de Troyes) already forbade the copying of marks by other mill owners, or placing watermarks originally for good quality paper into poor paper. Such texts raise questions concerning the function of watermarks in the Middle Ages and lead to a consideration of their forms and significance. Of course it is beyond the scope of this volume to offer a typology of the watermarks of the Middle Ages that even approaches comprehensiveness. Nevertheless, a sample of watermark motifs has been chosen in order to give at least an impression of their variety and imagery.

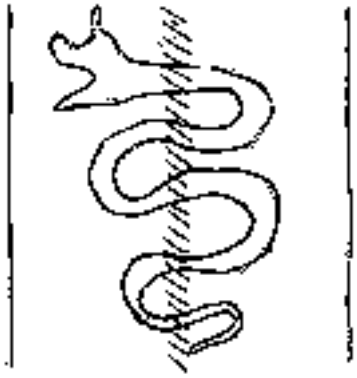
The oldest known watermark was used in Cremona (Italy) from as early as 1271. It is in the form of the letter *F*. Earlier, Briquet (1907) had presumed a Greek cross (No. 5410) used in Bologna from the year 1282 to be the oldest watermark. But regardless of whether a cross or a letter, it is without question that the first watermark originated in northern Italy (Bannasch). Chronologically, the next watermark that appears, sometime after 1293, is from Cividale, considered the site of the oldest paper mill in Friuli: a spiral in the form of a six or a nine. Personal names also appear as watermarks already before 1300, as seen in the documents of the notary Tommaso Cattaro from Piacenza. Here the name of the papermaker Puzoli of Fabriano can be found. The name Saluzzo can be found from 1305 (Weiß). The function of these watermarks is clear: they are a sign of ownership that clearly indicates the paper's origin. The names of papermakers are used as watermarks until about 1312; later this becomes unfashionable and the image and symbol world of the Middle Ages begins to spread.

Of course here and there single letters are found: in Germany, for example, *E* for Esslingen, *F* for Frankfurt am Main (Jaffé), *M* for Maria, Mother of God (Tschudin 1996), etc. Monograms indicate the producer of the paper as well as sovereign privileges. Abbreviations such as IHS (Jesus) also appear in the world of watermarks. Watermarks in the shape of a crown can be seen from shortly after 1310. The crown then became one of the most common watermark motifs. According to Briquet, it was used by Venetian paper mills into the 18th century.

A particularly dominant watermark is a bull's head with various forms and embellishments. Bull's head watermarks are seen in Italy as early as 1320, from where they spread to France and Germany. It was used intensively, not disappearing entirely until the beginning of the 17th century, three hundred years later. In the Ravensburg coat of arms, used as a watermark for the first time in 1395, one finds a bull's head combined with a city gate. Jaffé mentions in this regard Luke the Evangelist, whose animal attribute is an ox. Luke also is the patron saint of painters, an occupation close to papermaking. The animal attribute of Mark the Evangelist, a winged lion, can also be found in the world of watermarks. This was used above all by papermakers in Venice, where it was also part of the coat of arms. The paper mills of Colle di val d'Elsa (Tuscany) used a watermark in the form of a head; its first use can be dated to 1249. The watermark motif of a snake deserves particular attention. It is also found in coats of arms, as for example that of the Milan dynasty of the Viscontis. Papermakers used a snake watermark motif above all in Swabia. Here they succeeded in making particularly thin, good paper, and thus the snake motif became quasi a stamp of quality (Jaffé).

Another common watermark motif is a triple mountain. It can be found in paper made in Lucca and Padua between 1360 and 1513, although its exact origin remains unclear (Schweizer). Later the outline of a cross was often added to the triple mountain. According to Piccard, the first watermarks with this motif are dated to 1444. Watermarks in the form of a cross or staff are a good example of the symbolic world of the Christian Middle Ages. Here one can think of the bishop's staff, the crook of the Good Shepherd, and the cross staff, an attribute of many saints. The messenger staff of Hermes is considered the symbol of traders, and the Aeskulapian staff is a symbol still today of the medical profession. The rod of Basel, which represents the coat of arms of the bishopric and the city of Basel, can also be added to this group. It was used as a watermark, also by papermakers outside of Basel, from the 16th century.

Finally, heraldic watermarks should be mentioned. The use of coats of arms as watermark motifs can be seen in connection with the forming of territorial states in the later



Ill. 2: Visconti snake as watermark, based on Piccard Online No. 043243

Middle Ages. Watermarks of city, dynasty and state heraldry are included in this group as, for example, the Bourbon lily or the Amsterdam coat of arms. These watermarks were originally used as signs of origin or trade. Family heraldry, in the sense of a "speaking coat of arms", was also often used as a watermark motif.

To conclude, in addition to the various aspects concerning watermark motifs touched upon here, one must also mention Piccard's observation that they were usually anonymous. In the early period, the primary function of watermarks was not yet to indicate origin. Only after paper mills became more numerous and they had spread did papermakers find it necessary to use unique marks to identify their products. Watermarks then became marks of quality and developed further into signs of the producer and trader.

When systematizing the image world of watermarks from the Middle Ages, a biological/mythological order presents itself with three main categories – people, animals, and plants – to which one can add mythological figures such as creatures from fables. One also finds watermarks depicting other features of the natural world, depicting instruments and tools, which can be subsumed under the category of people, as well as heraldry and abstract symbols of geometry. Alone the watermarks collected by Gerhard Piccard, which number nearly 100.000, when ordered according to their motifs present a broad classification scheme that includes the world of the Middle Ages in all its natural forms: from amoebas to human beings and their tools, from leaves, flowers, and trees to mythological beings like unicorns and mermaids, and even the abstract world of geometric symbols (Ill. 1, p. 28). The watermarks are also always representative of the producer or the papermaker, whose personal background is expressed relatively clearly by the motif chosen.

An example for the symbolic strength of these signs is the scallop shell, which in the Middle Ages was originally used as a symbol for the important pilgrimage to Santiago de Compostela and soon came to represent a pilgrim as such. From the 12th century, representations of St. James portray him carrying a scallop shell as his main attribute, in addition to a pilgrim's staff and bag. Watermarks combining a scallop shell and pilgrim's staff are evidence of their close connection to the Santiago pilgrimage and the veneration of St. James. In some cases, this relationship is even reflected by the user or owner of the paper, as for example Count Adolph of Nassau, who in 1479 used paper with scallop shell watermarks (Ill. p. 29, based on Piccard Online No. 160170). In his family, the veneration of St. James traditionally played a major role, which apparently was decisive in his choice of writing paper.

Literature: Bannasch, Wasserzeichen als Datierungshilfen; Jaffé, Zur Geschichte des Papiers; Maier, Spuren des Jakobuskultes im Speyerer Raum; Piccard, Die Datierung des Missale speciale; Piccard, Die Wasserzeichenforschung als historische Hilfswissenschaft; Schweizer, Frühes Papier; Tschudin, Der Ursprung der Haus- und Handelsmarken; Tschudin, Grundzüge der Papiergeschichte; Weiß, Zeittafel zur Papiergeschichte.

C.K. / P.R. (C.P.-K.)

III 1 The Mömpelgard Genealogy

1474
Libellus (parchment), 8 Sheets
Hauptstaatsarchiv Stuttgart A 266 U 1
Page 10

The manuscript *Wie Mümpelgard an die herrschaft Wirtemberg khommen ist* seems to have come from the library of Count Eberhards im Bart, the grandson of Henriette von Mömpelgard and the great-grandson of Antonia Visconti. It describes the genealogical lines and family relationships of the Count von Mömpelgard from the marriage of Eberhard IV and Henriette before 1407. Of particular importance because of its sumptuous coloured illustrations, it includes a page that depicts the female line of Eberhards im Bart's family. The coat of arms of Antonia Visconti is seen in the left row above the coat of arms of Maria von Châtillon. Next to them are the coats of arms of his other two great-grandmothers, Katharina von Genf and Elisabeth von Zollern-Nürnberg, above which are those of his grandmothers, Henriette von Mömpelgard (on the left) und Mechthild von Savoyen (on the right). At the top are the coats of arms of his parents, Count Ludwig von Württemberg and Mechthild von der Pfalz.

Here, the Visconti coat of arms is portrayed with a blue snake facing right on a silver background, "half devouring a Saracen", as the accompanying heraldic description reads. Numerous watermarks of 15th century paper from upper Italy present similar depictions of the Visconti coat of arms. Obviously, the human figure that is half protruding from the jaws of the snake, the "Saracen", is easy to misinterpret if one is not familiar with the Visconti heraldry, and was not recognized as such by Gerhard Piccard in his watermark tracings (cf. Ill. 2).

Literature: Rückert, Antonia Visconti.

P.R. (C.P.-K.)


10.
zů Nuwenburg habent Jren tail uerkofft dem her
ren uō laffoy · aber darnach der uorgenant fürst
non dorinnges haut denn kouff wider vmb an sich
gezogen vnd kofft Jn namen Jmer hußfrowen
frow iohanne ꝛc

III 1

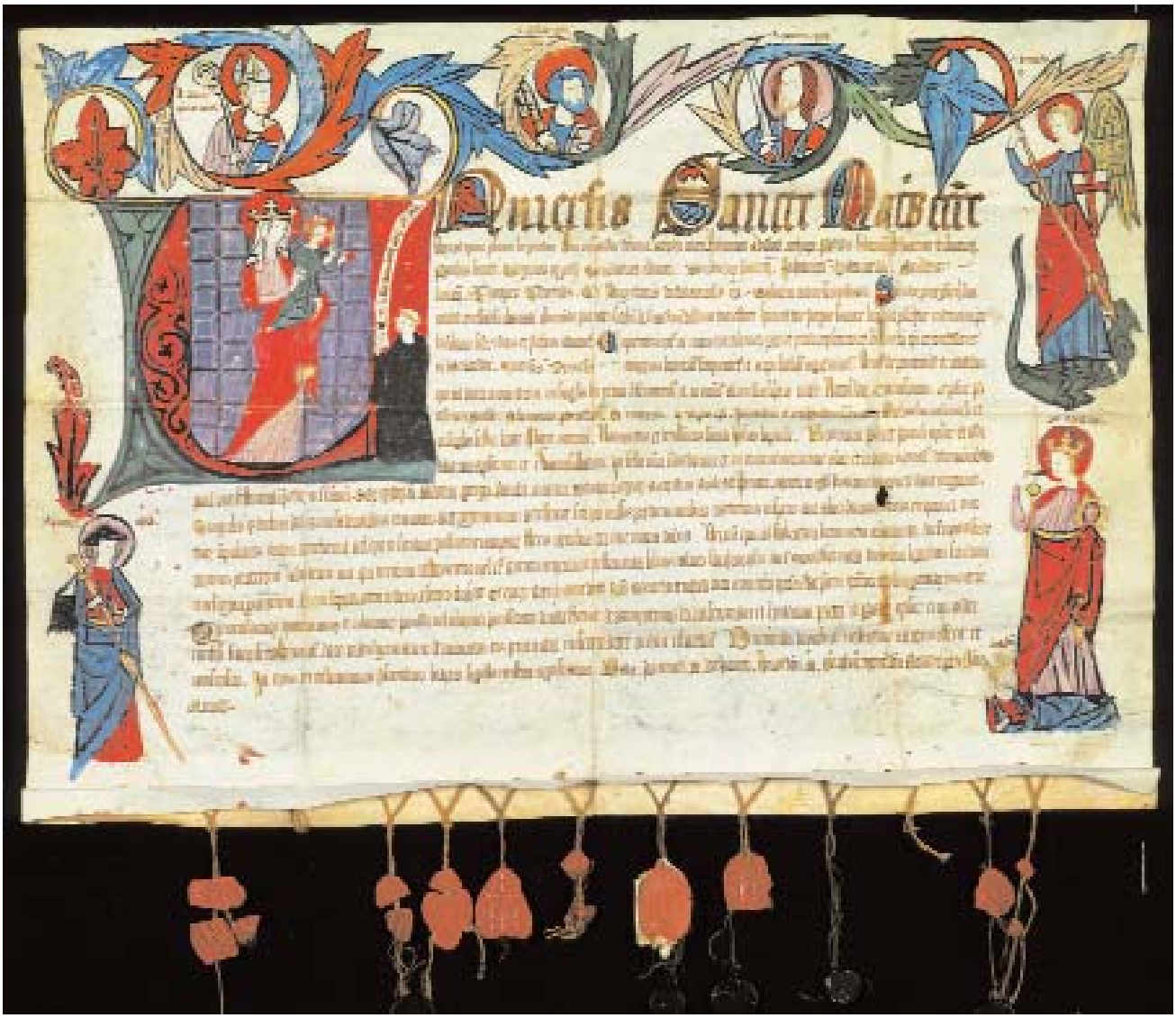
III 2 An Illustrated Indulgence for the Hirsau Monastery

12 January 1347, Avignon
Parchment, 52.5 x 73.5 cm; originally with twelve attached seals and transfix from 21 Juni 1347
Hauptstaatsarchiv Stuttgart H 52 U 14

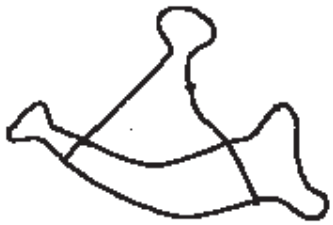
Twelve archbishops and bishops issued this indulgence for Hirsau Monastery, situated in the Black Forest. The diocesan bishop who was in charge added his transfix a few months later. The special importance of the document is found in its impressive illustrations: The upper border contains half portraits of the main patron saints of Hirsau, Aurelius, Peter and Paul. In the initial *U*, the Mother of God is portrayed with the child, a monk kneeling before her with a banner. The block of text is framed by St. Michael and the dragon to the upper right, below him, St. Catherine, and to the lower left, St. James. All of the saints are portrayed with their attributes, through which the individual figures can be clearly identified: a bishop's staff, a key, sword, dragon, the pilgrim's staff and hat with a depiction of a scallop shell. All of these signs and saintly attributes can also be found in the world of watermarks, representing also there an iconographic program that, depending on individual or institutional "preference", is based on the Christian realm of saints.

Literature: Rückert, Die Verehrung des hl. Jakobus im Umfeld des Klosters Hirsau.

P.R. (C.P.-K.)



III 2



IV Watermarks and Research on Manuscripts

Scientific research on watermarks, their systematic collection, classification and analysis, was already begun in the early 19th century, milestones being set thereby by the major works of Briquet and Piccard. The possibilities watermarks offer for historical research are, first of all, connected to questions concerning the history of paper, but also, of even more importance, the texts and illustrations the paper bears.

The use of particular watermarks not only allows one to determine where the paper was produced, their spread also testifies to the paper's distribution: paper trade and related economic questions can thus be examined. Maria Zaar-Görgens was able to map, on the basis of watermarks, the spread of paper from paper mills in Lorraine-Upper Rhine between 1385 and 1600, showing not only the impressive increase in paper production, but also developments in paper trade and the economic situation of southwest Germany, both over time and distance (Ill. 1).

Watermarks are of particular methodological importance for describing manuscripts, which includes an analysis of the paper they are written on as well as any inscriptions and the texts themselves. In addition to actual historical questions concerning the paper, undated manuscripts and prints can usually be dated to within a few years on the basis of their watermarks; watermark research is particularly significant as it provides a much more accurate aid for historical dating (Piccard) than, for example, palaeographical analysis. A prerequisite is, of course, the existence of an identical, dated watermark, which furnishes the time period for the paper's production.

The technical possibilities for copying or reproducing watermarks from original documents range from tracing, either hand tracing or rubbing, to expensive modern techniques such as beta radiography, which has increased accuracy. Analysis of watermarks has become standard in scholarly descriptions of manuscripts, and has profited from the continually growing watermark collections and their availability on the internet.

Literature: Zaar-Görgens, Champagne – Baar – Lothringen; Piccard, Die Wasserzeichenforschung als historische Hilfswissenschaft.

P.R. (C.P.-K.)

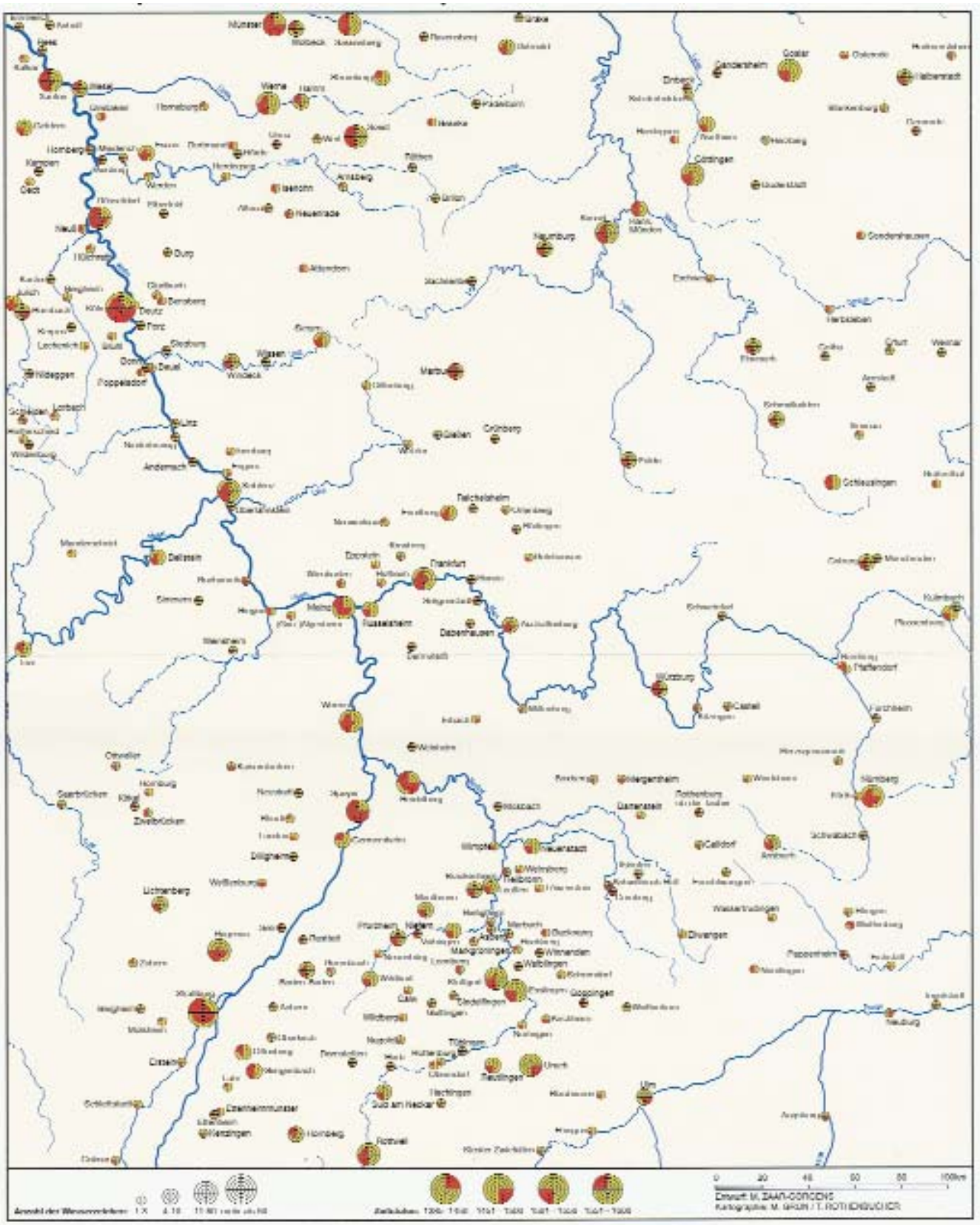
The Commercial Aspects of Paper

In common with all manufactured goods fabricated in every period and place, paper was a product that presented different mercantile properties depending on purchasers' needs. Even if a wide range of uses for paper has been identified – as a substitute for glass in windows, for example – the most important differentiating criterion distinguished between writing paper and wrapping paper, just as it does today. Contrary to what certain people have supposed, wrapping paper did not form the bulk of the paper that was produced; rather, it represented about 20–25% of production.

The thing that distinguished the two chief categories of paper wasn't only colour – inasmuch as wrapping paper was made from rags that were more or less brown, while writing paper was made from white rags – but also the material's degree of refinement: the pulp that was destined to produce writing paper was, in fact, far more refined, and in order to produce it, special pounding mills which were able to reduce fibres to the smallest dimensions were necessary.

For this reason, not all paper mills were able to produce both kinds of paper: thus, at Colle Val d'Elsa in the 16th century, paper mills were divided into two categories, "black", and "white", which only produced wrapping paper and did not enjoy the right to process white rags. However, even within the "writing paper" category, the product could present in various quality grades; in addition to "fine paper" one often encountered so-called "fioretto" grade product (the etymology of this term is unclear) or, descending even further on the quality scale, so-called "fiorettone" grade papers. In the absence of "archaeological" evidence, unfortunately we have to ignore the possible differences seen among the different quality grades. Indeed, today we would be completely unable to distinguish between the different types of sheets that corresponded to the different names.

The price of paper varied in function with its quality and, needless to say, cases of fraud were numerous and frequent. For this reason, a great many regulations were issued by civic authorities in places of production and/or consumption, testimony to the care taken to safeguard consumers' interests early on in the history of paper



Ill. 1: Distribution of paper from Lorraine-Upper Rhine paper mills (based on Zaar-Görgens)

manufacturing. Of these regulations only one example remains known to us today, and that dates back to the medieval period. It was issued in Bologna in the year 1389. Bologna was a large paper manufacturing centre and produced a high quality sheets; it also had (and still has) a renowned university and a large commercial district. Moreover, Bologna was considered the "world capital" of civil law, a fact which certainly explains the existence of very demanding and precise regulations.

The Bologna norm, beyond specifying the minimum dimensions of the paper formats in use (frequently by means of a template, a copy of which can be seen in the Istituto centrale per il restauro e la conservazione del patrimonio archivistico e librario's Museum), listed three types of paper: fine quality paper, so-called "fioretto" grade, and rag paper (i.e. wrapping quality), the prices of which were controlled. In order to differentiate among them, a single criterion was cited: the watermark. In fact, the norm stipulated that, within any single paper mill a distinct watermark had to be used to distinguish fine quality paper, whilst another one could be used for both the "fioretto" grade paper and rag wrapping grade paper. A requirement of this kind implies, then, that the watermark was not only a "trademark" and symbol that indicated its origin, but also a guarantee of quality. Bologna certainly didn't constitute an isolated case, inasmuch as Troyes in France was also a major production centre – and almost at exactly the same time (1399), an ordinance in that town reminded citizens that it was an offence to mark paper of mediocre quality with a watermark intended for papers of superior quality. The problem for paper historians consists in the fact that it is not known if, and in what way, the characteristics of the two watermarks suggested in themselves a quality hierarchy that enabled consumers to recognize the difference immediately.

In reality, the sole universal criterion available for making an objective assessment of the basic mercantile properties of paper, and to counteract a certain kind of fraud, was the weight of a ream (composed of 500 sheets, as it still is today), which, because formats were standardised throughout Europe, was equivalent to the paper's grammage. Needless to say, the weight of papers is mentioned in the Bologna norm; they were always quoted in legal contracts that have come down to us through the centuries. However, a paper's grammage far from expressed all its mercantile properties, among which were to be found its whiteness level, the presence of lumps or impurities, its transparency, and uniformness of sizing.

Despite the lack of quantifiable and objective criteria for the assessment of quality, the production and marketing of paper flourished without many disagreements arising. But on what basis? According to the practice that was in force at that time (one which has not altogether disappeared today), in many areas of artisan and industrial activity – and in particular in contracts regarding the copying of manuscripts – the procedure foresaw the preliminary presentation of a sample that all subsequent product/merchandise had to conform to in every way. When disputes arose, the two parties – customer and supplier – placed their faith in an impartial judgement made by an "arbitration commission". Thus, a purchase/sales contract drawn up at Ancona in 1581 specified: *... e che se saranno de qualità inferiore qualche balla di dette carte s di peso come di pasta, si debba fare il difalco che sarrà giudicato da uomeni periti ellecti dalle parte*. ("... if arguments arise concerning the quality of a paper with respect to its grammage, a discount must be made to serve as compensation; the judgement has to be made by a person with expert knowledge ...").

Today, needless to say, highly sophisticated instrumentation is available which is able to analyse with great precision all the qualitative characteristics of any sheet of paper. It seldom happens, however, that instrumental analysis is carried out for reasons of historical research; this is because ancient paper, in contrast to modern paper, does not present particular problems as regards conservation issues, and because ancient sheets are generally found bound together to form the text blocks of books that are kept in libraries where they are carefully safeguarded.

Nevertheless, about ten years ago an important research initiative was launched by the ICPAL: "Progetto Carta". The object of this project was examine the watermarks and measure the thicknesses and levels of whiteness of a corpus composed of approximately fifty incunabula printed in Venice, many of them the product of the famous printer Boneto Locatello, who is very much associated with the important contemporary bookseller Ottaviano Scoto.

The results of the tests carried out to establish whiteness levels brought to light, notwithstanding the effect of degradation that has taken place over the centuries, the papers' excellent quality, which represented a not insignificant selling point, and contributed to the exportation of Venetian books all over Europe. But the research carried out has also revealed, within this high quality criterion, small, but significant variations, which are correlated to particular circumstances: thus, the whitest paper is found in the those editions that one might judge as being the "most ambitious", meaning to say those in which the space reserved at the outset for decorative elements was larger and, judging by present day distribution of surviving examples, were exported in greater numbers.

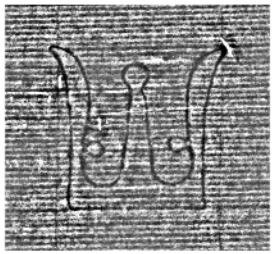
E.O. (M.L.)

The Time Span of Paper Use

Watermarks continue, above all, to be used to place undated documents into a timeframe. This can only be successful if an identical watermark to that in the document being examined is found in other paper that is dated, and when the time span is known when this paper was used. Among other things, this depends on the type of paper and its size; according to Piccard, it is "highly certain" that in the period from about 1360 to 1630/50, writing paper of normal quality, as used for the vast majority of manuscripts and chancellery documents, was used within three to four years (Piccard, Die Wasserzeichenforschung als historische Hilfswissenschaft, 111f.).
On the basis of the cards in Piccard's watermark collection and his "Findbücher", it is possible to verify this assertion only to a very limited degree. This is because Piccard only rarely noted identical marks on the individual cards of his collection, and also the majority of the "Findbücher" only mention the place of finding and a year. A scientifically verifiable statement about the period of time identical paper

Ill. 2

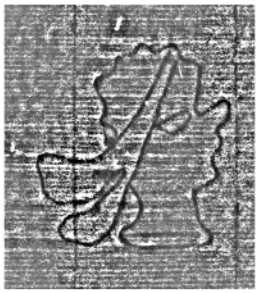
Stiftsbibliothek Klosterneuburg, Codex 315



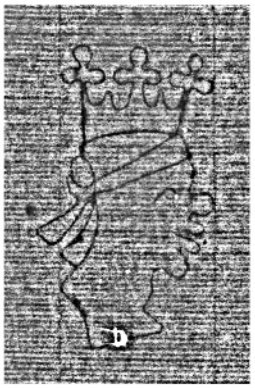
A AT5000-315_35

B AT5000-315_36

C AT5000-315_195



D AT5000-315_215

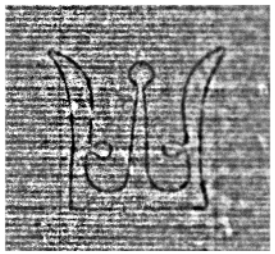


G AT5000-315_297

H AT5000-315_302

Identische Wasserzeichen/Varianten in Handschriften des Schottenklosters, Wien

AT8900-329_131



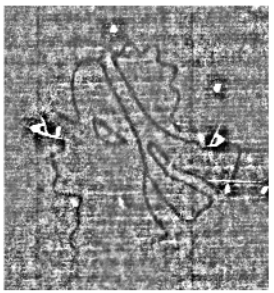
AT8900-329_130

AT8900-101_128

AT8900-101_127

AT8900-130_272

AT8900-130_271



AT8900-130_129

AT8900-130_128

was used can only be made on the basis of published and dated pictures or drawings of identical watermarks that are unambiguous in all their details.
An analysis of about three hundred watermarks in the WZ-MA collection, for which it could be established that at least two dated manuscripts contained the identical form, revealed that about a third of these watermarks exceeded the maximum time period of four years that was postulated by Piccard (cf. Haidinger, Datieren mittelalterlicher Handschriften, 17–20). Although, because of the small number of samples, this does not allow us to make a general statement about the time period identical paper was used, it nevertheless shows that Piccard's rule must be considered simply a working hypothesis, which, based on the current state of research, cannot be considered "highly certain", but merely valid for a majority of cases.

Literature: Haidinger, Datieren mittelalterlicher Handschriften; Piccard, Die Wasserzeichenforschung als historische Hilfswissenschaft.

A.H. (C.P.-K.)

Different monasteries – identical paper

Universities and monasteries, and increasingly also the administration of cities and estates, were the centres of the written word in the late Middle Ages. It can be assumed that there was brisk exchange between these institutions: university graduates were, for instance, employed in administrative positions. Unsurprisingly the connection between monasteries and universities was very close, especially between those lying close to one another such as the University of Vienna and Stift Klosterneuburg, which lies only a few kilometres outside the city, or the Vienna Schottenkloster, which, like the University, lay within the city walls. Students came from the monasteries to the University, when finished with their studies returned there, and later some came themselves to teach at the Alma Mater Rudolphina. The manuscripts that were written and used for studying and teaching found their way between the institutions in the hands of students and professors, as did the texts that were necessary for the daily liturgy. Based on the consideration that the paper used in this setting came from the stock of the same traders, within the framework of the Viennese project "Wasserzeichen des Mittelalters", the watermarks in manuscripts of Klosterneuburg began to be recorded as well as of those in the dated manuscripts of the Schottenkloster. The more identical watermarks from different dated manuscripts available, the more reliable dating based on them becomes. As expected, it could be established that the collections in the two monastery libraries contained corresponding watermarks, and thus also corresponding paper, and so with dated codices from one monastery it was possible to substantiate or further qualify dating assumptions about manuscripts in the other.

One example is the Codex 315 from Klosterneuburg, which contains a copy of a lecture held by Konrad Ülin von Rottenburg on Book III and IV of the *Sententiae*. Konrad Ülin von Rottenburg studied theology at the University of Vienna at the end of the 14th century, then taught there himself, taking on the deanship of the Faculty of Arts several times. In 1413 he became a canon at St. Stephen's cathedral, where after his death in 1416 his grave was also located. A systematic examination of his works, including lectures and sermons, has yet to be undertaken.

An important contribution to the chronology of his work's transmission could be made by means of research on watermarks. By comparing the watermarks in Codex 315 with other manuscripts in the monastery's library and with watermarks in the Piccard-Online Collection, it has already been possible to limit the dates of the manuscripts' writing to the years "1415/1420".

In addition, of the six watermark pairs in the Klosterneuburg Codex 315, three pairs could be found in the following dated manuscripts of the Schottenkloster (Ill. 2):

Cod. 101	New Testament	dated 1416
Cod. 130	Konrad de Brundelsheim: *Sermones de sanctis*	dated 1418
Cod. 329 Part I (fol. 1–132)	Sermons and moral-theological texts	dated 1417

The watermark pair "Crown" (A+B) in Codex 315 is also found in Codex 329, Part I of the Schotten collection, where it is found in eleven of sixty-six sheets, a quite substantial number. For two codices of the Schotten collection, paper with the watermark "Moor's head" (C+D) was used: in Codex 101 it appears in 114 of 156 sheets, in Codex 130 it is in 8 of 143. The watermark "Moor's head with crown" (G+H) is found on six sheets of the same manuscript. The dates of this Schotten manuscripts confirm the assumed date of the Klosterneuburg Codex 315 to "1415/1420", as was previously inferred.

Literature: Hohmann, Konrad Ülin von Rottenburg; Knapp, Die Literatur des Spätmittelalters, 180.

M.S. (C.P.-K.)

Watermarks and their variants

Watermark research differentiates between 'identical watermarks' and 'variants'. Watermarks that are considered 'identical' are the same in all details – both the impression of the wire figure and the placement on the mould – and so are perfectly congruent, which can be tested by laying transparent copies one above the other. In contrast, watermarks that are classified as 'variants', as the term is used today, were clearly made with the same wire figure, but during the production process the shape of the figure changed, creating watermarks that are different from one another. Through the mechanical wear and tear of the papermaking process or when the mould was cleaned, parts of the wire could become loose and then bent or moved. It was also possible for a wire to break.

The wire figure was usually attached to the laid and chain lines with sewing wire. When the mould was shaken during the papermaking process, it was possible for the wires of the figure to become loose or parts of them to begin to "wander". The wire was then re-attached at a spot that

Ill. 3: AT 5000-315_302

AT 5000-680_36

AT 5000-680_4

was not exactly the same as where it had previously been sewn or soldered. It also happened that single elements of a wire figure fell off the mould and were not re-attached, or that a wire figure was repaired only provisionally and so continued to become more and more deformed. A variant could also be formed by a wire figure, which had become loose, being removed from the mould completely and then re-attached, possibly inverted, at another spot. As a result, one finds sheets of paper in which their watermarks differ to varying degrees, although they were made with the same paper mould.

At first glance it is often not possible to say whether two watermarks are identical, variants or marks from different paper moulds. Drawings are usually too inexact to determine whether the differences between two figures are a result of the figure having changed or the drawing being inaccurate. Since not only the drawing itself, but also the placement of the mark on the screen must be taken into consideration, variants can only be established by means of photography. Photo software makes it possible to lay scanned photos with different degrees of transparency on top of one another, which allows even subtle differences to be visible.

To classify undated paper chronologically, it is clear that such variants are useful since they originate from the same paper mould. Relevant for dating paper based on their watermarks is the length of time such a mould was used, not the condition of the wire figure attached to the mould. What is decisive is that variants are recognized as such, and are not treated as if they were differing marks, as they would then be lost for a dating process.

Ill. 3 depicts the watermark "Moor's head with crown (and additional motif circle)" in three variants, although it is not possible to determine an unambiguous logical order for the watermark's development. The wire figure was attached to the paper mould very well. One finds only a slight deformation in AT5000–680_4 at the lower part of the head, to the right of the circle. Probably the adjacent circle was added later, only after the screen had been in use for some time, or it was a replacement for a circle that was lost. This is indicated by the fact that its wire is less carefully bent than that of the Moor's head, as well as the fact that it is rather coarsely mounted, as can be seen by the clearly visible sewing wire. Whether the two variants of the circle are one and the same circle, or whether a new circle was attached later also cannot be said with certainty. Only the differences can be noted with certainty: the circle of AT5000–680_4 is farther left, in the shape of a ring, and attached at three points; that of AT5000–680_36, in contrast, clearly shows four sewing points, is more oval, and the wire is broken at its upper right.

The Bull's head in Ill. 4 shows how many variants of one watermark could arise. Several parts of the wire figure moved over the time the mould was in use: the eyes, for example, were shifted to the right. One also sees striking changes in the horns. They gradually shift to the right and differ greatly in width. The cross, which forms the upper part of the watermark, must have broken loose several times and was repeatedly re-attached in a makeshift manner, only to become loose again and be sewn to yet another new position. The outline of the head and ears, in contrast, was attached so well to the laid and chain lines that its position did not change.

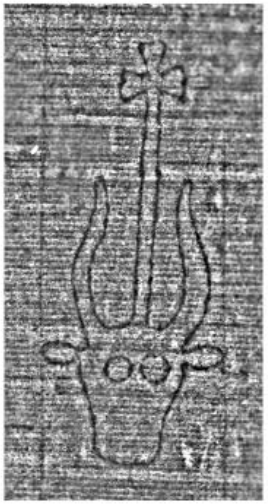
Literature: Haidinger, Datieren mittelalterlicher Handschriften mittels ihrer Wasserzeichen; Gerardy, Datieren mit Hilfe von Wasserzeichen; Gerardy, Das Papier der Seckelmeisterrechnungen, 72 ff.; Piccard, Die Wasserzeichenkartei im Hauptstaatsarchiv Stuttgart Bd.2/1–3: Die Ochsenkopfwasserzeichen, Stuttgart 1966, Bd. 2/1, 3 ff.

M.S. (C.P.-K.)

Ill. 4

AT5000-327_257

AT5000-327_269



AT5000-537_170

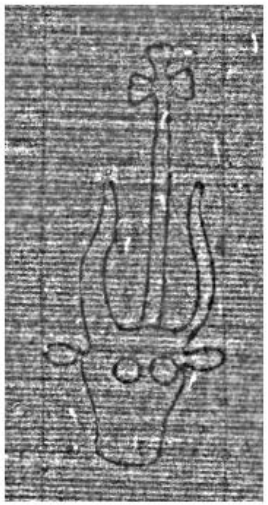
AT5000-537_174

AT5000-537_258

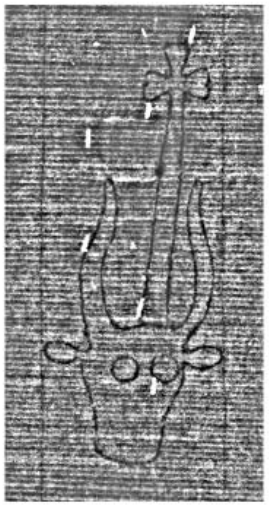
AT5000-391_313

AT5000-537_125

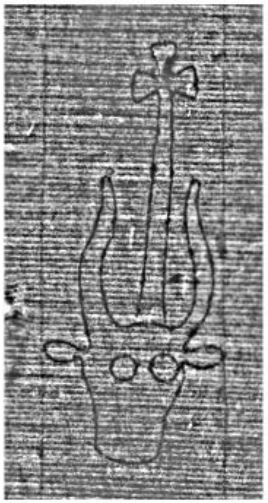
AT5000-RB1_1_213



AT5000-537_42



AT5000-537_296



AT5000-537_63

Sheets and Watermarks in Printed Books: the Example of Venice

It is universally recognized that the printed book, from the very outset, has been a massive consumer of paper. The development of printing technology in the last thirty years of the 15th century therefore coincided not only with a rapid increase in demand for raw materials, but also determined an intense concentration in space and time: in space, because a small number of major centres played hegemonistic roles in the production of books; and in time, because the production of a particular edition necessitated the immediate availability of a large number of reams, which were in turn consumed very rapidly. At this moment in history, however, we are still a long way from the practice of keeping archives/chanceries, and even further removed from the consumption of paper by private citizens.

The quality of being a "massive consumer" of paper that characterises printed books becomes very clearly apparent as soon as a one embarks on a systematic census of all the watermark variants contained in a single volume. One immediately notices, in fact, that a single example of a given edition can contain, on average, something like fifty variants of a single motif, whilst normally, in an integral manuscript, one only encounters a handful. This difference is in part due to a mechanical phenomenon: whilst the sheets that compose a manuscript represent at the most a portion of a ream from a stock of purchased paper, the sheets in a printed edition constitute a random "sampling" from a large quantity of reams.

However, this fact is not sufficient to fully account for the phenomenon: in theory, there is no reason not to suppose that a printer was not able to obtain a homogeneous stock of paper, purchased from a single papermaker. Now, in the incunabula analysed during the course of "Progetto Carta", an example of this kind only emerged once: in an edition of *Etymologicum Magnum Graecum*, published in Greek in 1499 in Venice by Zacharias Callierges, and certainly addressed to an erudite and wealthy readership, and for this reason printed on paper of excellent quality. In all the other cases, though, a mixture of different papers was the rule, and the degree of mixing increased little by little with the advance of time. Moreover, when further examples of the same edition were analysed, new variants continually came to light. This means that even at this time, within the reams of paper marketed by wholesalers, the degree of mixing was already considerable.

The fact that different sources were combined in a single stock of paper is in the first place a direct consequence of the "voracity" of printers: a single papermaker, in fact, could not have satisfied in a short time the simultaneous demand of multiple printers operating at full capacity. It was therefore necessary for papermakers and buyers to interpose a "flywheel" between themselves; this "flywheel" took the form of a group of wholesalers that could guarantee a supply of paper to the market by drawing on different sources. But there is something more to add: it is entirely reasonable to suppose that in more than a few cases books were not assembled using paper originating from the same ream; rather, sheets were mixed on purpose. The most likely reason for this practice was to mix the quality of the papers placed on the market, in the same way that a fruit seller mixes unripe bunches of grapes with ripe ones on his stall.

In any event, we can see that the development of printing necessarily exerted a powerful influence on the structure of paper marketing. Analogously, the increase in demand necessarily influenced the characteristics of the manufactured product. One must consider that the quantity of rags that could be recycled through paper manufacturing – the quantity is necessarily linked to demographic data – could not increase in a way that was concomitant with the rise of new and ever more exigent customers, and therefore it was imperative that the manufacturing process underwent significant improvements. In other words, it was necessary to manufacture a greater quantity of superior quality sheets from the same quantity of raw materials. For this reason, a gradual diminution of grammage was seen: from the 18 pounds (*libbra*) per ream prescribed by the Bologna norm, the weight dropped over a period lasting a little more than a century to 13–14 pounds (*libbra*). The thickness measurements – a parameter certainly linked to weight – carried out during the course of "Progetto Carta" – very effectively demonstrate a rapid thinning in the paper used to make Venetian books.

This phenomenon had an impact on the moulds used for papermaking: thinner paper, in fact, can not be made with heavy gauge wires, which would have had a negative effect on the finished product's strength (i.e. tearing resistance). Therefore one sees, as a consequence, closer weaving of the laid lines applied to moulds, which in turn called for chain lines to be closer to one another in order to avoid sagging of the laid lines under the weight of the pulp. Statistical analysis makes it clear that this phenomenon affected production all over Europe, but in rather different ways: it was relatively contained in Venice (most likely not entirely by chance); this evolution was, however, much more pronounced in Northern Europe. The effects of the phenomenon can also be observed in watermarks; not in relation to the choice of motifs, but instead in the changes that can be seen in their dimensions. These changes can probably be attributed the ancient printers' dislike of large, intrusive watermarks (located between chain lines divided by wider spaces, or alternatively straddled over two chain lines) because of the risk of damaging fragile surfaces when exposing them to the considerable pressure exerted by printing presses. Indeed, it should be recalled, in this connection, that the image of a watermark can be seen in transparency precisely because it coincides with thinner areas in a sheet of paper.

The effects of the printers' preferences are also very evident in "Venetian" paper. Today, we know that the paper consumed in Venice originated, in reality, from a large number of papermakers located close to Lake Garda. In addition to supplying the Venetian republic, the Garda area also exported its output far and wide, with their products reaching Southern Germany, Austria, Dalmatia, and even the Ottoman Empire. In the final thirty years of the 15th century the watermark motifs most often used for the sheets that composed Venetian incunabulae were, by far, the balance (weighing scales), followed by the bull's head, the hat, and the anchor. These subjects were represented in all the above-mentioned geographical areas, but in varying proportions: the balance is the most frequently encountered

motif in Italy; the bull's head in Southern Germany and the anchor in parts of Austria, and, above all, in Dalmatia. In addition, within the same motif category, the characteristics of a watermark can differ depending on whether it was used in archives or by printers.

This well-ordered diversity leads us once again to pose the question: what kind of world is hidden behind the choice of subjects for watermark motifs? It has already been said that medieval norms required that two different watermarks had to be used to distinguish fine quality paper and so-called "fioretto" grade product, but it is not out of the question that the choice of subject for watermarks indicated quality on a much more compressed scale. The phenomenon is clearly attested to in the 16th century in Zurich – where it was prescribed that watermarks for superior quality papers had to be larger – and implicitly, at the same time, at Regensburg. But can it be by chance that the cardinal's galero, which appeared in Venice after the year 1480, happens to be associated with a paper that's generally whiter and less "lumpy" (i.e. course) than other papers, or that the watermark seen in the sheets that compose the highly esteemed edition of Callierges happens to be a lily? The choice of motifs for a watermark can hide other clues: the case of the half-moon is well-noted, the production of which, including in the Garda area, was especially aimed in the direction of the Ottoman Empire; in the same way, the predominance of the anchor as a motif in Dalmatia surely suggested in an indirect way that that particular paper was destined to travel overseas. And it is impossible not to notice that the bull's head, which was mainly directed towards Germany, was the watermark motif most used by papermakers based in the German-speaking area. The implicit meanings "concealed" in watermarks certainly represent an interesting and relatively unexplored area of study.

Finally, we should make some mention of a phenomenon that originated in Venice and only later on appeared in other countries: the countermark. This is a watermark that is smaller than the principal watermark in a sheet, and is almost always to be found in a corner on the opposite side of a sheet to the one in which the principal watermark is situated (i.e. sewn onto the original mould). The countermark made its first appearance a little after the year 1480, but its full development only occurred in the successive decade: in that period, the *Corpus* analysed during "Progetto Carta" contains a little more than 25% of sheets that include a countermark. Moreover, the appearance of the phenomenon can be linked to a differentiation method that was desired by papermakers in a geographical area teeming with papermakers that used the same watermark motif. This explanation, however, does not take into account other factors: the phenomenon did not appear in other regions of the continent, such as the Eastern Europe and France, where the situation was exactly the same. Countermarks appear much earlier and in greater numbers in printed books than in archival documents. There is a positive correlation between the presence of countermarks and the whiteness level of papers.

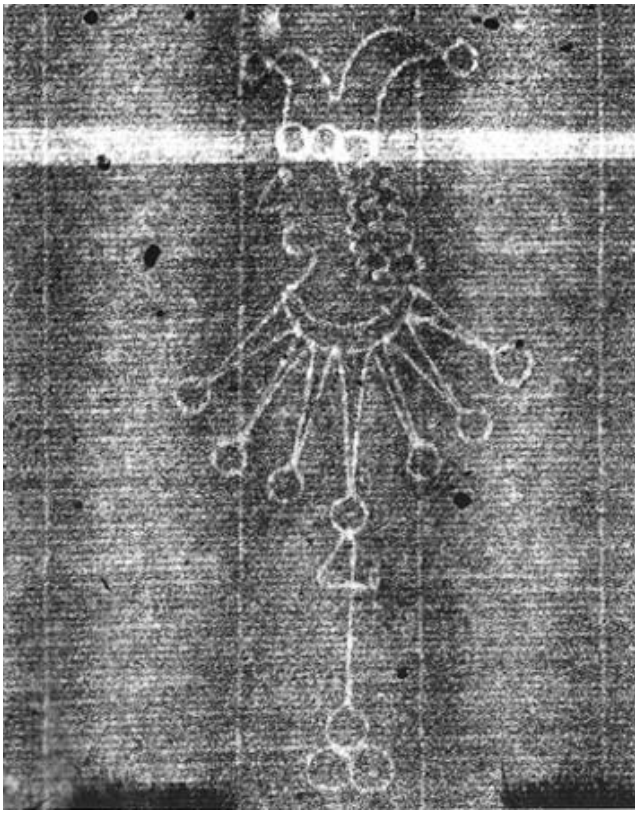
Literature: Ornato et al., La carta occidentale nel tardo medioevo, Volumes I and II (Addenda 4).

E.O. (M.L.)

Paper and Watermarks in Art History

European artists have used paper as support for preparatory and other drawings as well as for etchings, engravings and woodcuts for many centuries. However, only scant information is available about the paper they used. Although paper travelled and often was made in one European country, but bought and used by artists and printmakers/dealers elsewhere, establishing the place and date of production and/or use of paper, sometimes ascertained by watermarks, may help to identify the artist who used the paper. It would be interesting to know how and when a given paper brand was used by a particular artist and artists in general and if, and in what way, paper used by artists for their prints differs from that used for their drawings, letters or poems.

As other paper-consumers, artists and print dealers bought their paper in relatively small quantities: either in reams of 500 leaves that due to the methods of paper production have one and the same structure and watermark or also in books of 25 leaves each with the same watermark. In general, these leaves with the same watermark were used by artists during a relatively small number of years. When an impression of a print by a particular artist that carries a date and another one without date are printed on the same kind of paper with the same watermark it is highly probable that the print without date is from more or less the same period as the dated example. Mutatis mutandis this is also valid for dated drawings or undated ones related to a datable commission. Other drawings with the same



Ill. 5: Foolscap

Ill. 6: Rembrandt, Old man Shading his Eye with his Left Hand, Bartsch 259 II (2), Dresden, Staatliche Kunststammlungen, Kupferstich-kabinett, c. 1639

Ill. 7: Rembrandt, Resurrection of Lazarus, Bartsch 72 i (2), Braunschweig, Herzog Anton-Ulrich Museum, inv.no. 5441a, signed and dated 1642

watermark may well have belonged to the same ream of leaves and were probably used by the same artist or his workshop within a rather short period.

Datable paper may provide insights in a given paper brand used by an artist, could help establish a chronology of works, verify authenticity, and highlight workshop practices. The uncertain attribution of a drawing to an artist when the drawing contains a particular watermark which is already known from a certain work by the same artist may give additional support to the attribution of the uncertain work.

As paper-leaves used for drawings by an artist have often been cut into various pieces, registering the characteristics of one piece of paper with a drawing by the artist may be a starting point for recognizing other pieces of paper with drawings that have belonged to the same leaf and even the same ream of leaves. Many of the so-called "peintre-graveurs" such as Albrecht Dürer, Parmigianino and Rembrandt made prints as well as drawings. Sometimes their prints are dated. If the paper of these prints has identical watermarks, they may well help establishing dates and authenticity of undated prints and drawings by the same artist and his workshop and of the relationship among print impressions. Some watermarks may be typical for a certain year or period.

For all these reasons a large set of data and images of watermarks and paper-leaves would provide a fundamental instrument for the study of prints and drawings, i.e. for the art history scholar, for museum staff, for collectors, and for art dealers. In the past watermarks have been regularly retrieved for research. They are usually hidden in individual catalogues if published at all or otherwise held closed by the owners' institutions of the art works. The database of the Dutch Institute in Florence now under construction will offer the great advantage of a centralized collection of large quantities of watermark material. Its cumulative effect will be an essential surplus value to its clients/users.

Example of a watermark in an etching by Rembrandt:

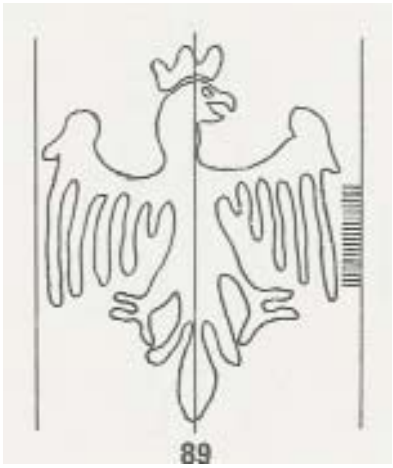
The Foolscap watermark (Ill. 5) has been found in many variants in paper of etchings produced by Rembrandt. This variant (foolscap, collar with seven points, long loose hair, small balls at the lower side of the collar-points and below) is for example present in a number of etchings from the years 1639 until 1642, such as those illustrated in illustrations 6 and 7, the first one approximately datable 1639 and the second one signed and dated 1642.

Example of a watermark in Michelangelo

A watermark with an eagle (Briquet 89; here ill. 8) found in a drawing of fortifications (Florence, Casa Buonarroti inv.no. 27a, De Tolnay Corpus no.567; ill. 9) is identical to the watermark recently found in a study of fortifications attributed until now to the school of Michelangelo (Florence, Casa Buonarroti, inv. no. 12a, De Tolnay Corpus 565; ill. 10). The discovery of the identity of these watermarks provides an excellent argument to reconsider whether the second drawing is in fact by an artist of Michelangelo's school or rather by an artist active in the workshop, or by Michelangelo himself.

Selective Bibliography: Ash / Fletcher, Watermarks in Rembrandt's Prints; Boorsch et al., exhibition catalogue; Filedt Kok et al., Jan Muller as Printmaker; Griffiths, On Some Albums; Griffiths / Hartley, Watermarks; Hinterding, Rembrandt als etser; Hinterding, Rembrandt as an etcher; La Chapelle, Michel-Ange; La Chapelle et al., Les filigranes; La Chapelle et al., Les relevés de filigranes; Lanfiuti Baldi, Contributo alla conoscenza; Lanfiuti Baldi, La cattura di Cristo di Dürer; Lunning, Characteristics of Italian paper; Meijer, An International Database; Roberts, Dictionary 1998; Woodward, Catalogue of Watermarks.

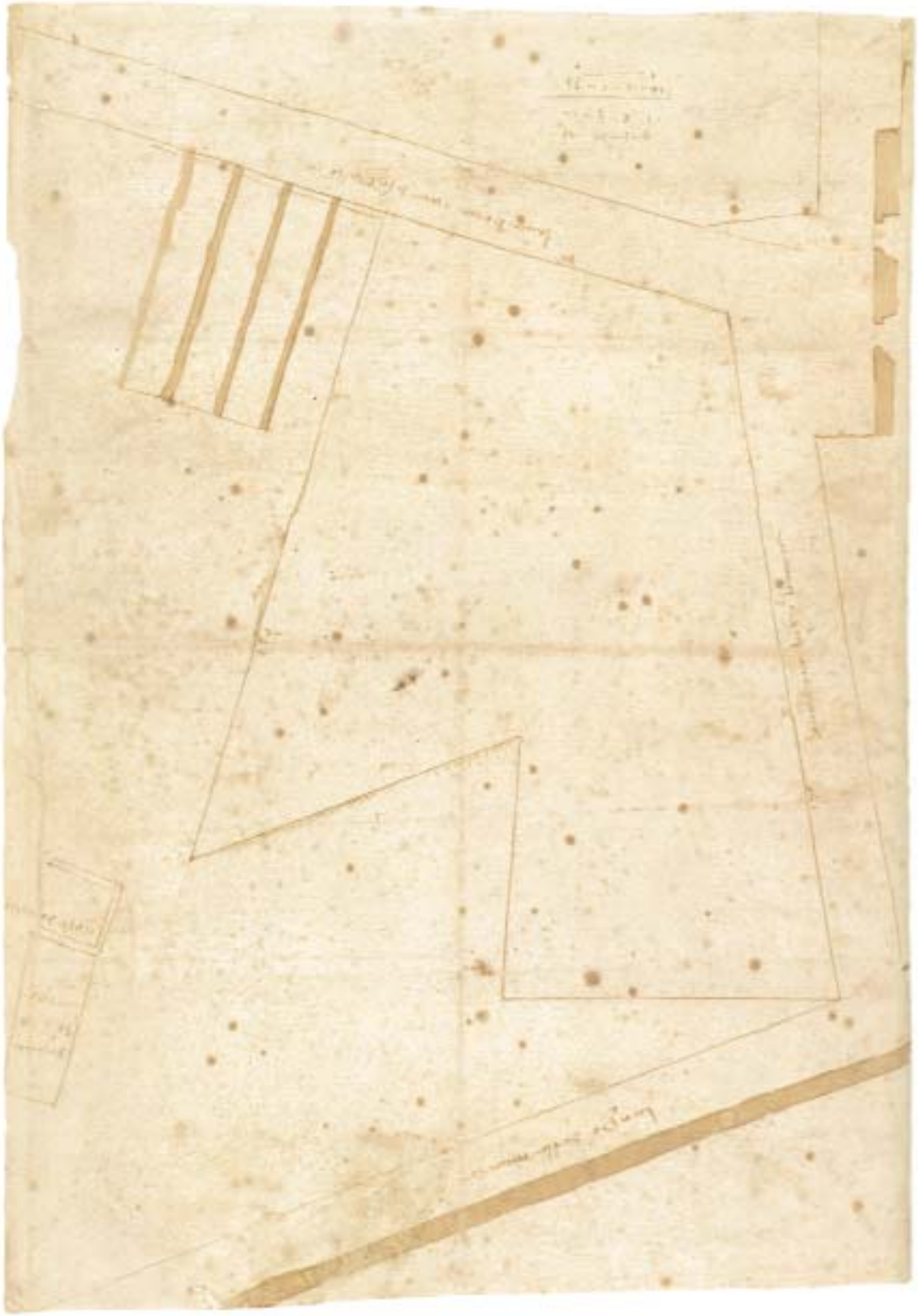
B.W.M. (B.W.M. / L.D.)



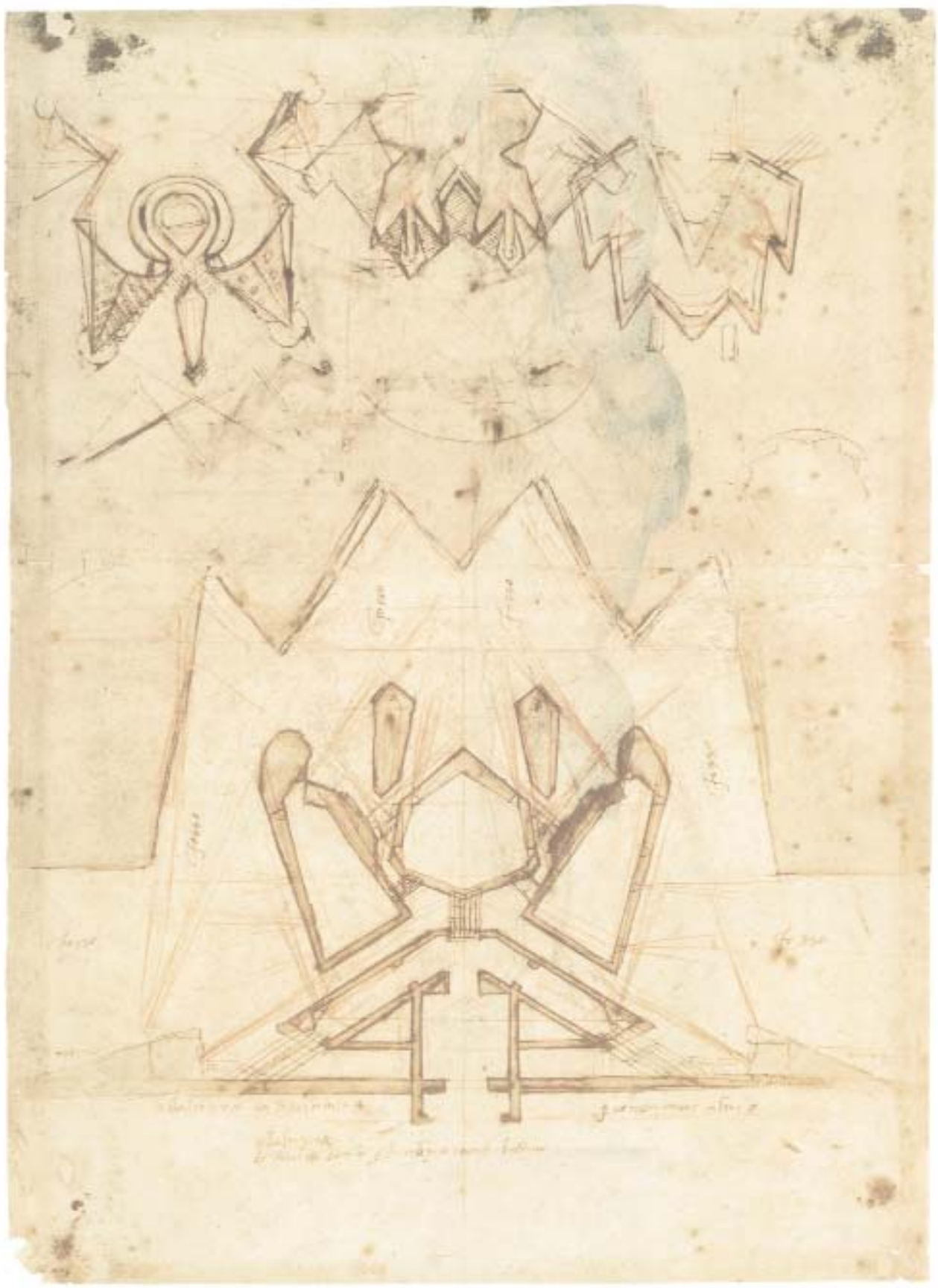
Ill. 8: Watermark, "Eagle" (Briquet 89)

Watermarks and Musicology

More than any other field of historical study, musicology has found the additional information that can be gained by research on paper and watermarks of inordinate value. A detailed survey of the results that such research can bring has already been published by Frederick Hudson in 1987, and it is thus unnecessary to go into great detail in this regard here. The significance of such research and documentation activities can be seen in the special watermark volumes that are part of the complete works of Bach, published in 1985 by Wisso Weiß in co-operation with



Ill. 9: Michelangelo, Fortifications, Florence, Casa Buonarroti, inv.no. 27a (De Tolnay, Corpus no. 567)



Ill. 10: Michelangelo, Fortifications, Florence, Casa Buonarroti, inv. no 12a (De Tolnay, Corpus no. 565)

Yoshitake Kobayashi, and of Mozart, published in 1992 by Alan Tysen. Nevertheless, in an article about the importance of paper and watermark research for musicology, Ulrich Konrad pointed out in 1999 that a methodical survey of music paper has long been needed, and emphasized that "strictly speaking, it is still missing today" (Konrad, Notenpapier, p. 20). Musicological results with regard to watermarks have often been drawn from the point of view of paper historians, and the publishing of such documentation is frequently strewn here and there, often hidden in the addenda of special studies that are not catalogued separately. This can especially be seen with regard to the critical reports relating to the New Schubert-Edition.

In certain cases, an exact description of the paper and an analysis of its watermarks help to reorganize the various parts of a manuscript whose order has become obscure through years of historical tradition. When lucky, it can be found that a paper's provenance agrees with a life station of a composer or a conductor, thus providing additional testimony regarding, for instance, the chronology of bequests or the location a piece was composed. The watermarks must be clearly identifiable for such additional information to be reliable, and therefore the need for knowledge about the history of the respective paper mills, the sequence of the mills' owners, and about the papermakers themselves must not be underestimated. The examination of the paper music is written on can provide tentative answers to questions that, in turn, can often be confirmed by other facets of the written sources.

Literature: Duda, Das musikalische Werk Franz Xaver Süßmayrs; Hudson, Musicology and paper study; Hudson, Concerning the watermarks; Konrad, Notenpapier; Konrad, Wasserzeichen; Konrad, The use of watermarks; Kümmerling, Katalog der Sammlung Bokemeyer; LaRue, Watermarks and musicology; Rudén, Vattenmärken; Schmidt-Görg, Wasserzeichen; Schmidt-Görg, Die Wichtigkeit der Wasserzeichen; Schubert, Werke; Shearon, Watermarks and rastra; Tyson, Paper studies and Haydn; Tyson, Wasserzeichen-Katalog; Weiß, Katalog der Wasserzeichen; Weiß, Zu Papieren und Wasserzeichen.

F.S. (C.P.-K.)

Watermarks and Cartography

The many advantages offered by the identification of watermarks for the history of cartography was first recognized by the English map specialist and librarian of the Royal Geographical Society Edward Heawood (1863–1949). He had examined the work done by the watermark scholars of the 19th century and had intensively studied the results of their research, such as the four-volume magnum opus of Charles-Moïse Briquet published in 1907. In 1924 Heawood published an article related to this field dealing with the verification of the period and the geographic location that specific watermarks were used. He was the first to chart, on the basis of data collected by Briquet, the spread of the "Bull's head" and "Rod of Basel" watermarks.

Heawood referred to the Mercator Atlas in this publication and recommended a detailed analysis of its first edition: "A careful study of the marks in all copies available would no doubt throw light on the precise manner of issue of the various parts of this first edition." (cf. Heawood, The Use of Watermarks, p. 398). An examination of the sheets of one set of the large Mercator maps kept at the University Library in Rome resulted in the discovery that in this collection, maps that had originally been published over a extended period of time here all contained the same watermark, suggesting that this copy of the atlas was a reissue. Such results demonstrated that when using watermark analysis in studying the printing history of maps, new considerations were necessary.

In reaction to the restrictions of period and subject matter Briquet had imposed on his collection, Heawood decided to examine a different period, turning to paper from the 17th and 18th century. He also took paper that was used for printing into account. His first step was to systematically analyse watermarks in large format paper, which was used for printing maps and sea charts, as at the time of his research such paper had not been documented precisely enough. His epoch-making work about the watermarks of the 17th and 18th century appeared posthumously as a publication of the Paper Publication Society founded by Émile Joseph Labarre. It became the first volume of the series "Monumenta chartae papyraceae historiam illustrantia", a series that became extremely important for watermark research as a whole.

The Hessian geodesist and watermark scholar Robert Große-Stoltenberg, whose estate is now held by the Hauptstaatsarchiv Stuttgart, dealt repeatedly with the importance of watermarks in research on old maps. His study "Der Große Atlas von Deutschland von Johann Wilhelm Abraham Jaeger", Frankfurt 1789, which he published in 1969, is based on his research on old maps and the paper they are printed on. After an examination of eight complete copies of the maps contained in this atlas, eighty-one of Germany and seven of other countries, Große-Stoltenberg asked, "whether the watermarks of maps, printed primarily on large-format sheets (Grand Royal and the like), may also be used without reservation in making decisions with regard to verifying the service life of moulds and motifs" (cf. Große-Stoltenberg, Wasserzeichen, p. 94). One aspect pointed out by Grosse-Stoltenberg is of particular relevance for watermark research: when maps were reissued, the cartouche usually remained unmodified, meaning that print of the chart, including the original date, also stayed the same. Thus, one must be careful when drawing conclusions about dates of watermarks based on the dates printed on maps.

In the USA, over last few decades David Woodward has dealt with the physical aspects of old maps, above all carefully analysing the ink used for drawing or printing them. In Woodward's opinion, the most important methodical progress that has been made in watermark research has been the transition from tracing by hand to more objective means of documentation like photographic contact prints, the Dylux method, or beta radiography. Through a rigorous examination of the watermark motif "Mermaid", Woodward has tried answer the question whether differences between two watermarks were caused by two different states of the same mould or because of two different moulds being used. For this, he has analysed the number and position of knots with which the watermark figure was sewn to the

screen. To compare the watermarks, digitised beta radiography photos were evaluated with a computer-based image analysis.

Woodward's catalogue of watermarks in printed Italian maps – which contains nearly 330 Italian maps from the Franco Novacco Collection of the Newberry Library, Chicago, as well as additional holdings – set completely new standards. All of the watermarks are published as beta radiography photos. It is the first publication to consistently use the classification standards proposed by the International Association of Paper Historians.

Watermark research has remained unable to clarify the facts regarding what was the perhaps most controversial map discovery of the 20th century. When in 1965 the so-called Vinland map became known, a critical evaluation of its origin was given great importance. The object of interest was a drawn map depicting parts of the American east coast. It was ostensibly from the 15th century, a date considerably earlier than the expeditions of Christopher Columbus. Because it is drawn on parchment, there are no watermarks to assist the dating, and thus ink and radiocarbon analyses were undertaken. In 1974 Theodor Gerardy declared the map a fake. Nevertheless, the map, bought by Yale University in 1959 with the support of Paul Mellon, is still today considered authentic by the owner. Although the parchment it is drawn on is old, it was found that one of the inks used for the document was produced on basis of a specific titanium dioxide which was not manufactured before 1923. Thus, sceptics consider the map a forgery, setting this date as the earliest possible point in time it could have been drawn. One might see evidence here that forgers have also carefully followed the results of watermark research, thus preferring in some cases not paper, but other writing materials.

Literature: Gerardy, Die Vinlandkarte; Große-Stoltenberg, Wasserzeichen; Große-Stoltenberg, Der Große Atlas; Heawood, The Use of Watermarks; Heawood, Watermarks; Kazmeier, Aus der Geschichte des Papiers; The Große-Stoltenberg Collection, overview; Woodward, The Analysis of Paper; Woodward, Catalogue of Watermarks.

F.S. (C.P.-K.)

The Significance of Manuscript Dating as Demonstrated by Codex 214 of the Schottenkloster in Vienna

This manuscript, owned by the famous jurist Johannes Polczmacher, is one of the few pieces of evidence for the humanistic interests of the Viennese professor, about which we otherwise know only through his will, dated 1453. The will lists eighty-two books that he bequeathed to the Schottenstift, including thirty volumes with classical or humanistic texts. Codex 214 includes, in addition to eight comedies by Plautus and numerous letters of the Florentine Poggio Bracciolini, an early humanist, also two works by Cicero (*Laelius – De amicitia* and *De officiis*), which, according to notes by the scribe at the end of the texts, were completed in 1446 and 1447. Through an exact analysis of the watermarks it has been possible to date an undated text, also included in the codex, to the latter half of the 1440s, the constitutional treatise *De ortu et auctoritate imperii Romani* by Eneas Silvius Piccolomini (Pope Pius II, 1458–1464). Thus it is possible to determine that this transmission is one of the oldest copies, if not the oldest copy, of this extremely interesting text, which was dedicated by Piccolomini in March 1446 to the later Holy Roman Emperor, Friedrich III. This is important evidence for reception of the humanist, which until now has been underestimated, in circles close to the University of Vienna.

This example shows how important it is for the transmission history of texts and intellectual currents to date texts as exactly as possible and thus also their reception and spread. In this case, of the various approaches to scholarly dating, research on watermarks offers itself as one of the best methods.

Codex 214 consists of five sections, of which two are dated:

I	fol. 1–12	dated 1446	Scribe A
II	fol. 13–84	dated 1447	Scribe A
III	fol. 85–106, 119–128	"about 1445–50"	Scribe B
IV	fol. 107–118	"about 1451–56"	unwritten
V	fol. 129–229	"about 1445–50"	Scribe C (possibly two hands)

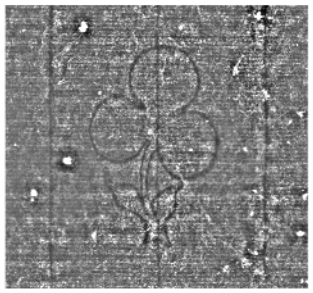
The dating of the undated sections of the manuscript was based on the following observations, which could be derived on the basis of images of the watermarks (Ill. 11): Section III was written by a different scribe than Sections I and II, but the paper used contains the identical watermark pair "Cloverleaf" (A+B) as found in the first two sections, which suggests that the third section was written at the same time. This can be confirmed on the basis of dates of manuscripts in Klosterneuburg: the same watermark pair is found in both the Codex 926 of the Klosterneuburg library, written in 1445, and the Grundbuch 7/2 of the monastery archives, which was drawn up in 1446. In the Piccard-Online Collection there are also a number of marks that are related to this pair: No. 126976 (1446), No. 126977 (1449), No. 126978 (1449), No. 126979 (1445) and No. 126981 (1447). In addition to paper with the watermark "Cloverleaf", paper with the watermark "Scales in circle" (C+D) was used in Section III. This also has corresponding watermarks in the Piccard-Online Collection, namely No. 116702 (1448) and No. 116703 (1448). This compound corroboration of these watermarks in different manuscripts and archival materials for the years 1445–1449 makes dating Section III to "about 1445/1450", and thus the treatise by Eneas Silvius Piccolomini described above, plausible.

The situation is similar for Section V. This section, whose scribe was neither Scribe A of Sections I and II nor Scribe B of Section III, contains the watermark "Cloverleaf" in an identical form as in Sections I, II, and III, so that the considerations with regard to Section III are also valid here. The watermark "Scales in circle" (G) is found in only one sheet and can be disregarded for the dating.

Section IV consists in a layer of sheets that were left unwritten. The watermark found here, "Triple mountain in cir-

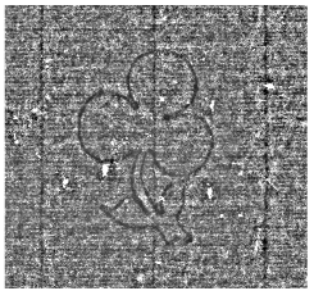
Identische Wasserzeichen und Varianten zu Codex 214

zu A

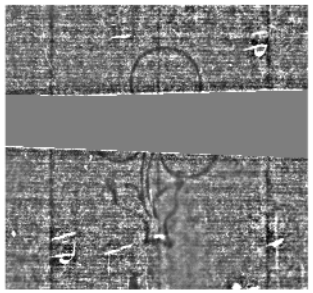


AT5000-GB7_2_179 (1446)

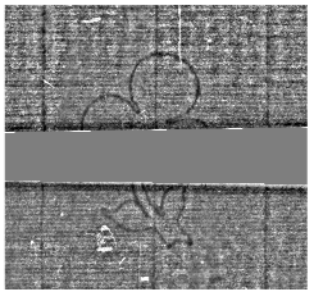
zu B



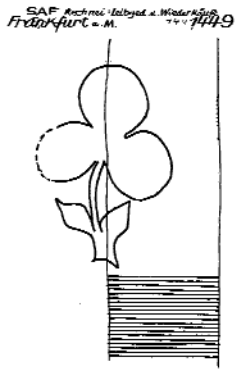
AT5000-GB7_2_151 (1446)



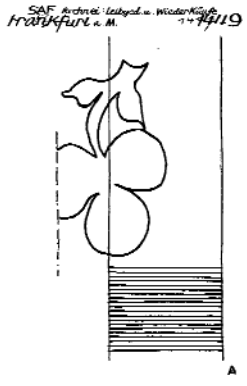
AT5000-926 91 (1445)



AT5000-926 186 (1445)

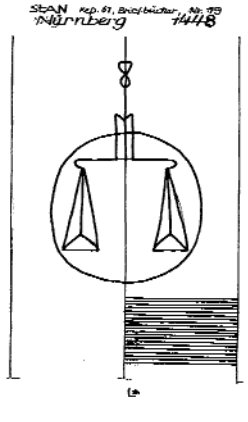


Piccard-Online Nr. 126977 (1449)



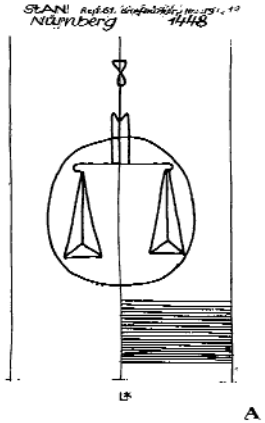
Piccard-Online Nr. 126978 (1449)

zu C



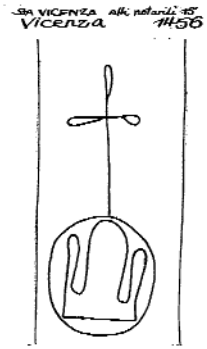
Piccard-Online Nr. 116703 (1448)

zu D



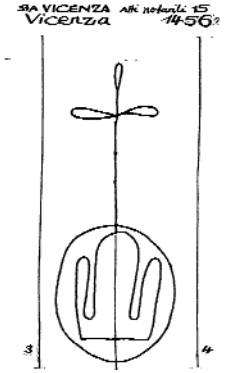
Piccard-Online Nr. 116702 (1448)

zu E



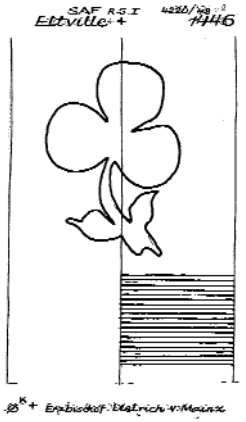
Piccard-Online Nr. 153726 (1456)

zu F



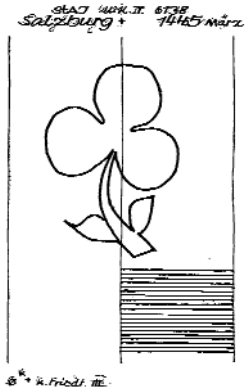
Piccard-Online Nr. 153721 (1456)

zu B



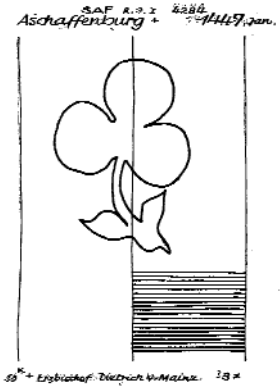
Piccard-Online Nr. 126976 (1446)

zu B



Piccard-Online Nr. 126979 (1445)

zu B



Piccard-Online Nr. 126981 (1447)

cle, cross consisting in two lines above" (E+F), does not match those of the other sections. Related watermarks are found in the Piccard-Online Collection under No. 153721 (1456) and No. 153726 (1456). In the related repertory volume, "Triple Mountain", Piccard has established that this type of triple mount, numbered 1615–1624 in Section 5 of the book, dates to between 1451 and 1456. Since this layer of papers is found within the third section of the manuscript, it seems to have "slipped in" by mistake when the codex was being bound. This explains the slightly later date of "about 1451–1456", as the manuscript could only be bound after the other four sections were finished.

Literature: Unterkircher / Horninger / Lackner, Die datierten Handschriften in Wien, Nr. 255; Piccard, Die Wasserzeichenkartei im Hauptstaatsarchiv Stuttgart, Bd. 16/1–2.

M.S. / M.W. (C.P.-K.)

IV 1 Letter from Sigismund, Archduke of Austria to Count Ulrich von Württemberg

5 August 1459
Paper, 22 x 32 cm, with pressed seal on the back
Hauptstaatsarchiv Stuttgart A 602 Nr. 4828

With this letter, Sigismund, Archduke of Austria announces his appointment of Count Hug von Montfort as the head of Swabia to Count Ulrich von Württemberg. The paper's watermark is a triple mount with a rod and letter Tau. This is placed in the centre of the sheet, facing from left to right. The triple mountain is considered a heraldry watermark. It is formed of three arched hills, the middle of the three the highest. Here it serves as a pedestal or base for the stem and cross above. The triple mountain is a common heraldry motif, found in this form already in early coats of arms. In addition to the very common triple mountain, depictions of five and six mountains are also found. In the heraldry of the Middle Ages, the triple mountain often has the function of the base. In modern heraldry, the same function is usually served by a single hill at the lower edge of the shield. Mountains are found in many variations, above all in Germany, Switzerland, Hungary and Italy.

Based on this letter's exact date and the watermark of triple mountain, rod and letter Tau watermark, Gerhard Piccard was able, by means of his important proof on the basis of identity, to date the *Missale speciale (Constantiense)* (Bayerische Staatsbibliothek Munich, Clm. 63 ao.) (Piccard 269, Ill. 39).

Literature: Gert, Lexikon der Heraldik, S. 60; Piccard, Die Datierung des Missale speciale; Scheibelreiter, Heraldik, S. 77.

C.K. (C.P.-K.)

IV 2 Vocabularius « Ex quo »

[1444–1446]
Paper, 193 Sheets, 30 x 21 cm
WLB Stuttgart HB VIII 8
Sheet 19 (Watermark: "Hunting horn")

The *Vocabularius "Ex quo"* was written by various hands in a fluid bastarda script and is distinguished by its decorative book ornaments and embellished initials. The manuscript was acquired by the Württembergische Landesbibliothek from the Constance Cathedral library by way of the Weingarten Monastery. The bilingual *Vocabularius* has been composed in Latin and a Swabian dialect. On the front cover is found a coloured woodblock print portraying John the Baptist and John the Evangelist dated to between 1440 and 1455 (Ill. IV 2a). This type of text can be found throughout the German-speaking realm of the 15th century. The *Vocabularius* was intended as a practical guide for understanding the Bible as well as for interpreting other Latin texts. It was drafted especially for the so-called *pauperes scolares*, who had only a rudimentary knowledge of Latin. It offered condensed and basic information about grammar. A siglia code makes the grammatical category of each lemma clear. The Latin explanation of each term is augmented by a translation into the vernacular dialect. On occasion, mnemonic rhymes or quotations are included as examples. The aim of the *Vocabularius "Ex quo"* is to be a short, comprehensive handbook that is practical to use.
Gerhard Piccard wrote an expertise on the watermarks of this manuscript, and described the paper from Sheet 1 to Sheet 161 as containing the Ravensburg watermark "Hunting horn". From Sheet 162 this is replaced by paper produced in Milan with "Bull's head with eyes, mouth, etc., with stem and five-lobed flower". Piccard was able, based on a comparison of this watermark with other examples in manuscripts in the Stadtarchiv Nördlingen, to establish their identity. Both Nördling manuscripts indicate the year 1446. The second watermark is found as No. 966 and 967 of the Bull's head types included in Piccard's published Findbuch "Ochsenkopf". Piccard points out that these Bull's head watermarks are characterized by significant deformations. He initially dates them to the period after 1440, later considering the years between 1443 and 1446 the most likely timeframe for their use. Based on its watermarks, it was possible for Piccard to date the *Vocabularius "Ex quo"* to between 1444 and 1446.

Literature: Buhl, Die Handschriften der ehemaligen Hofbibliothek Stuttgart, Bd. 4,1; Grubmüller, Vocabularius Ex quo, 1967; Grubmüller, Vocabularius Ex quo, 1999.

C.K. (C.P.-K.)

IV 1

IV 3 John of Mandeville: Journey to the Holy Land

[1468–1472]
Paper, 41.5 x 29 cm, 160 sheets
WLB Stuttgart HB V 86
Sheet 2

This anthology, in various hands, has been identified as having been written in the Earldom of Württemberg; a linguistic analysis indicates its provenance as being the upper Neckarland. It was first acquired by the Weingarten Abbey as part of the library of Johann Friedrich Ochsenbach. The first section (Sheets 2ra-53va) contains a German translation, by Michael Velser, of "the Journey to the Holy Land" by John of Mandeville. The text is a French travel documentary in the form of a novel that was composed between 1357 und 1371; the anonymous author calls himself Jean de Mandeville. The travel report, large portions of which are fictive, quickly found a wide circulation after having been translated into Latin and nearly all European languages.

A watermark expertise on this manuscript was provided by Gerhard Piccard. He describes it as written on Großregal-format paper from Milan containing a watermark of an eight-petalled flower without stem. Piccard was able to find an identical watermark in a Strasbourg incunabulum with the date 1474. Sheets 158 and 159 are different, and thus Piccard assumes that the Milan paper ran out in the course of the writing. The two added sheets are of the common Kanzleiformat and contain the watermark "Bull's head with eyes, stem and five-petalled flower with attached mark". For this watermark, Piccard refers to his Findbuch "Ochsenkopf" (No. 861), where the manufacture of paper with this type of Bull's head is documented as dating from 1470 to 1472. It is assumed that the stocks of large format paper took a longer period of time to be depleted, and thus Piccard first suggests manuscript HB V 86 as having been written between 1468 and 1478. The added pages in Kanzleiformat, however, enable a further chronological limitation, so that the final dating he offers is the period between 1468 and 1472.

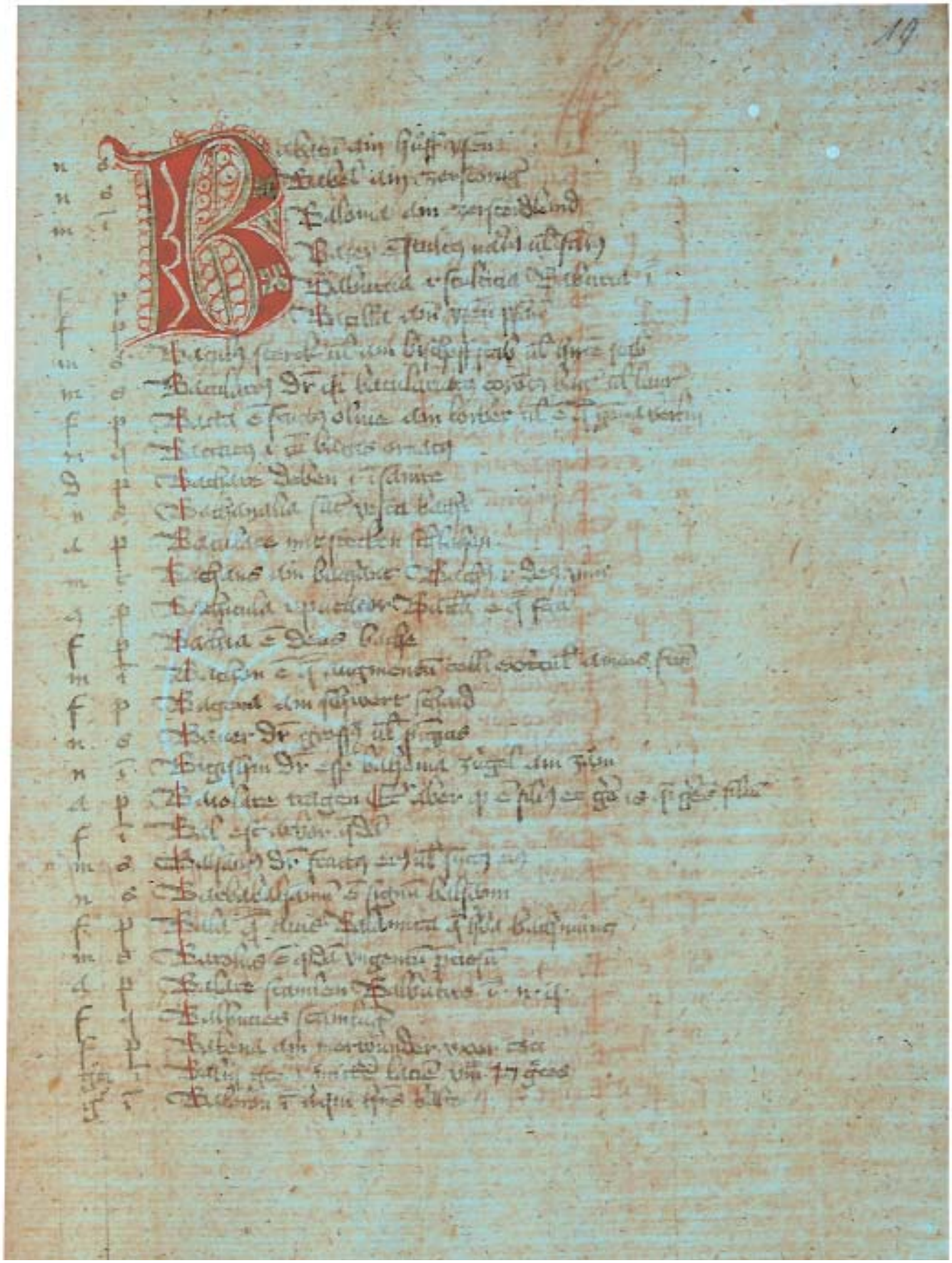
Literature: Bremer, Jean de Mandeville; Irtenkauf / Krekler, Die Handschriften der ehemaligen Hofbibliothek Stuttgart, Bd. 2,2.

C.K. (C.P.-K.)

IV 4 Vitae sanctorum

[1439–1442]
Paper, 29.5 x 21 cm, 178 sheets
WLB Stuttgart HB XIV 19
Sheet 4 (blank, watermark: "Bull's head")

The original owner of this manuscript, "Lives of the Saints", was the early humanist Felix Hemmerli. Hemmerli was born in either 1388 or 1389 in Zurich and died in Lucerne probably in 1458 or 1459. It is known that he was a participant in both the Council of Constance (1414–1418) and the Council of Basel (1432–1435). The manuscript later was ac-



IV 2a

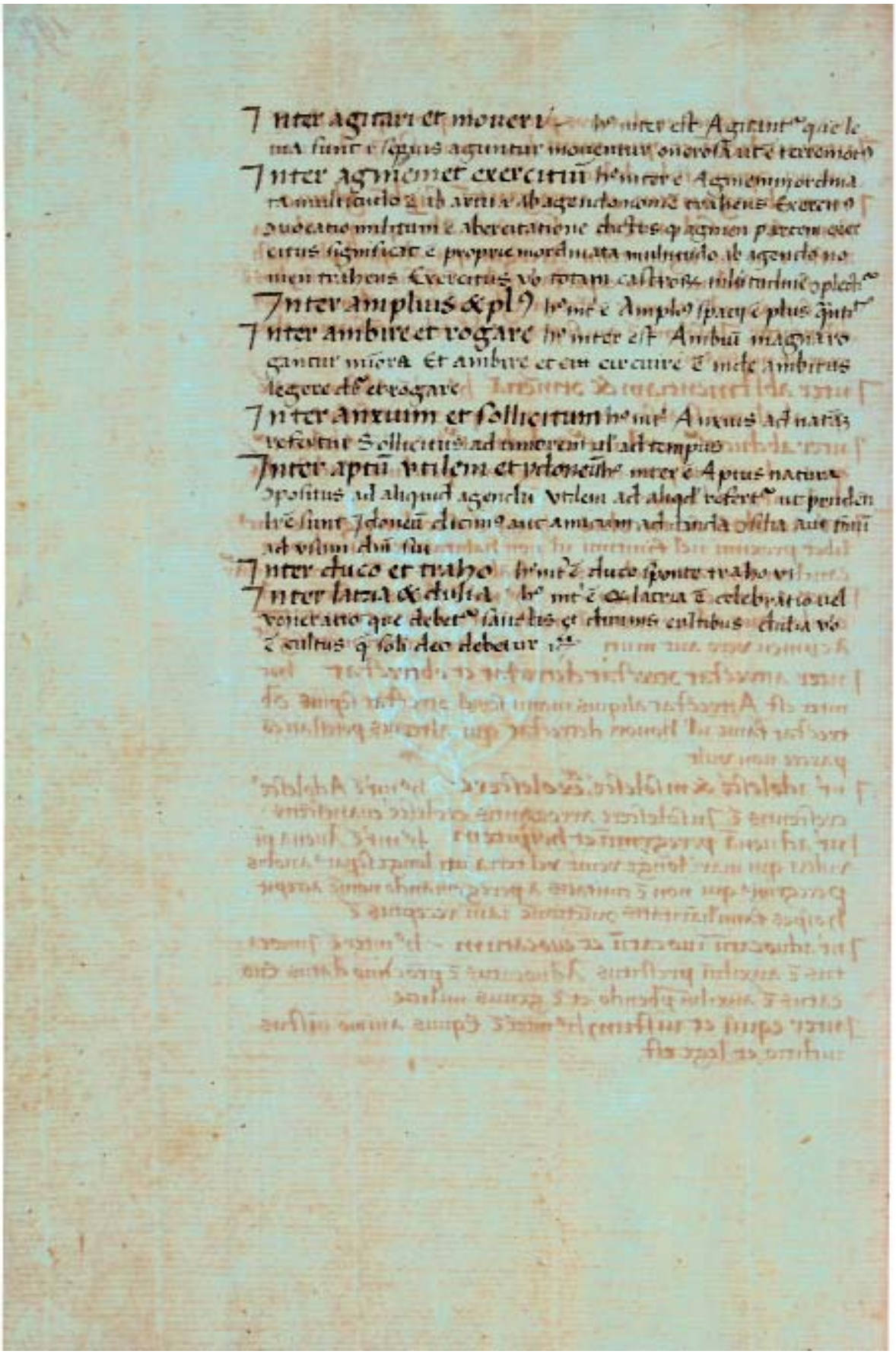
Hie hebt sich an das Buch des Rit-
ters herr Johannsen von mandavilla
von Engellant des werden Ritters

Do ich von haymat us für In dem
jar vnd in der sich dat ich wolt
faren über mer zu dem hailigen
grab vnd zu dem gesegnotten ert-
terich das man in latin nempt
Terra Jerusalems vnd es hailsetlich
billich das gesegnet ertterich vnd
das hailig land Wann es geseg-
net vnd gehailiget ist mit dem ko-
speren vnd hailigen plut vnsers
herren Jhesu cristi Wann er wolt
in dem selben land sinen hailigen
lib opfferen an dem galgen des hai-
ligen krütz für vns arme sünder
vnd wolt ouch in dem selben land
die menschait enpfahen von der
edeln Junckfrowen Sant Marien
Ouch wolt er in dem selben land
mit sinen hailigen füssen gon vnd
das land hailgen mit wunderen
vnd mit predigen vnd an wisen
die mirackel vnd da von das er
alsz gehailiget hatt es als ich vor
gesprochen han Do wolt er ouch
genant sin von dem land ain küng
vnd nampt sich sunderlich küng
von Juden wie wol das war das
er küng were vnd ist himelrichs
vnd ertterichs vnd aller ding vnd
sach die das firmament beschlüsset
Dennocht nampt er sich selb von dem
selben land Rex sum Judeorum Wan
das land was ee der Juden land
vnd das land hett im vnser herr er-
korn als ouch das land das edlest
vnd wirdigost vnd das best land was

das ieren in der welt was Also mag
man das bewären mit ainem philo-
sophen gesprich Virtus rerum in me-
dio consistit vnd da von so es da best
was vnd das edlest vnd die hail-
igost land was da wolt got selber
sin leben da verschiessen durch sei-
nen willen vnd vns da selbst er-
lösen von der ewigen pin vnd von
ewigem tod den vns bracht hatt vn-
ser erster vatter Adam vnd Eua
das vnser herre got für vns starb
zu Jerusalem das tätte er dar vmb
das es enmitten in der welt was
Als ich vor gesprochen han das es
solt dester ee erschallen uff aller ort
der welt Wan ir wol wissent wen
man etwas gebietten beschreien oder
rüffen wil So tut man es als wir
enmitten uff dem platz oder mitten
in der statt Also wolt cristus sinen
tod liden enmitten in der welt das
es yederman verstan wissen oder hören
vnd sehen möcht vnd solt innen
werden der grossen trüw vnd liebin
die er zu vns arme sünder gehept
hett Durch das sy wir es vmb in
ie billicher verdienet Wann wir
mügent wol sehen vnd wissen das
er vns nit mit gelt mit burgen
mit stetten noch mit landen erlöst
er hatt besunder er hatt vns er-
löset mit sinem hailigen fronlich-
nam vnd mit sinem hailigen rosen-
farwen plut das er vmb vnser
sünd vergossen hatt Da von ge-
denck ain yetlicher man wa man
möcht ainen herren finden der vmb
sin diener wölt sterben vnd liden
ains sollichen schamlichen tod vnd
ain vnschuldiger vnd ain schuldiger
sterben Dar vmb sollen wir billich
dem herre vnd das land da er ge-
wonet hatt Eren vnd wirdigen
Wann das land hatt getragen die
frucht die vns von dem ewigen
tod erlöset hatt Dar vmb ain
yeglicher cristen der es vermöchte
solt gern vnd mit grossen andacht
das vns got mit sinem hailigen
plut gehailiget hatt vnd vns das

G. H.

IV 3



IV 5

Betr.: LB Stuttgart Handschrift HB VIII 1

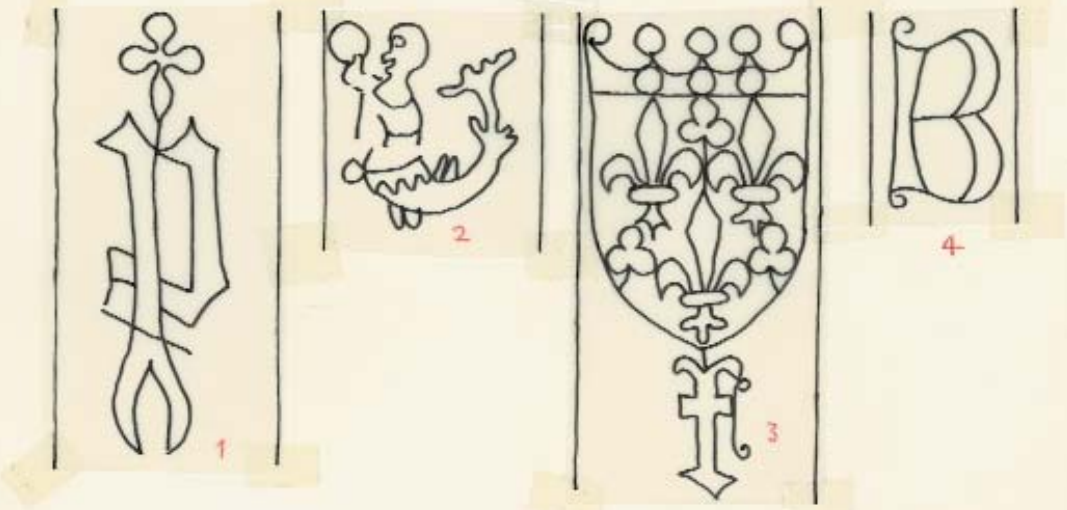
Die Handschrift enthält die Papiermarken

Abb. 1, Gotisches P mit Schrägstrich, Provenienz Burgund/Ostfrankreich, abgenommen von Bl. 5, 7, 9, 11-15, 22,

Abb. 2, Sirene, Provenienz Ostfrankreich (Champagne), abgenommen von Bl. 125, 129,

Abb. 3, Drei Lilien im gekrönten Schild, mit angehängter Herstellermarke, Provenienz Ostfrankreich, abgenommen von Bl. 197,

Abb. 4, Buchstabe B, Provenienz Nordfrankreich, in Bl. 198 - 252.



Identitätsnachweisungen

für Abb. 1 :	a) RijksA Arnhem, HA 400,	Nijmegen	1467
	b) StadtA Köln, Hanse,	Deventer	1467
	c) HStA Stuttgart, WR 14922,	Engen	1468
	d) HStA Stuttgart, B 205 -Bu.59	Heilbronn	1469
für Abb. 2 :	= Briquet 13659,	Chaussin	1466,
		Bâle	1468/69
für Abb. 3 :	= Briquet 1654	Paris	1468
		Pontoise	1469

Für Abb. 4 liegen keine Nachweisungen vor. Der enge Abstand der Rändrohte weist auf den Zeitraum nach 1480.

Somit ergibt sich für Handschrift HB VIII 1, bis Bl. 197: Wahrscheinlicher Zeitraum der Beschriftung -wahrscheinlich in Frankreich - : 1467 - 1469. Für Bl. 198f: wahrscheinlich erst nach 1480; wohl ebenfalls in Frankreich geschrieben worden.

IV 6

quired by the Weingarten Abbey by way of the Cathedral of Constance library.

At the beginning of the manuscript there are a few blank pages (sheets 1rv, 2v-10r). On these sheets the watermark type "Bull's head with eyes, nose and mouth, single stem and seven-lobed flower" is immediately visible. Tracings of this watermark are particularly easy to make. For an identical form of this "Bull's head" with its various embellishments, Gerhard Piccard refers to XII No. 981 in his Findbuch "Ochsenkopf". This type of Bull's head is documented as having been used in the years 1439 to 1443.

This manuscript also contains pages with the watermark "Hand with five-pointed star", whose provenance Piccard posits as Upper Italy. Since it is identical to a watermark found in a court record dated to 1442, and taking the analysis of the Bull's head watermark into consideration, Piccard has dated the manuscript to the period between 1439 and 1442.

Literature: Bautz, Felix Hemmerli(n); Buhl / Kurras, Die Handschriften der ehemaligen Hofbibliothek Stuttgart, Bd. 4,2.

C.K. (C.P.-K.)

IV 5 Distinctiones

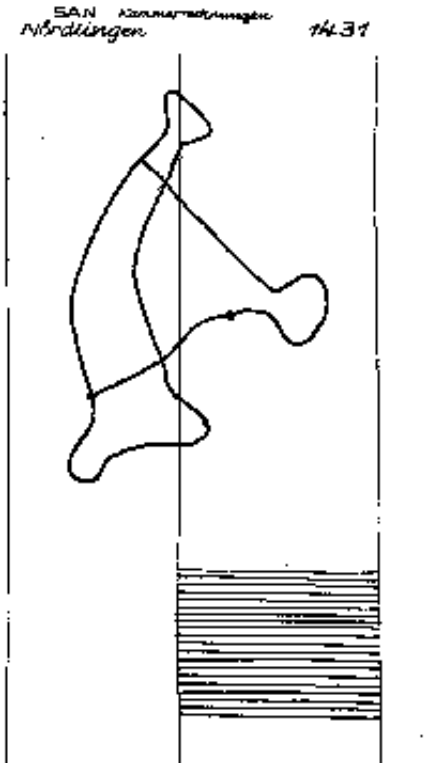
[1467–1469]
Paper, 27 x 20 cm, 256 Sheets (here: Sheets 192r-197v)
WLB Stuttgart HB VIII 1
Sheet 197 (Watermark: "Coat of arms with lily")

This manuscript, in two hands, was written in a typical "Humanistica" script. Of particular interest are the Greek words appended to the Latin text. The text contains texts by the philosopher and grammarian Nonius Marcellus, by Marcus Terentius Varro and by Sextus Pompeius Festus, who is found in records in France from the second century AD.

Sheet 197 contains the conclusion of the so-called *Distinctiones*. This genre of text was used in scholastic theology and philosophy to analyze and note differences between opposing teachings and authorities based on the scholastic principle of "sic et non". Piccard describes the text as having been written on paper made in eastern France containing, among others, a heraldry watermark – three lilies in a crowned shield – to which the sign of the paper's producer is attached. Briquet lists this coat of arms under No. 1834, and describes it as being from Paris and Pontoise, both cases dating to 1468. In Piccard's expertise on the manuscript, he identifies all the watermarks it contains (Ill. IV 5a) – in addition, the watermarks "Letter *P*", "Mermaid" (siren) and "Letter *B*" – and dates it as having been written most probably between 1467 and 1469. The manuscript, on various papers from eastern and northern France, was most likely written entirely in France.

Literature: Buhl, Die Handschriften der ehemaligen Hofbibliothek Stuttgart, Bd. 4,1.

C.K. (C.P.-K.)



IV 6a

IV 6 The Stuttgart Deck of Cards

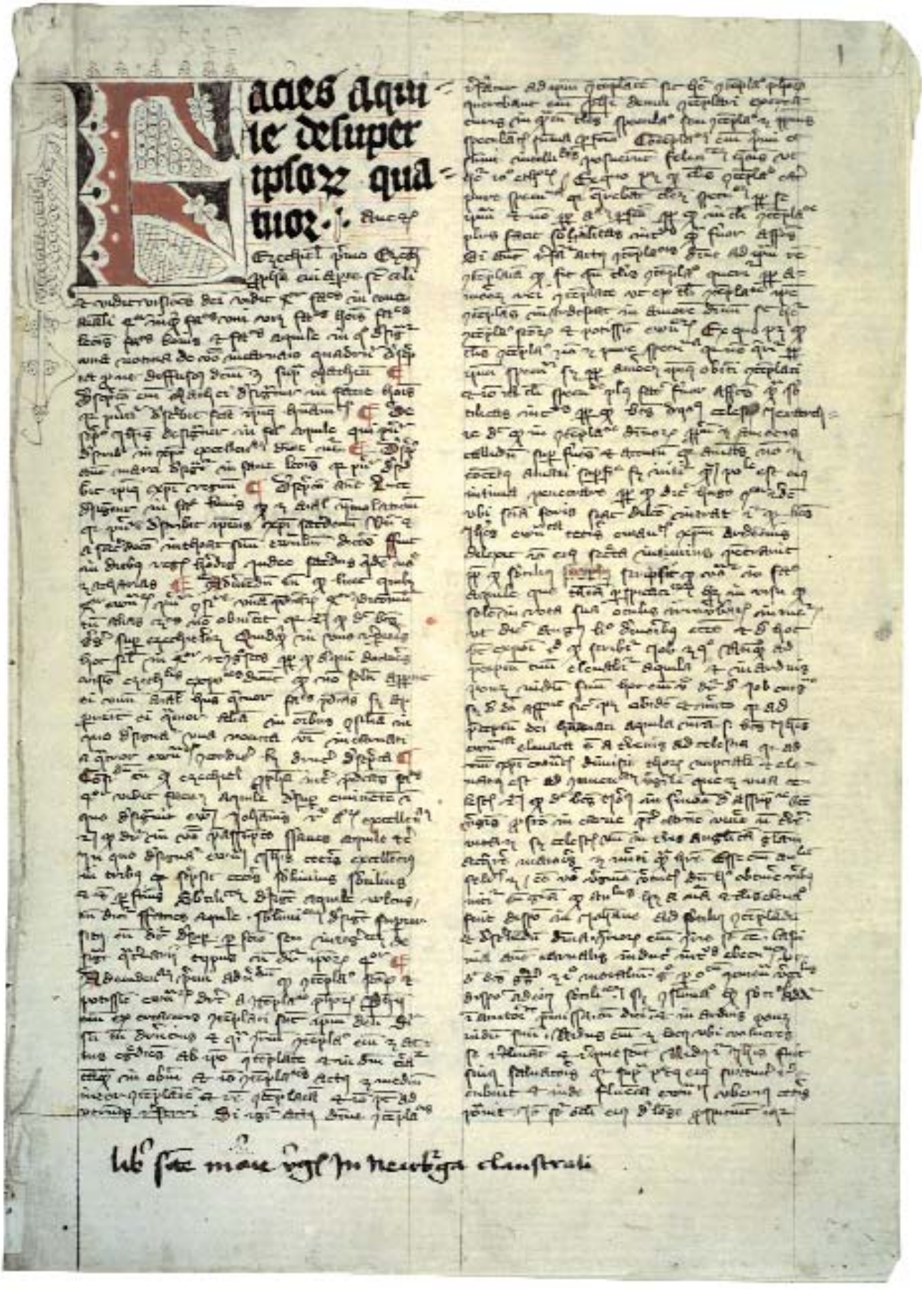
[about 1430]
Paper, 49 cards with miniatures, 19 x 12 cm
Facsimile from the Deutsches Spielkartenmuseum Leinfelden-Echterdingen
(selection)

The "Stuttgart Deck of Cards" is considered as one of the oldest existant European card games. Made around 1430 in southwest Germany, it was originally in the possession of the Duke of Bavaria, becoming the property of the House of Württemberg in the 17th century. It is clear that the cards were well used. Nevertheless, it remains unclear how the game was played, as very little is known about games in that period.

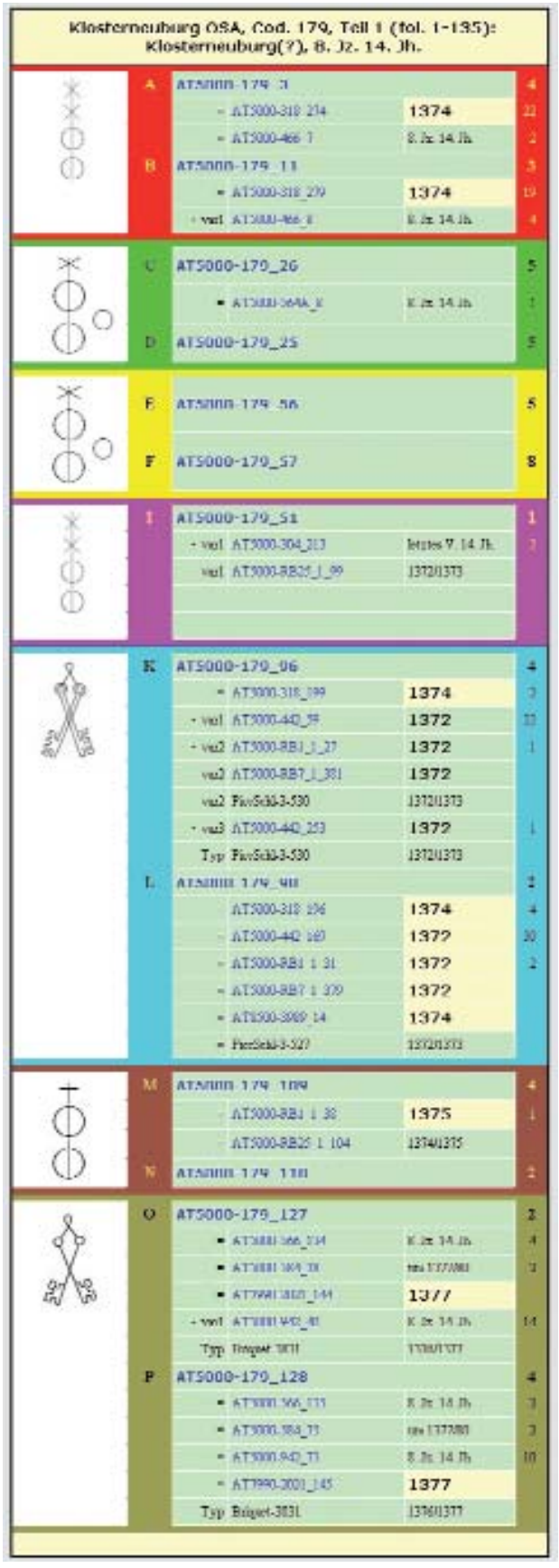
The dating of the famous deck of cards was long disputed. Only an analysis of the watermarks, undertaken by Gerhard Piccard in 1958, provided clear indications that it was produced around 1430. This date is corroborated by the clothing of the figures portrayed on the cards. By examining the reverse side of two cards using a bright light, Piccard discovered a characteristic hunting horn watermark that was the sign of a Ravensburg paper mill. On the basis of a number of identical watermarks in his collection, he was able to show that the paper used for the Stuttgart Deck of Cards was in circulation between 1427 and 1431, especially in south-western Germany, thus providing a clear timeframe and region for the deck's production.

Literature: Meurer, Das Stuttgarter Kartenspiel; Sporhan-Krempel, Das "Stuttgarter Kartenspiel"; Rückert, Antonia Visconti, 161f.

P.R. (C.P.-K.)



IV 7



IV 7a

IV 7

Klosterneuburg, Stiftsbibliothek, Cod. 179, Part I (ff. 1–135)
[1370s]
Origin: Klosterneuburg (?)

The first part of the manuscript, which consists of two parts, is a commentary on the Bible by Nicolaus de Lyra. It contains more than a dozen different watermarks. In the 14th century, more so than in the 15th century, manuscripts were commonly written on a number of types of paper with different watermarks, each represented by only few sheets. Why this was so remains to be explained. The watermark motifs found in Codex 179 – geometric shapes and pairs of keys – were especially common in Italian paper of the last third of the 14th century.

Like the vast majority of manuscripts from the Middle Ages, this manuscript contains no indication of when it was written. The handwriting suggests that it was written in the last third of the 14th century, but an analysis of its watermarks allows Codex 179 to be dated with still more precision.

The compilation of the watermarks of Codex 179 shows that the majority are identical (indicated by =) or are variants (indicated with var1, var2, etc.) to watermarks of the following manuscripts: Klosterneuburg, Stiftsbibliothek, Cod. 304, 318, 442, 466, 564A, 566, 584, 942 and Stiftsarchiv, Rb 1/1, Rb 7/1, Rb 25/1, Vienna, Erzbischöfliche Bibliothek, Cod. 2021 and Vienna, Österreichische Nationalbibliothek, Cod. 3989 (Ill. IV 7a).

Of the manuscripts with related watermarks, six are dated. Since they all fall in the period between the years 1372 and 1377, it is highly likely that the first part of Codex 179 dates to the 1370s.

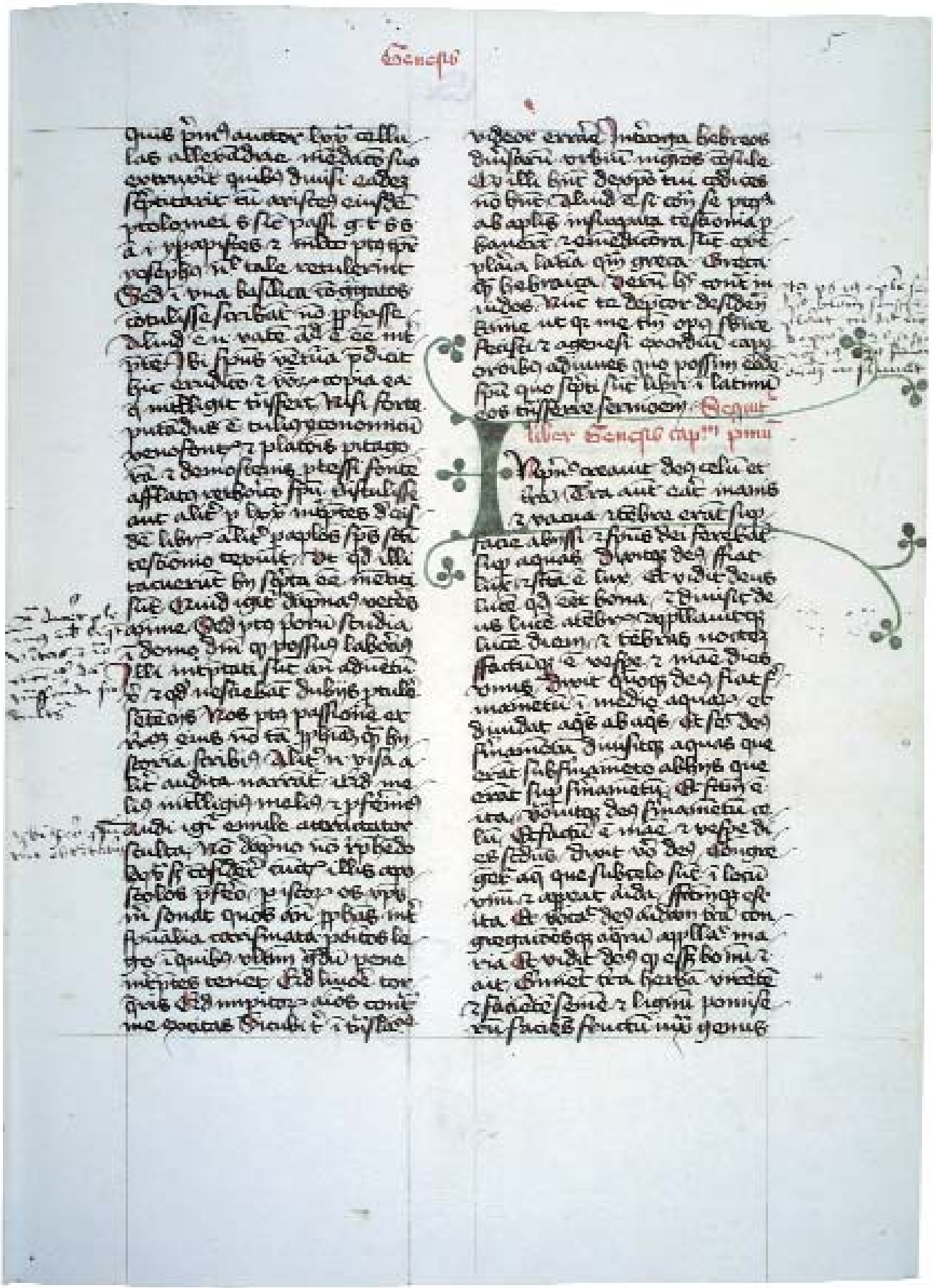
A.H. (C.P.-K.)

IV 8

Klosterneuburg, Stiftsbibliothek, Cod. 146
1428
Origin: Southern Germany (?)

This manuscript contains books of the Old Testament. Johannes Lindenfels from Rottenburg, the last of the scribes who worked on the manuscript, gave, on 294r, his name and 1428 as the manuscript's date of completion. Although this makes dating by means of the watermarks unnecessary, it is useful to record the watermarks of all dated manuscripts (if possible, photographically). On one hand, watermarks with definite dates can then be added to the collections used for comparisons with undated manuscripts and thus increase the basis of comparison; on the other, they can help verify the reliability of dating by means of watermarks.

Codex 146 contains nine different Bull's head watermarks, one of the most common motifs in the extant paper of the Middle Ages. The probable reason for its widespread circulation is that the Bull's head had become generally accepted, already in the 14th century, as a papermaker's



IV 8

AT5000-146_219 = AT8500-4390_150 (dat. 1427)

AT5000-146_220 = AT8500-4390_149 (dat. 1427)

IV 8a

mark for quality products (Piccard, "Ochsenkopf-Wasserzeichen", 25).

Two watermark pairs found in the Klosterneuburg manuscript can also be found in Codex 4390, dated 1427, of the Austrian National Library, Vienna: the watermarks AT5000–146_219, AT5000–146_220 and AT5000–146_163 are found in absolutely identical form in Codex 4390 and to AT5000–146_364 exists a variant in Codex 4390 (Ill. IV 8a). As well, all of the watermarks in Codex 146 (with the exception of AT5000–146_109, which is found in only a single sheet) can be found in Klosterneuburg manuscripts.

Of the manuscripts that use partially paper with the same watermarks as in Codex 146, three (Vienna ÖNB, Cod. 4390 and Cod. 5287, as well as Klosterneuburg, Cod. 474) contain dates in the text of the manuscripts themselves. These dates fall in the period between 1427 and 1432, and thus, if they were used as a basis for dating Codex 146, it would be classified as being "about 1430", a premise that comes very close to the manuscript's actual date. Hence this confirms the reliability – as seen in many other examples – of dating manuscripts by means of their watermarks.

As mentioned above, Piccard estimated four years as being the maximum time period that normal paper with identical watermarks was used (Piccard, Wasserzeichenforschung, 11). However, after an examination of the watermarks in the WZMA collection (Haidinger, Datieren mittelalterlicher Handschriften, 18–20), in about a third of the cases this time period is longer. For instance, the Bull's head AT5000–146_163, found in an identical form in both Klosterneuburg, Cod. 474 (dated 1432) and Vienna, ÖNB, Cod. 4390 (dated 1427), shows that the time period paper with this watermark was used was at least six years.

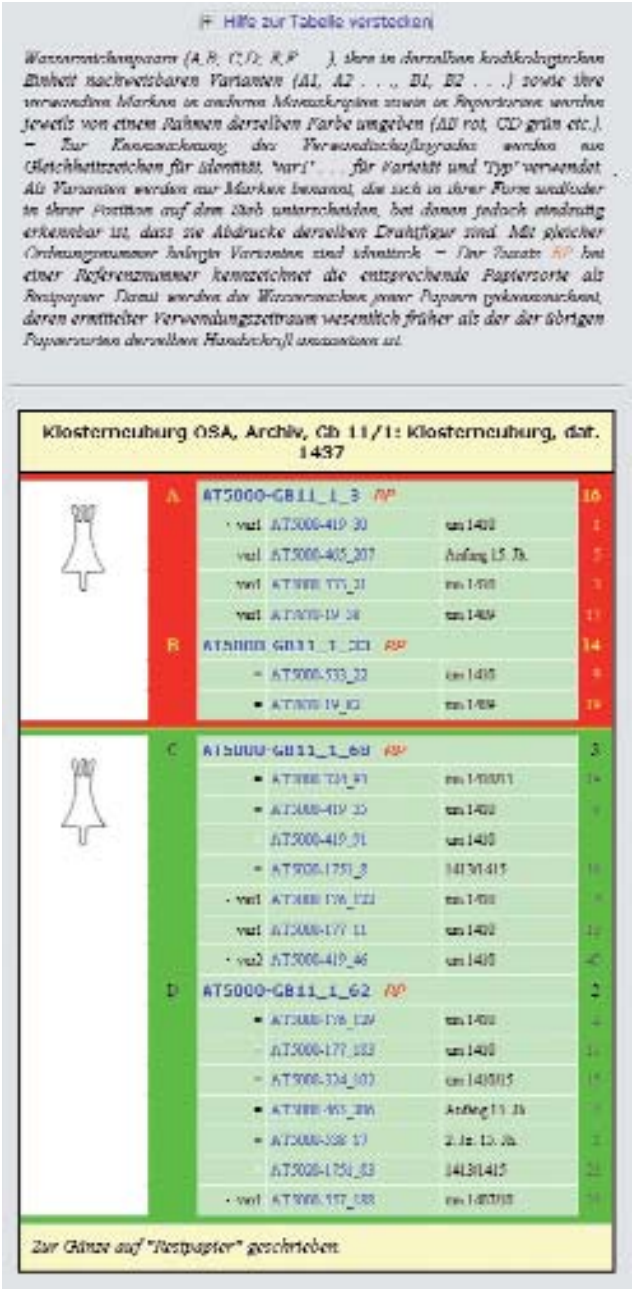
A.H. (C.P.-K.)

IV 9

Klosterneuburg, Stiftsarchiv, Gb 11/1
1437
Origin: Klosterneuburg

Of the manuscripts whose watermarks have been examined for the WZMA data bank, in about a dozen, "left over paper" has been found – single pieces of paper where identical watermarks have otherwise only been found in documents that are considerably older. In most such manuscripts, only a few sheets, or several quires, of older paper are found. There are very few cases known in which an entire manuscript was written on paper a few decades old. One example, however, is the manuscript C-2, dated 1460, in the Vienna Erzbischöfliches Diözesanarchiv, Kirnberger Bibliothek der Wiener Dompropstei, which is written on paper that as yet has otherwise only been detected in manuscripts dating between the years 1429 and 1440.

The 1437 Klosterneuburg Grundbuch Gb 11/1, dated 1437, is also such a document. It is written on paper that is otherwise only found in manuscripts that have mostly been dated to "around 1410". That some of these older manuscripts even contain paper that is younger than that found in the Grundbuch, written twenty years later, can also be seen by comparing the watermark pairs of the Grundbuch holding the sigla A and B with the respective watermarks in the Klosterneuburg Codex 533. The watermarks AT5000–533_22 and AT5000-GB11_1_33 are absolutely identical. Although the impression on folio 21 of Codex 533 (AT5000–533_21) and that on folio 3 of the Grundbuch Gb 11/1 (AT5000-GB11_1_3) are slightly different, it is without a doubt that they were created by the same wire figure; the left wire outlining the bell-shaped watermark has moved a few millimetres outward, probably having worked its way loose as a consequence of the mechanical demands made on the mould and wire figure during the papermaking process.



AT5000-GB11_1_3

Variante: AT5000-533_21

AT5000-GB11_1_33 =

AT5000-533_22

IV 9

If such manuscripts, written, as in these two cases, exclusively on paper that was produced a few decades earlier, are dated on the basis of watermarks, the result will unavoidably be incorrect. This is because all dating based on watermarks is undertaken on the premise that the same type of paper – paper with watermarks that were definitely made by one and the same wire figure – was used within a few years.

A.H. (C.P.-K.)

V Watermark Imaging Technologies, Watermark Collectors and their Collections

Imaging Technologies for Watermarks

For nearly all watermark compendia until the middle of the 20th century watermarks are just tracings allowing cheap and quick accumulation of large stocks. This tracing method doesn't allow to capture the whole paper structure of an object – apart from the already mentioned deviations of the tracings from the original watermarks. Many other imaging technologies for watermarks exist. All of them have already been published. In the following, the imaging methods used by the Bernstein partners will be briefly explained.

Rubbing

(Ill. 1 a, b, c) In order to make a rubbing of a watermark a soft pencil and a piece of thin paper are needed. A Plexiglas plate serving as a stable underlay is placed underneath the sheet of paper which contains the watermark and the thin sheet of paper on top of it. Rubbing the pencil on the thin paper creates a copy of the watermark. In folio-size papers the watermark is found in the middle of the leaf. Watermarks in quart or octave formats were usually cut into several parts; in this case the rubbings have to be reassembled again. Rubbing is an easy method to collect these several parts and to put them together for a complete image of the watermark.

Other methods

Three different X-ray technologies for watermark and paper structure imaging exist and have now been used for more than 20 years. These technologies are: beta radiography, electron radiography and soft-X-ray radiography. Their use depends strongly on the watermark source and the circumstances under which the images are to be taken.

Beta radiography

(Ill. 2) Beta radiography can provide very high-quality images of watermarks, primarily because of the good contrast and secondly due to the evenly exposed films. Depending on the intensity of the radiation and the films used the exposure time varies usually from 2.5 to 8 hours for a single copy. This technology was tested in the mid-forties in the U.S.A (cf. Kaiser, Neue Erkenntnisse, p. 203). D. P. Erastov published the first beta radiographies of watermarks in 1960. The British Museum in London has been applying identical procedures from July 1966 onwards. Researchers in Copenhagen have been working with a modified beta radiography procedure since January 1967.

Electron radiography

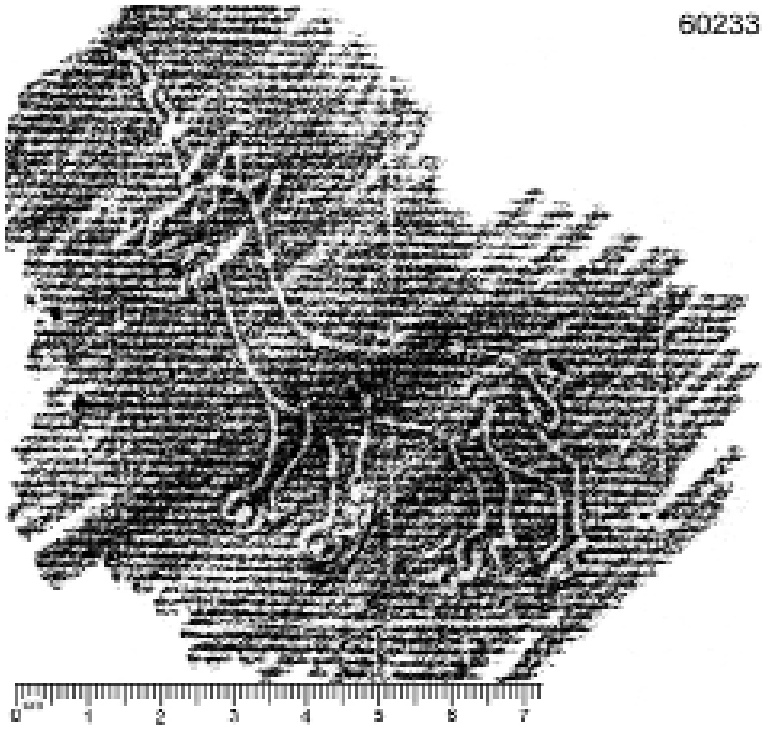
(Ill. 3) Very good results in watermark imaging are achieved by electron radiography. The resulting images look very sharp and clear. Here, a metal foil is irradiated by a high energy X-ray source causing the electrons from the metal foil to break free. These electrons are then absorbed by the penetrated paper differently depending on its thickness and structure. An X-ray film placed on the opposite side of the paper is exposed by them thus making watermarks and paper structures visible. The technology offers the possibility to collect several images from an incunabulum in a single pass. One of the Bernstein project partners (National library of the Netherlands, Koninklijke Bibliotheek, The Hague) processes usually five or more incunabula with a single radiation impulse exposing up to six films per incunabulum. The technology is very appropriate for imaging watermarks from books.

Electron radiography requires with quite strong X-ray sources (200–250kV) which necessitates extensive radiation protection. In contrast to beta radiography, the electron and the soft-X-ray radiography have shorter exposure times which make them less time consuming. A single radiation lasts between 1–2 minutes depending on the used X-ray films.

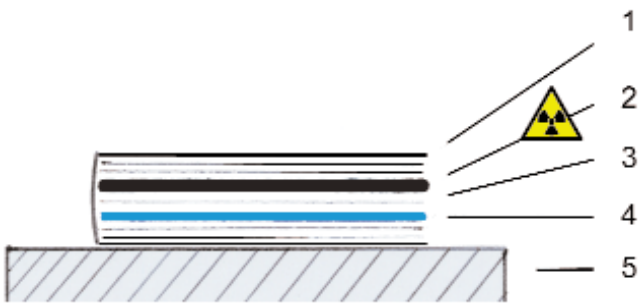
Soft-X-ray radiography

(Ill. 4) Soft-X-ray radiography is one of the safest and most appropriate technologies for watermark imaging in the area of art history. The necessary devices are transportable without difficulties and can be positioned directly in museums or private collections. The method works in a very low-energy (7–10kV) radiation range and the short exposure times make an efficient work possible. For the exposure of the film by soft-X-ray, the film has to be placed directly underneath the paper containing the watermarks.

In comparison to beta and electron radiography soft-X-ray images can have different exposure intensities within the film. This is caused by the air layer between the object and the radiation source, which interferes with the radiation. The difference between distances S1 and S2 (cf. Ill. 4)

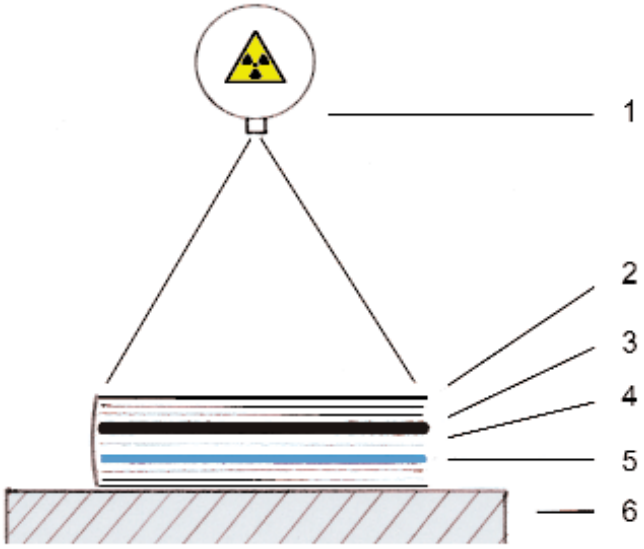


Ill. 1 a, b, c: rubbing



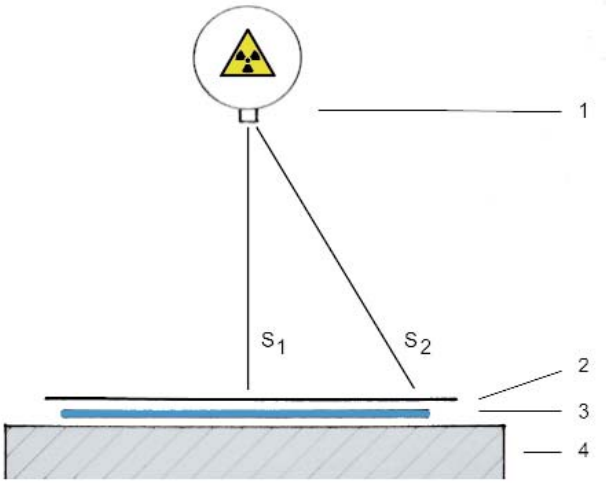
1 *Book / incunabulum*
2 *Radiation beams / C14-source*
3 *Folio with watermark*
4 *Film*
5 *Object slide / table*

Ill. 2: Beta radiography



1 *X-ray source*
2 *Book / incunabulum*
3 *Electron transmitter / Metal foil*
4 *Folio with watermarks*
5 *Film*
6 *Object slide / table*

Ill. 3: Electron radiography



1 X-ray source
2 Items with watermarks
3 Film
4 Object slide

Ill. 4: Soft-X-ray radiography

is increasing by up to 22 percent for A4 formats while the intensity of film exposure is decreasing accordingly towards the edges. For this reason modified soft-X-ray devices have been used in the last years. For example, the disturbing air layer was replaced by helium. Helium blocks X-rays less and thus makes the influence of the varying distance to the X-ray source negligible.

Image subtraction method

The image subtraction method for watermark imaging has been used approximately since the late 1990s. In this approach a transmitted light image is subtracted digitally from a reflected light image, which deletes eventual pictures/-marks on the reflecting side of the paper. Merely the paper structure (visible in the reflected light image) and possible pictures on the verso of the paper remain visible (Ill. 5 a, b, c).

The 'image subtraction' also known as 'backlight'-method, seems very appealing, because it is appropriate for the watermark- and paper structure imaging of single-sheet items such as drawings or prints. In contrast to most of the other imaging technologies it is noticeably cheaper, 1:1 images of paper structures up to A1-format are possible, the needed equipment is very easy to handle and to transport for everybody.

Literature: Brown / Mulholland, Using microfocus X-radiography; Holle / Schreiner, Sichtbarmachung von Wasserzeichen; Kaiser, Neue Erkenntnisse; La Chapelle / Le Prat, Les relevés de filigranes; Needham, IDL, ILC, WILC; Nordstrand, Beta-Radiographie; Schnitger / Ziesche, Elektronenradiographie von Wasserzeichen; Thienen / Veldhuizen, Watermarks and Incunabula; Ziesche / Schnitger, Elektronenradiographische Untersuchungen.

G.D. / M.v.D. (G.D. / L.D.)

Ill. 5a: recto image

Ill. 5b: transmitted image

Ill. 5c: result of image subtraction

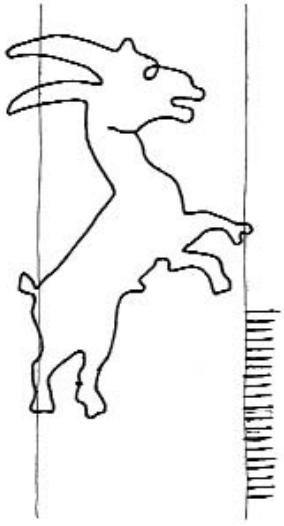
AT8100-W270_63

Piccard-Online Nr. 085687 (1383)

AT8100-W270_63 / Piccard-Online Nr. 085687

Ill. 6

AT8100-W211_16



Piccard-Online Nr. 085727 (1361)

AT8100-W211_16 / Piccard-Online Nr. 085727 (1361)

Ill. 7

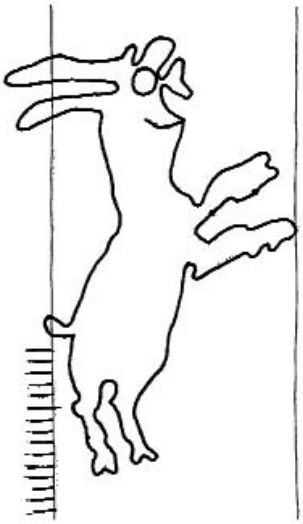
Precision in Width: A Comparison of Tracing and Beta Radiography

In July 1956, on the recommendation of the Hauptstaatsarchiv Stuttgart, Gerhard Piccard made his first visit to the Haus-, Hof- und Staatsarchiv in Vienna (HHStA). During this and subsequent visits, he made about 1,700 tracings of watermarks in manuscripts, records and documents. The HHStA was established by Maria Theresia in 1749 as a central archive for bringing together the state documents scattered in the various provinces of the House of Habsburg. The collecting of such documents was ended in 1918, and the archive has since become the historical department of the Austrian State Archives. It contains documents from a large geographical area.

During his sojourns at the HHStA, Gerhard Piccard copied 1,648 watermarks from the collection of state papers ("Reichssachen": Fridericiana, Maximiliana) and the document department ("Urkundenabteilung": Görz), as well as 40 additional watermarks from paper in the manuscript department ("Handschriftenabteilung"). His inspection of these collections was most likely similar to his earlier examination of documents in the Landesarchiv Innsbruck, where he had gone through the Fridericiana, Sigmundiana, Maximiliana and Ferdinandea as well as the Tyrolean Raitbücher. The sixteen manuscripts that he worked on in the HHStA are all from the 14th century. Eleven volumes are from the Innsbruck Schatzgewölbe and deal with Tyrol or the chancellery of the dukes of Tyrol-Görz; the other five are from the chancellery of the Habsburg dukes from Albrecht II to Albrecht III. The logic

AT8100-W211_11

AT8100-W211_13



Piccard-Online Nr. 085729 (1361)

AT8100-W211_11 / Piccard-Online Nr. 085729

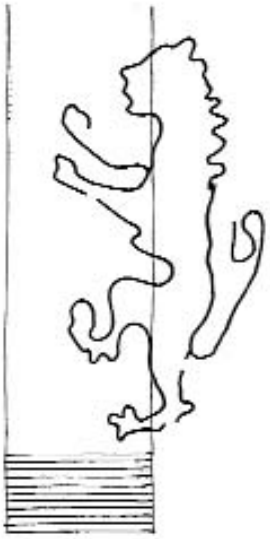
Ill. 8

behind the choice of chancellery documents appears to be understandable: since the early 1950s Piccard had been interested in the time period between the production of paper and its use, which he attempted to establish with the help of watermarks in chancellery records, since such offices were continually run and their records are clearly dated.

Gerhard Piccard made direct pencil tracings, which, upon his return to Stuttgart in the winter months, he drew true to scale in black drawing ink onto standardized acid-free index cards by means of tracing, and filed them into his card index. Tracing watermarks with pencil onto transparent paper, a simple and inexpensive method, is still quite common. The tracing should only include what can actually be seen; what cannot be seen may not be added, even if the figure is then incomplete. According to his own records, Piccard made 130,000 such tracings, and in his collection, he refers to the exactitude of his depictions: "It can be taken as given that the watermarks have been drawn with the greatest precision possible. Any variances from the originals do not go beyond the limits of potential differences that occur because of ordinary pressure on the paper. Numerous comparisons have shown that occasionally, in the transfer onto the tracing paper or because the tracing or drawing was done twice, small differences from the original can be found. These are within the limits of the normal "width of a line", and thus it is possible to speak of copies that are true to the original." (Piccard, Wasserzeichenkartei V, p. 9).

There have gradually begun to be reservations about the method of copying watermarks by tracing since much more accurate methods such as beta-radiography have been de-

AT8100-W718_22



Piccard-Online Nr. 085283 (1398)

AT8100-W718_22 /
Piccard-Online Nr. 085283

AT8100-W718_22 / Abzeichnung

Abzeichnung zu AT8100-W718_22

Piccard-Online Nr. 085283 / Abzeichnung

Ill. 9

veloped. In the summer of 2006, the Commission for Paleography and Codicology of Medieval Manuscripts of the Austrian Academy of Sciences began to record the watermarks in the manuscripts of the HHStA, Vienna by means of beta-radiography, and therefore it seems reasonable for a comparison between the two methods, tracing and photography, to be made.

In Ill. 6, on the left is a beta radiography of the watermark "He-Goat" (head, Piccard-Online No. 085687) from folio 63 of the manuscript W 270 of the HHStA (Böhm I Nr. 555), a Urbar for the Starkenberg estates and the Etsch Valley for the years 1382 to 1388. If one compares the photo to Piccard's tracing No. 085687 by laying one over the other, it is possible to see that the drawing is very exact and varies from the photo at the most only by the width of the line. If examined more carefully, however, one sees that Piccard augmented the tip of the right horn: on the photo the wires at the tip are open, and also when checking the original, one sees that they are not closed as drawn by Piccard.

The manuscript with signature W 211 (Böhm I Nr. 408), a Registraturbuch of Duke Meinhard IV of Tyrol-Görz (dated 1361–1362), was brought from the Schatzgewölbe, Inns-

Ill. 1: Briquet: Les Filigranes

bruck to Vienna at the beginning of the 19th century. From this codex the watermark pair "He-Goat" (entire figure, Piccard-Online No. 085727) can also be used for comparison (Ill. 7). Piccard gives as his source for drawing No. 085727 the folia 10, 16, and 17. A comparison of the beta-radiography of this watermark and Piccard's drawing thereof reveals this drawing's precision. The second drawing, No. 085729 (Ill. 8), is quite different: the wire figure of the paper mould seems to have been deformed – the he-goat's head has been flattened. Piccard names folia 11 and 13 as the source for this tracing, but when examining photos of the watermarks in these two sheets, two variants of the he-goat were detected. The sections circled in Ill. 8 show that in folium 11 the wire was broken, whereas the wire for folium 13 was clearly connected. In addition, the point marked with a white arrow shows a different bending of the wire. And lastly, it is possible to see differences in how rounded parts of the head are (black arrow).

Piccard's drawing gives quite a different impression of this watermark. By incorrectly interpreting the section around the eyes and mouth, whose deformations can only really be understood by comparing it to No. 085727, the relationship between the two watermarks has become blurred. And whether Piccard's simplifications of the forelegs are within the "width of the line" seems doubtful.

Because they are found in the fold of the codex, it is difficult to record the watermarks of the semi-folio manuscript W 718 (Böhm II Suppl. Nr. 413), a Lehenbuch of the Earldom of Görz from the years 1398 to 1408 that was brought to Vienna in 1870 from the Schatzgewölbe in Graz. In addition, the exact course of the wire of the watermark "Lion" (Ill. 9) is difficult to make out, both in the original and in the beta-radiography. By placing the beta radiography and the drawing over one another, one sees that a number of simplifications have been made (for instance at the belly of the lion), as well as a misinterpretation of the heart-shaped tassel at the end of the tail, and a deviation of several millimetres in the position of the chain wires (see white arrow). In the face of these wide deviations, and in order to better understand the course of the wire, the author has also attempted to trace the watermark, comparing this drawing with that of Piccard (Piccard/white, my own drawing/grey).

This comparison shows that the precision of tracings must still be brought to question, and Piccard's statement that his drawings vary from the original only with regard to the width of the lines does not always stand. Nevertheless, after my own attempt at drawing this watermark, Piccard's accomplishment deserves our highest respect.

Literature: Auer / Wehdorn, Das Haus-, Hof- und Staatsarchiv; Bittner, Gesamtinventar; Böhm, Die Handschriften des Kaiserlichen und Königlichen Haus-, Hof- und Staats-Archivs; Antonius, Die Handschriftenabteilung; Piccard, Die Wasserzeichenforschung als historische Hilfswissenschaft; Piccard, Die Wasserzeichenkartei Piccard im Hauptstaatsarchiv Stuttgart, Bd. V; Amelung, Nachruf auf Gerhard Piccard, 388; Bannasch, Wasserzeichen als Datierungshilfe; Gerardy, Datieren mit Hilfe von Wasserzeichen, 51 f.

M.H. (C.P.-K.)

Watermark Collections

One of the first to realize the significance of watermarks as an aid in dating was the natural scientist Gotthelf Fischer von Waldheim, who in a paper published in Nuremberg in 1804 titled "Beschreibung einiger typographischer Seltenheiten nebst Beiträgen zur Erfindungsgeschichte der Buchdruckerkunst", reproduced thirty watermarks from the

Ill. Abb. 2: Piccard's Findbücher (watermark registers) (selection)

14th century. He realized that "if one ... collects rare paper marks, this has the effect of letting us determine the age, to a high degree of certainty, of documents or manuscripts written on paper with this or that mark" (p. 138).

Forty years later, the Benedictine Gottfried Werl of Göttweig Abbey included a collection of 306 watermark types at the beginning of his catalogue of the manuscripts of Göttweig (V 1). A list of 368 watermarks from the 14th century, also as an aid for dating, was published in 1897 by Friedrich Keinz, collected from the manuscripts in the Bayerische Staatsbibliothek (V 3).

In the second half of the 19th century, a number of collections were published, some quite extensive and in most cases with true to scale drawings. In this connection must be mentioned above all the extensive collections of Etienne Midoux and Auguste Matton, as well as of Franciszek Piekosiński, Nikolai Petrovich Likhachev (V 5) and Paul Heitz. Unsurpassed by all of these collections was, however, the four-volume compendium "Les Filigranes" (Ill. 10) by Charles-Moïse Briquet (V 4), which includes 16,112 reproductions of watermarks from the period between 1282 and 1600 (Ill. 10).

The first large watermark collection published after Briquet that can be considered a valuable supplement to his work was published in 1957 by Wladimir A. Mosin and Seid M. Tralji[u22], entitled "Filigranes des XIIIe et XIVe ss". Between 1961 und 1997, Gerhard Piccard (V 10), to whom the study of watermarks owes its standing today as a historical field in its own right, published seventeen so-called "Findbücher" (Ill. 11) named by the motifs of the printed watermarks, which include reproductions of 4,540 watermark types and 44,497 individual watermarks (Ill. 11).

Besides to Piccard's Findbücher, in the past few decades a series of smaller collections have also been published. Of note can be mentioned the collection of watermarks from Greek manuscripts by Dieter Harlfinger, the catalogue of watermarks in Hebrew manuscripts to 1450 in France and Israel by Monique Zerdoun Bat-Yehouda, as well as the inventory of the watermarks in the manuscripts of the Royal Library Albert I in Brussels by Martin Wittek. David Woodward has published a monograph devoted to the watermarks in printed Italian maps of the years 1540 to 1600. Also notable is the "Mélanges archéographiques" (Belgrad), which since 1991 has been publishing the watermarks of southeast European manuscripts.

Just as in the collections published two hundred years ago, today's publications depict the watermarks in outlines that are more or less accurate. Although far superior to older methods (but very expensive), the method of photographing watermarks by radiographic means was nevertheless only used for the collections of Woodward and Zerdoun.

Despite the Findbücher of Piccard and the large internet collections Piccard-Online, WILC and WZMA (cf. chap. VI) that have come into being in the last years, the old published collections have not outlived their usefulness. They still provide valuable information, especially about the time span that relatively uncommon early watermarks were in use.

Published collections of watermarks in paper of the Middle Ages and early modern period (selected):

Charles-Moïse Briquet: Les Filigranes. Dictionnaire historique des marques du papier dès leurs apparition vers jusqu'en 1600, 4 Vol. Paris etc. 1907, 2. Aufl. Leipzig 1923. – C.-M. Briquet, Les Filigranes. The New Briquet, Jubilee Edition. Ed. Allan Stevenson, 4 Vol., Amsterdam 1968.

Bruno Giglio: Le filigrane nelle carte degli archivi diocesani di Ivrea nei secoli XIII – XIV – XV, Ivrea 1981.

Dieter u. Johanna Harlfinger: Wasserzeichen aus griechischen Handschriften, 2 Bde., Berlin 1974 und 1980.

Paul Heitz: Les filigranes des papiers contenus dans les archives de la ville de Strasbourg, Strasbourg 1902.

Ders.: Les filigranes des papiers contenus dans les incunables strasbourgeois de la bibliothèque imperiale de Strasbourg, Strasbourg 1903.

Friedrich Keinz: Die Wasserzeichen des XIV. Jahrhunderts in Handschriften der k. bayer. Hof- und Staatsbibliothek. Abhandlungen der philosopisch-philologischen Classe der königlichen bayerischen Akademie der Wissenschaften 20 (München 1897), 481–524.

Likhachev's watermarks, ed. J. S. G. Simmons, Bé van Ginneken-van de Kasteele (Monumenta Chartae Papyraceae Historiam Illustrantia XV), Amsterdam 1994.

Leonardo Mazzoldi: Filigrane di Cartiere Bresciane I, Brescia 1990.

Etienne Midoux et Auguste Matton: Etudes sur les filigranes des papiers employes en France aux XIVe et XVe siècles, Paris 1868.

Wladimir A. Mošin/Seid M. Traljić: Filigranes des XIIIe et XIVe ss, 2 Bde., Zagreb 1957.

Gerhard Piccard: Die Wasserzeichenkartei im Hauptstaatsarchiv Stuttgart, 17 Bde., Stuttgart 1961–1997.

Franciszek Piekosiński: Średniowieczne znaki wodne, zebrane z rekopisów, przechowanych w Archiwach i Bibliotekach polskich, glownie krakowskich, Wiek XIV, Krakau 1893. (Wasserzeichen aus Handschriften des 14. Jahrhunderts der polnischen Archive und Bibliotheken)

Oriol Valls i Subirà: Paper and watermarks in Catalonia (Monumenta chartae papyraceae historiam illustrantia XII), 2 Bde., Amsterdam 1970.

Martin Wittek: Inventaire des plus anciens manuscrits de papier conservés à la Bibliothèque Royale Albert Ier et de leurs filigranes (XXXe-XIVe siècles), Bruxelles 2001.

Ders.: Inventaire des manuscrits de papier du XVe siècle conservés à la Bibliothèque Royale de Belgique et de leurs filigranes. Tome I: Manuscrits datés (1401–1440), Bruxelles 2003. Tome II: Manuscrits datés (1441–1460), Bruxelles 2004. Tome III. Manuscrits datés (1461–1480), Bruxelles 2005. Tome IV. Manuscrits datés (1481–1500), Bruxelles 2006.

David Woodward: Catalogue of watermarks in Italian printed maps ca. 1540–1600 (Biblioteca di bibliografia italiana CXLI), Florenz 1996.

Monique Zerdoun Bat-Yehouda: Les papiers filigranés des manuscrits hébreux datés jusqu'à 1450 conservés en France et en Israël (Bibliologia 16/17), Turnhout 1997.

Aurelio & Augusto Zonghi/A. F. Gasparinetti: Zonghi's watermarks (Monumenta chartae papyraceae historiam illustrantia III), Hilversum 1953.

(Vgl. WWW-Seite "Wasserzeichen-Repertorien": http://www.ks-bm.oeaw.ac.at/wz/lit/rep.htm)

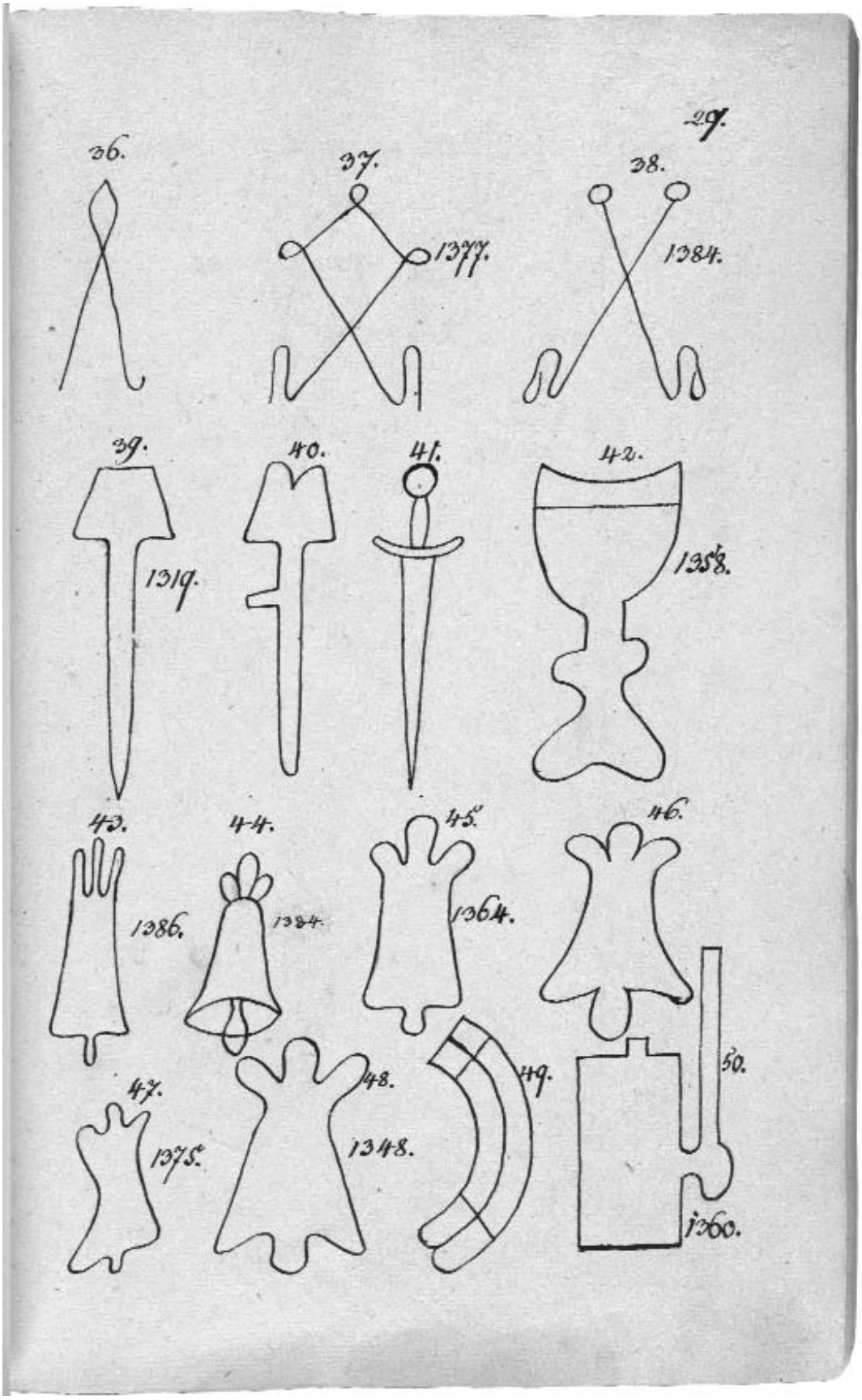
A.H. (C.P.-K.)

The Historical Paper Collections in the Deutsche Buch- und Schriftmuseum of the Deutsche Nationalbibliothek Leipzig

The watermark holdings of the Historical Paper Collections in Leipzig have come to the collection from various sources. The museum, founded in 1884, was managed from 1929 to 1954 by Hans H. Bockwitz (1884–1954), who, although publishing a large number of works on the history of paper, did not set up a watermark collection. During the directorship of Fritz Funke, the institute incorporated the holdings of the Deutsche Papiermuseum, which had been founded in 1957 in Greiz (Thuringia) from the estate of the lawyer and historian Karl Theodor Weiß (1872–1945) (Ill. 12). It was then managed in Leipzig by his son Wisso Weiß (1904–1991) until 1969. In the following two decades, Wolfgang Schlieder (*1926) and especially Gertraude Spoer (1925–1999) undertook the systematic cataloguing of the watermark collection and the reference library containing literature on the history of paper and watermarks. The holdings were expanded quite considerably in 1992, when the institute in Leipzig was given the watermark collection of the Deutsche Museum von Meisterwerken der Naturwissenschaft und Technik, Munich. This collection had initially been a gift from the Forschungsstelle für Papiergeschichte, Mainz in 1973, a collection begun in 1937 under the supervision of Alfred Schulte. It had obtained archival materials from many German archives, which were then systematically catalogued to enable their use for research on watermarks.

Ill. 12: Bookplate of the watermark researcher Karl Theodor Weiß, designed in 1931 by Karl Friedrich Kaiser

Karl Theodor Weiß aspired to carry on the studies of Charles-Moïse Briquet (1839–1918), whose investigations and publications he considered exemplary. He admired the accuracy of Briquet's watermark reproductions, which in-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cluded not only the laid and chain lines, but also the watermarks' position and the size of the individual sheets of paper. Weiß, however, pointed out that Briquet had ignored the existence of pairs of moulds. Moreover, the watermarks in paper used for printing books and for copper prints, tobacco paper and tissue paper had been very little analysed and were awaiting "a second Briquet".

Thus, despite the far-reaching results Briquet had brought to watermark research, there was a much broader range of material that needed to be considered, both temporarily and substantially, material that required a systematic examination according to historical methods. For this reason, Weiß developed the following personal goal: "It is hoped that the author's historical paper collection, as far as a private person is able, might fulfil this need. Eventually, if public funding is granted, an important German paper museum might someday emerge, where individual scholars might quickly and dependably have access to information about watermarks." (Weiß 1926).

According to both Charles-Moïse Briquet and Gerhard Piccard, the timeframe in which it is possible to make sufficiently accurate datings of watermarks based on their comparisons was from the first known watermarks in the late 13th century to 1600. Karl Theodor Weiß and his son, Wisso Weiß, however, did not accept this limitation: "With regard to watermarks, the last centuries have, especially from a scientific viewpoint, no less importance than earlier centuries. The fact that far more material exists from the modern period and in many locations, especially in archives and libraries, actually urgently requires intensive work ..." (Weiß 1962).

Based on these considerations, over the period of nearly a century a watermark collection has emerged that contains more than 300,000 watermark documents which have been indexed and arranged systematically. Whenever possible, the watermarks have been identified according to their provenance, a paper mill or papermaker, which became increasingly easier after the emergence of bi-partite and multipart watermarks with heraldic elements, monograms, place names or personal names. If not enough information is known about a watermark to include it in the collection's Division II, which contains watermarks that can be classified according to these criteria, the documents are included in Division I, which contains a multileveled taxonomy organized by watermark motifs.

In the last few decades, the significance and value of this collection has been demonstrated through numerous musicological studies, documentation, in the treatment of bequests, as well as in the context of the fine arts and conservation. Due to the heterogeneity of the assembled material, it has not yet been possible to digitise these unique holdings, and thus it cannot be used without the support of the library's specialist staff. Over the last fifteen years, however, the associated research library has been indexed, thereby making it possible to include it within the Bernstein Project as a historical paper database.

* * *

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Frieder Schmidt: Am Ziel und am Anfang: die Wasserzeichensammlung am Deutschen Buch- und Schriftmuseum der Deutschen Bücherei Leipzig, in: Das Papier 46 (1992), p. 606–610.

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Karl Theodor Weiß: Die Papiermühle zu Stockach, ihre Geschichte und ihre Wasserzeichen, in: Schriften des Vereins für Geschichte des Bodensees 44 (1915), p. 14–24, p. 198–204.

Karl Theodor Weiß: Papiergeschichte und Wasserzeichenkunde. Erreichte Ziele und zu lösende Aufgaben, in: Archiv für Buchgewerbe und Gebrauchsgraphik 63 (1926), p. 277–308, 310.

Karl Theodor Weiß: Die Bedeutung des Gesetzes der Formenpaare für die Wasserzeichenkunde, in: Allgemeine Papier-Rundschau (1950), p. 164–166.

Karl Theodor Weiß: Handbuch der Wasserzeichenkunde. Bearbeitet und hg. von W. Weiß. Leipzig 1962 (Reprint Leipzig 1983).

Ulman Weiß: Karl Theodor Weiß, Prolegomena zu einer Biographie, in: International Paper History = Papiergeschichte international, Marburg 5 (1995), p. 48–53.

Wisso Weiß: Zur Entwicklungsgeschichte der Wasserzeichen im europäischen Handbüttenpapier, in: Gutenberg-Jahrbuch, Mainz 62 (1987), p. 109–124.

Wisso Weiß: Dreiteilige Wasserzeichen, in: Gutenberg-Jahrbuch, Mainz 64 (1989), p. 15–29.

F.S. (F.S. / C.P.-K.)

Watermark collectors

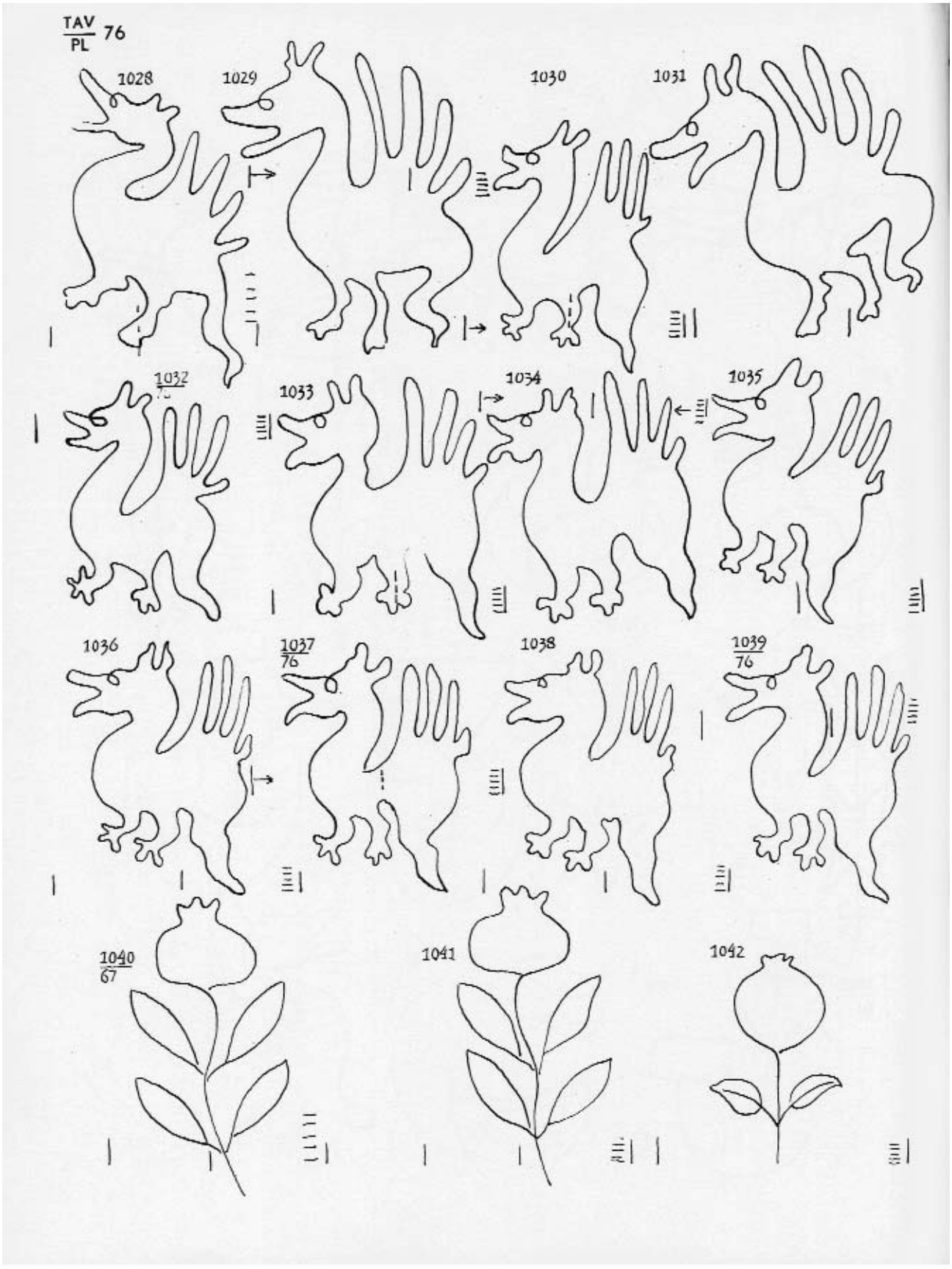
V 1 Vinzenz Franz Werl (OSB)

* 1810, 1828 novitiate at the Benedictine Abbey Göttweig, 1833 ordination to priesthood, 1835 professor of theology at the Hauslehranstalt für Dogmatik, 1844 author of a three-volume catalogue of the monastery manuscripts (handwritten), † 1861.

The Manuscripten-Catalog der Stiftsbibliothek Göttweig includes, on pages 25–36 of the first volume, a total of 306 somewhat enlarged tracings of watermarks from Göttweig manuscripts. In only a few cases are the images based on a single watermark; most are watermark "types", that is, drawings of the most important features of several similar watermarks. If a watermark of a particular type is found in a dated manuscript, the respective date is noted. In the manuscript descriptions, the numbers of the recorded watermarks are listed.

Page 29 includes the following motifs: "Pincers" (No. 36), "Two crossed keys" (No. 37, 38), "Spade" (No. 39, 40), "Sword" (No. 41), "Chalice" (No. 42), "Bell" (No. 43–48), "Bale" (No. 49) and "Hatchet" (No. 50).

A.H. (C.P.-K.)


TAV
PL 76
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1038
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1040
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V 2

V 2 Aurelio Zonghi

* 1830 Fabriano, 1888 Bishop of Sanseverino, † 1902.
Aurelio Zonghi, one of the most important Italian scholars of watermarks, dedicated himself to the study of the watermarks in Fabriano paper of the Middle Ages where it can be proved that already in the 13th century paper was produced. In two essays, published in 1881 and 1884, Zonghi describes a total of 1,887 watermarks. After seeing Zonghi's tracings of these watermarks in 1884, Briquet wrote him a letter, emphasizing the necessity of their being published ("... L'indication et la description des masques telle que vous l'avez faite est insuffisante, il faut des fac-simile ..."). Although Zonghi made some of his drawings available to Briquet, it took another seventy years for Briquet's wish, the publication of the Fabriano watermarks, to be fulfilled.

The drawings of the collection are organized according to motifs, and within this, according to their time of origin. Plate 76 shows, under the numbers 1028–1039 from the time period from 1372 to 1412, examples of a watermark that was still in use at the end of the Middle Ages. The winged, two-legged dragon was first seen in Italian paper; in the form given here, it was particularly common in the last third of the 14th century and the first two decades of the 15th century. (Ill. p. 78).

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Aurelio Zonghi: Le Marche principali delle Carte Fabrianesi dal 1293 al 1599, Fabriano 1881.

Aurelio Zonghi: Le antiche Carte Fabrianesi alla Esposizione Generale Italiana di Torino, Fano 1884.

Aurelio & Augusto Zonghi/A. F. Gasparinetti: Zonghi's watermarks (Monumenta chartae papyraceae historiam illustrantia III), Hilversum 1953. – The collection of 1,887 watermarks is printed under the title "The watermarks collected by Aurelio & Augusto Zonghi as traced from the original papers by C. Canavari of Fabriano".

A.H. (C.P.-K.)

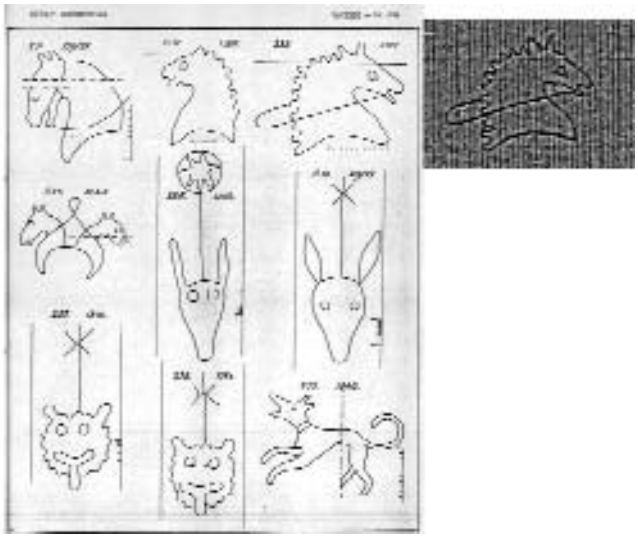
V 3 Friedrich Keinz

* 1833 Passau, librarian at the königlich bayerische Hof- und Staatsbibliothek 1865–1899, † 1901 Munich.

Based on his realization "that if a large amount of material is classified in a solid system through its scientific examination, these marks would be another important means of determining the age of undated manuscripts" (Keinz p. 485f.), Keinz saw his collection as an aid that "should enable anyone to find viable information about a mark he encountered" (Keinz p. 491).

Plate XXIII depicts the watermarks "Horse head" (No. 231–234), "Donkey head" (No. 235, 236), "Dog head" (No. 237, 238), and "Dog" (239). Next to each drawing is a date (either from a manuscript or reconstructed).

Keinz classifies the watermarks according to object (the four main groups being: line drawings; humans, including their handiwork, tools and utensils; animals; plants). In contrast to Werl, Keinz does not group the watermarks into types, but reproduces individual watermarks in scale tracings. The descriptions of the watermarks include references to identical and similar watermarks, as well as to depictions in published watermark collections.



V 3

An example of Keinz' precision in his rendering of the marks can be seen by the nearly perfect correspondence of his tracing of the watermark "Horse head with bridle" (No. 233) to the watermark AT5000–359_10 from the Klosterneuburg manuscript Codex 359 in the WZMA collection.

* * *

Friedrich Keinz: Die Wasserzeichen des XIV. Jahrhunderts in Handschriften der k. bayer. Hof- und Staatsbibliothek. Abhandlungen der philosophisch-philologischen Classe der königlichen bayerischen Akademie der Wissenschaften 20 (München 1897) 481–524.

A.H. (C.P.-K.)

V 4 Charles-Moïse Briquet

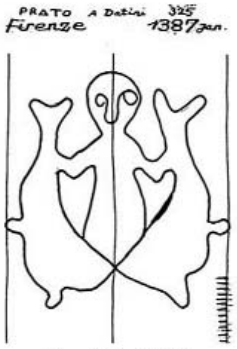
* 1839 Geneva, paper dealer, intensive research on watermarks from approximately 1880, 1908 publication of his magnum opus, Les Filigranes, † 1918.

According to Briquet, his published collection, ordered by motifs, contains 16,112 of the approximately 44,000 tracings of watermarks from paper made between 1282 and 1600 that he collected in archives in Western and Central Europe (cf. Les Filigranes, p. XV). The unpublished drawings are listed as 'variétés' of the watermarks found in the publication.

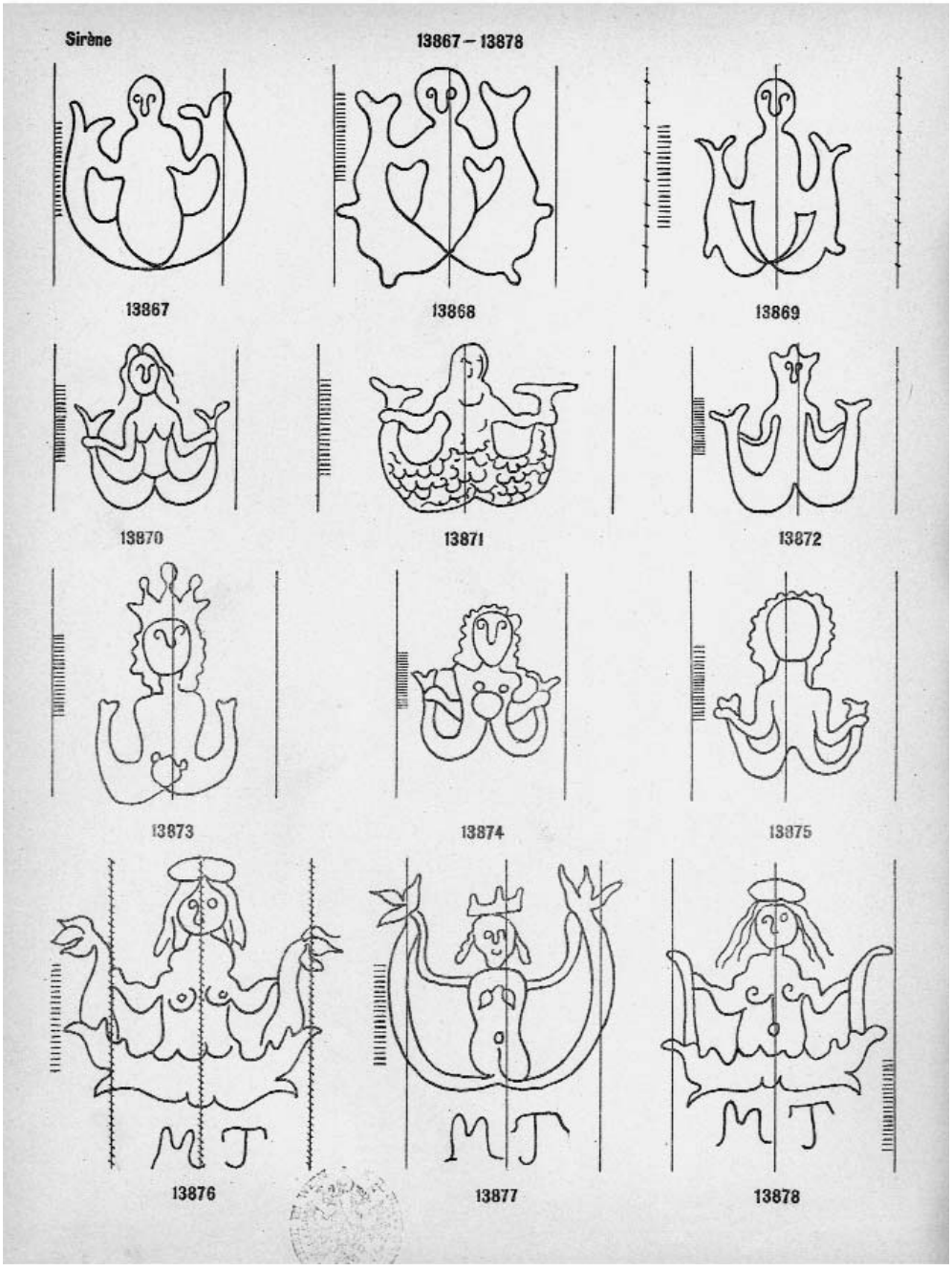
Most of the variants that Briquet left unpublished are now found in the approximately 27,000 drawings from the scholar's estate that now form the "Briquet Archive" at the Bibliothèque publique et universitaire in Geneva. It was started to integrate the watermarks of the Briquet Archive into the "Thomas L. Gravell Watermark Archive" and thus to make it available online.

To each motif group, where the individual watermarks are described, Briquet has provided introductions that give a range of details, including definitions of sub-groups, evidence about provenance, or deductions about the time

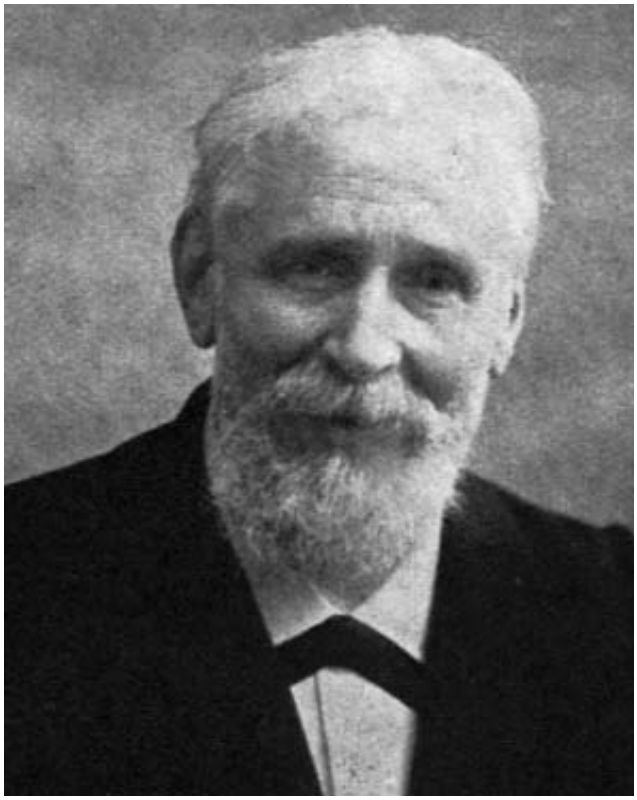
WZMA AT5000-410 11



Piccard-Online 160219



V 4a



V 4 Charles-Moïse Briquet

span the watermarks of a particular group were in use. For example, within the motif "Mermaid" Briquet makes a distinction between two sub-groups, French and Italian. According to Briquet, the watermark No. 13868, dated 1389, belongs to the latter. Here, Briquet also refers to similar watermarks he had made tracings of but was not including in the publication, or that had already been published in earlier collections. He further divides these into 'variétés identiques' and 'variétés du groupe'. When comparing the dates of all the watermarks listed under No. 13868, it can be established that the watermarks in this group were used from 1380 to 1401.

Briquet's groups are not always convincing (cf. Piccard, Ochsenkopf, p. 12–14). However, in cases where Briquet classified a motif as part of a clearly differentiated group (type) based on its distinctive outer features, recent research often confirms the deductions he made about the period the particular type was used. For instance, the WZMA collection currently contains fifteen manuscripts with watermarks that correspond to Briquet's group around No. 13868 (including Korneuburg, Stadtarchiv, Inv. Nr. 3/1752, dated 1382, and Wien, ÖNB, Cod. 4470, dated 1390). In the Piccard-Online collection are sixteen watermarks that fall within this group (Nos. 160211–160213, 160215–160225, 21211, 21212); they are all dated, with one exception, to the period from 1380 to 1400. Watermarks absolutely identical to Briquet No. 13868 are also found in both the WZMA collection (AT5000–410_1: Klosterneuburg Cod. 410, dated to the 1480s) as well as in Piccard-Online (No. 160219: Florence, 1387) (Ill. V 5a).

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Charles-Moïse Briquet: Les Filigranes. Dictionnaire historique des marques du papier dès leurs apparition vers jusqu'en 1600, 4 Vol, Paris etc. 1907, 2nd Edition Leipzig 1923. – C.-M. Briquet, Les Filigranes. The New Briquet, Jubilee Edition. Ed. Allan Stevenson, 4 Vol., Amsterdam 1968.

The Briquet Album. A miscellany on watermarks, supplementing Dr. Briquet's Les filigranes, Hilversum 1952.

Briquet's Opuscula. The Complete Works of Dr. C. M. Briquet without Les Filigranes, Hilversum 1955.

Daniel W. Mosser: Papiers Briquet: The Charles-Moise Briquet Archive in Geneva, in: Looking at paper: evidence & interpretation. Symposium proceedings, Toronto 1999, held at the Royal Ontario Museum and Art Gallery of Ontario, May 13–16, 1999, ed. by John Slavin ..., Ottawa 2001, 122–127.

Ders.: The Papers of Charles Moise Briquet. Translation (with annotations) of the French description of the Briquet Archive supplied by the Bibliothèque publique et universitaire. http://ada.cath.vt.edu:591/DBs/Gravell/briquet/briqeng.html

The Thomas L. Gravell Watermark Archive. Incorporating the The University of Delaware Library's Thomas L. Gravell Watermark Collection and The Unpublished Watermarks and Records from the C.-M. Briquet Archive at the Bibliothèque publique et universitaire, Geneva. Provided by the Center for Applied Technologies in the Humanities (CATH) at Virginia Tech (Virginia Polytechnic Institute & State University) http://ada.cath.vt.edu:591/dbs/gravell/default.html

A.H. (C.P.-K.)

V 5 Nikolai Petrovich Likhachev

* 1862, university studies in Western European history, dissertation on paper and the oldest paper mills in Moscow, one of the most important Russian collectors of manuscripts, documents, books and autographs, 1899 publication of his watermark collection, † 1936.

Likhachev, who without a doubt was the most important Russian scholar of watermarks, began to collect watermarks in 1890, primarily in libraries and archives in Moscow and St. Petersburg. His work, published in 1899, contains depictions of a total of 4,258 tracings of watermarks, collected mainly from Western European paper from the period before 1700.

Plate 59 of the English version of Likhachev's watermark collection depicts watermarks that were formed out of simple geometrical shapes, very common in Italian paper especially in the second half of the 14th century (Ill. p. 82).

This important collection only became available to a larger audience with the publication of the English version in 1994, in which the material was augmented with a number of extra registers.

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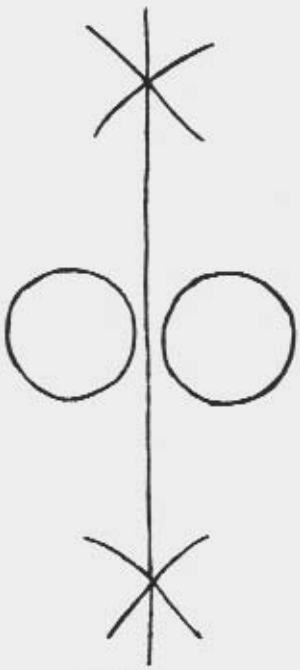
Nikolai Petrovich Likhachev: Das Papier und die ältesten Papiermühlen Moskaus (russian), St. Petersburg 1891.

Ders.: Die paläographische Bedeutung der Wasserzeichen (russian), St. Petersburg, 1899.

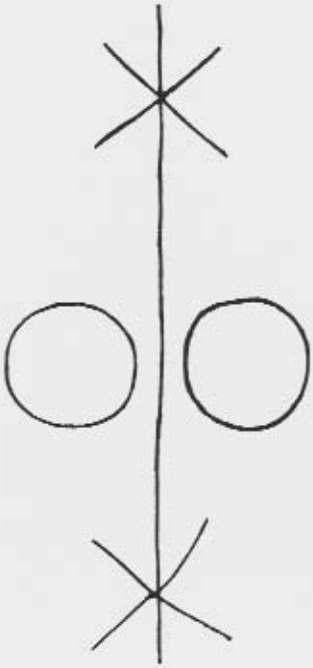
Likhachev's watermarks, ed. John Simon Gabriel Simmons, Bé van Ginneken-van de Kasteele (Monumenta Chartae Papyraceae Historiam Illustrantia XV), Amsterdam 1994.

Nikolai Petrovich Likhachev, 1862–1936: scholar and pioneer codicologist and student of watermarks, von John Simon Gabriel Simmons, Oxford 1994.

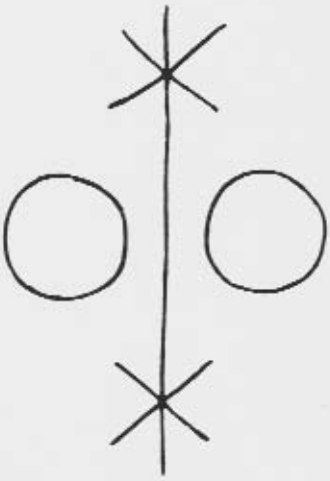
A.H. (C.P.-K.)



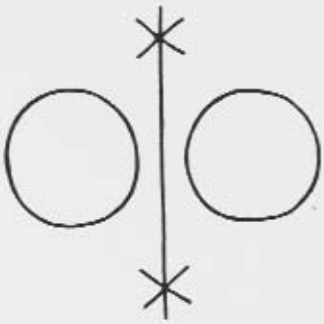
2082 (1360-80)



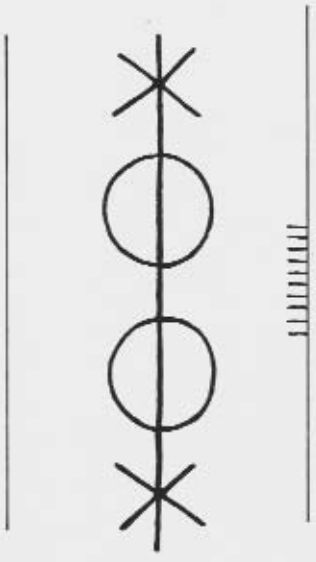
2083 (1360-80)



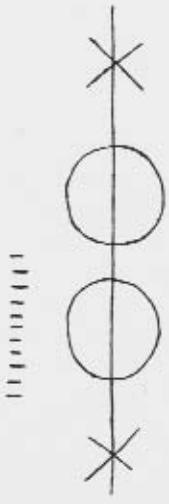
2100 (1380s)



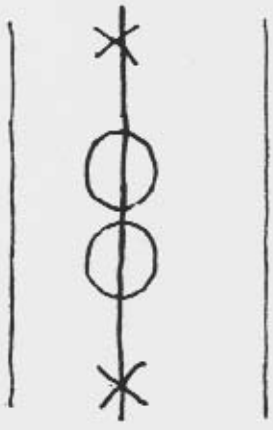
3465 (1496)



269 (1379)



3645 (1387)



2105 (1391)

V 6 William Algernon Churchill – Edward Heawood

William Algernon Churchill: * 1865, British Consul in Amsterdam, Milan, etc., † 1947.
Edward Heawood: * 1863, 1886 Fellow of the Royal Geographical Society, librarian of the Society until 1934, † 1949.

The monograph "Watermarks in paper in Holland, England, France etc. in the XVII and XVIII centuries and their interconnection", published by William Algernon Churchill in 1935, is not merely a collection of watermarks, but is rather a history of papermaking, above all Dutch, illustrated with 578 watermark tracings. Papermaking is recorded in Holland from the end of the 16th century. In the second half of the 17th century, Amsterdam established itself as an important centre for paper production and its export – not only of Dutch paper, but also paper from France and Germany. One of the most important importers of Dutch paper in the 17th and 18th century was England. The excellent reputation of Dutch paper in the 18th century led to its paper (and its watermarks) being copied in France and also, to some extent, in southern Germany.

Closely connected to the above publication of Churchill is the watermark collection "Watermarks mainly of the 17th and 18th centuries" of Edward Heawood. Churchill's publication includes many watermarks from Heawood's collection; conversely, for his own publication, Heawood, who was a close friend of Churchill, used many tracings Churchill had made but not included in his work. Heawood's collection contains 4,078 tracings of watermarks, classified according to motifs, collected primarily from books and maps from the library of the Royal Geographical Society, the Victoria and Albert Museum and the British Museum.

* * *

William Algernon Churchill: Watermarks in paper in Holland, England, France etc. in the XVII and XVIII centuries and their interconnection, Amsterdam 1935, Reprint Nieuwkoop 1985.

Edward Heawood: Watermarks mainly of the 17th and 18th centuries (Monumenta chartae papyraceae historiam illustrantia 1), Hilversum 1950, Reprint Amsterdam 1957 and 1970.

A.H. (C.P.-K.)

V 7 Karl Theodor Weiß

* 13 February 1872 (Schwetzingen), parents from Constance, paper historian and watermark researcher, † 12 Mai 1945, Erfurt.

Karl Theodor Weiß passed his general qualifications for university entrance in Ettenheim and subsequently studied philology, German language and literature as well as history at the Universities of Freiburg, Strasbourg, Tübingen and Heidelberg. After an internship at the Großherzogliche Landesbibliothek in Karlsruhe, he studied – pushed by his father, with whom he had a difficult relationship – law in Freiburg and Heidelberg. He graduated, however, from the faculty of philosophy. Two years later, Weiß founded the Deutsche Papiermuseum. At the turn of the century he worked as a lawyer in Karlsruhe and later, in Engen (Hegau); his greatest commitment, however, was devoted to his studies on paper and watermarks. Three children were born between 1899 and 1904: Werner, his daughter Wissigard, and finally his son Wisso. From 1910 he conducted systematic surveys, sending questionnaires of up to 5,000 copies to public institutions, church parishes, archives and active paper mills. These questionnaires asked for a broad range of information about former paper mills, individual paper makers, their products and their watermarks.

Weiß was not only interested in acquiring watermark tracings, he also collected original paper samples and described them in a standardized manner. In the context of his research on watermarks, he also studied historical papermaking techniques intensively. He collected old moulds and studied the watermarks pairs produced from two moulds in a single papermaking process. In a study on the Stockach paper mill published in 1915, he carefully noted watermark pairs: "Only both moulds of a pair of moulds are of value. They allow the most reliable dating of writing paper, prints, and drawings." His monograph, "Paper History and Watermark Research", was published in 1926. It clearly demonstrates that he did not consider the history of paper merely an auxiliary science.

His "Handbuch der Wasserzeichenkunde" (Handbook of Watermark Research), a project that he planned and worked on for decades, remained unfinished at his death. Also projected "Regesten zur Papiergeschichte" (Inventory of Paper History), mentioned in his correspondence with the publisher Karl W. Hiersemann of Leipzig, was not completed. After World War I, Weiß discontinued his law practice, moved to Mönchweiler near Villingen, and for the following two decades privately worked on his research in limited financial circumstances. In 1937, on the suggestion of Hellmuth Müller-Clemm, an Expert Committee for Paper History and Watermark Research was founded by the Verein der Zellstoff- und Papier-Chemiker und -Ingenieure (Association of Pulp and Paper Chemists and Engineers), but despite some negotiations, he declined a position. He was also not willing to place his collection at the disposal of the Forschungsstelle für Papiergeschichte (Research Centre for Paper History), founded in 1938 in Mainz. Alfred Schulte, who Weiß had familiarised with the fundamentals of paper history already in 1930, became the head of this institution. In 1939, Weiß and his wife, urgently in need of support, were brought by their son Wisso to live with him in Erfurt. The collection was packed into cases and became nearly inaccessible. During World War II, under the threat of air raids, a paper manufacturer had parts of the collection transferred to a bunker. Wisso Weiß was a prisoner of war when his father died on 12 May 1945 in Erfurt, immediately after the end of World War II. It was left to his son to finish all the works his father had left incomplete.

* * *

Alfred Nadler: Zum 100. Geburtstage von Dr. Karl Theodor Weiß, in: IPH-Information N.F. 6 (1972) 1, p. 5–7.

Karl Theodor Weiß: Die Papiermühle zu Stockach, ihre Geschichte und ihre Wasserzeichen. Nach seiner papiergeschichtlichen Sammlung dargestellt von Dr. Karl Theodor Weiß, in: Schriften des Vereins für Geschichte des Bodensees 44 (1915), p. 14–31.

Karl Theodor Weiß: Papiergeschichte und Wasserzeichenkunde. Erreichte Ziele und zu lösende Aufgaben, in: Archiv für Buchgewerbe und Gebrauchsgraphik 63 (1926), p. 292–308.

Karl Theodor Weiß: Handbuch der Wasserzeichenkunde, bearbeitet und herausgegeben von Wisso Weiß, Leipzig 1962.

Ulman Weiß: Karl Theodor Weiß. Prolegomena zu einer Biographie, in: International Paper History 5 (1995), Heft 3, p. 48–53.

F.S. (F.S. / C.-P.-K.)

V 8: Wisso Weiß, unknown photographer

V 8 Wisso Weiß

* 2 January 1904 Baden-Baden, son of Karl Theodor Weiß and his wife Josefine, 1923 general qualifications for university entrance, 1929 doctorate, 1962 publication: "Handbuch der Wasserzeichenkunde" (Handbook of Watermark Research), † 17 November 1991.

Wisso Weiß completed his final secondary school examinations in Donaueschingen in 1923. During World War I his father served first as a military volunteer, from 1916 he was drafted into the "Landsturm". He studied economics at the Universities of Tübingen, Munich, Freiburg and Heidelberg and received his doctorate in 1928. His doctoral thesis dealt with socialised housing. After his graduation he took a job in this field, but from 1932 he was unemployed. After some temporary jobs, was then employed by the Mitteldeutsche Heimstätte from 1936 to 1949. From 1939 his parents lived with him and he began to examine questions concerning historical paper together with his father. After the war and the nearly simultaneous death of his father, the conservation of his father's sizable paper collection came under his care. In 1949 Wisso Weiß left his job and began to devote himself to research projects concerning watermarks. Under the auspices of the Johann Sebastian Bach Institute in Göttingen, he documented the watermarks in the works of Bach and in 1955 wrote a supplementary volume to the New Bach Edition, which, however, was published only in 1985, three decades after its completion. During these years he also contributed to the field of watermark research with a number of articles and prepared the monograph "Thüringer Papiermühlen und ihre Wasserzeichen". In 1957, twelve years after his father's death, he succeeded in having his father's private collection transformed into a public institution. The Ministry of Culture of the German Democratic Republic purchased the collection and established the German Paper Museum in Greiz (Thuringia). Wisso Weiß became its curator. In 1962, a few years after the museum's founding, Wisso Weiß finally published his father's "Handbuch der Wasserzeichenkunde", after careful revisions to bring the work up to date with regard to the state of research at the time. It is the first monograph to deal with all aspects of watermarks. The work's ten chapters examine the production and use of watermarked paper, watermarks themselves and their analysis, watermarked papers and their forgeries, watermarks and the dating of manuscripts, the collecting of watermarked papers and watermarks, their identification, and watermarks in modern paper. When in 1964 the German Paper Museum was integrated into the Deutsche Buch- und Schriftmuseum (German Book and Writing Museum) of the Deutsche Bücherei Leipzig (since June 2006: Deutsche Nationalbibliothek Leipzig), Wisso Weiß became an employee of that institution, remaining there until 1969. After his retirement he continued to publish papers relating to paper history and watermark research up to his death on 17 November 1991.

* * *

Frieder Schmidt: Rückblick auf ein Forscherleben: zum 100. Geburtstag des Papierhistorikers und Wasserzeichenforschers Dr. Wisso Weiß, in: Wochenblatt für Papierfabrikation 132 (2004) 1/2, p. 39–42.

Wisso Weiß: Alte Ausgaben auf Feinpapier, in: Imprimatur N.F. 14 (1991), p. 305–324.

Wisso Weiß: Badische Bildnis-Wasserzeichen, in: Zeitschrift für die Geschichte des Oberrheins Vol. 100 = N.F. 61 (1952) 2, p. 766–777.

Wisso Weiß: Dreiteilige Wasserzeichen, in: Gutenberg-Jahrbuch 64 (1989), p. 15–29.

Wisso Weiß: Eckzier-Wasserzeichen, in: Gutenberg-Jahrbuch 33 (1958), p. 37–43.

Wisso Weiß: The emergence of the shadow watermark, in: Kufferatz, Franz-Ferdinand: The 200-year history of Messrs. Andreas Kufferatz, Düren-Mariaweiler 1982, p. 11–19.

Wisso Weiß: Historische Wasserzeichen, Leipzig 1986.

Wisso Weiß: Katalog der Wasserzeichen in Bachs Originalhandschriften. Unter musikwissenschaftlicher Mitarbeit von Yoshitake Kobayashi (Johann Sebastian Bach – Neue Ausgabe sämtlicher Werke, Ser. 9, 1), Leipzig/Kassel et al. 1985.

Wisso Weiß: Kirchendarstellungen in Thüringer Wasserzeichen, in: Mosaiksteine, zweiundzwanzig Beiträge zur thüringischen Kirchengeschichte, Berlin 1981, p. 208–227.

Wisso Weiß: Schiller und das Papier, in: Zellstoff und Papier 4 (1955) 12, p. 376–379.

Wisso Weiß: Thüringer Papiermühlen und ihre Wasserzeichen, Weimar 1953.

Wisso Weiß: Vom schattenlosen gerippten Handbüttenpapier, in: Gutenberg-Jahrbuch 50 (1975), p. 11–17.

Wisso Weiß: Vom Wasserzeichen im Druckpapier, in: Gutenberg-Jahrbuch 35 (1960) = Festschrift, p. 11–18.

Wisso Weiß: Wasserzeichen (Bearbeitung: Wisso Weiß; Anfertigung der Pausen: Harald Kümmerling), in: Harald Kümmerling, Katalog der Sammlung Bokemeyer (Kieler Schriften zur Musikwissenschaft 18), Kassel/Basel u.a. 1970, p. 283–423.

Wisso Weiß: Das Wasserzeichen im alten handgeschöpften Velinpapier, in: Gutenberg-Jahrbuch 36 (1961), p. 11–17.

Wisso Weiß: Zeittafel zur Papiergeschichte, Leipzig 1983.

F.S. (F. S. / C.P.-K.)

V 9 Theo Gerardy

* 3 August 1908 Euskirchen, engineer, 1972 director Kadaster Hannover, † 19 June 1986, Hannover.

Theo Gerardy first came into contact with research on watermarks when he made an inventory at the University of Göttingen of the estate of C.F. Gauss, which contained

documents concerning land surveying. He grew enthusiastic about research on watermarks and started to study the theoretical aspects of the field, especially its use for dating and assessing the provenance of 15th century manuscripts and incunabula. By applying research on watermarks to his studies of very early German incunabula, he increased the accuracy of his dating and was able to ascribe his objects of study to certain printers. His publications on the *Missale Speciale* and *Catholicon* have become well known.

Gerardy compiled a huge collection of watermark images, which he took from documents in German archives by means of tracing, photography and beta radiography. He supplemented this collection with watermarks taken from reference books such as Briquet's "Les Filigranes". The core of his collection is made up of watermarks from 15th century German documents. Consequently, most of the watermarks in his collection are of the "Bull's head" motif, which was frequently used in Germany.

Gerardy collected almost 15,000 images of watermarks. Each watermark image also includes additional information, such as its source, the institution holding the document it was taken from, and whether it was copied from the 'screen' or 'felt' side of the paper. When making tracings, he also included the chain lines as well as other details.

It was Gerardy's wish that his collection be kept together after his death and be sold to an institution that was interested in paper and its history. He favoured the Koninklijke Bibliotheek in The Hague because of his friendship with Hendrik Voorn, at that time curator of the library's historical paper collection. Moreover, he had earlier sold 2,000 watermarks taken from 18th and 19th century documents to the same library. For this reason, in 1987 the Association of Friends of the KB bought the Gerardy collection from his heirs. The Friends presented the collection to the KB, where it has found a perfect home, complementing the watermark research on Dutch incunabula that was begun by Gerard van Thienen, former curator of the KB.

* * *

Severin Corsten: Theo Gerardy, in: Lexikon des Buchwesens, Bd. III, Stuttgart 1989–1991, p. 138.

Albert J. Elen: Die Wasserzeichensammlung Dr. Ing. Theo Gerardy, in: IPH-Information 22 (1988), p. 160–165.

Theodor Gerardy: Zur Methodik der Wasserzeichenforschung, in: Papiergeschichte 6 (1956) 2, p. 14–20.

Theodor Gerardy: Die Wasserzeichen des mit Gutenbergs kleiner Psaltertype gedruckten Missale Speciale, in: Papiergeschichte 10 (1960) 2, p. 13–22.

Theodor Gerardy: Datieren mit der Hilfe von Wasserzeichen: beispielhaft dargestellt an der Gesamtproduktion der schaumburgischen Papiermühle Arensburg von 1604–1650. Bückeburg 1964.

Theodor Gerardy: Die Wasserzeichensammlung: der Aufbau einer Wasserzeichensammlung, in: Papiergeschichte 15 (1965) 1–2, p. 7–14.

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Theodor Gerardy: Zur Methodik des Datierens von Frühdrucken mit Hilfe des Papiers, in: Ars impressoria: Entstehung und Entwicklung des Buchdrucks: eine internationale Festgabe für Severin Corsten zum 65. Geburtstag. Munich1986, S. 47–64.

M.v.D. (M.v.D. / C.P.-K.)

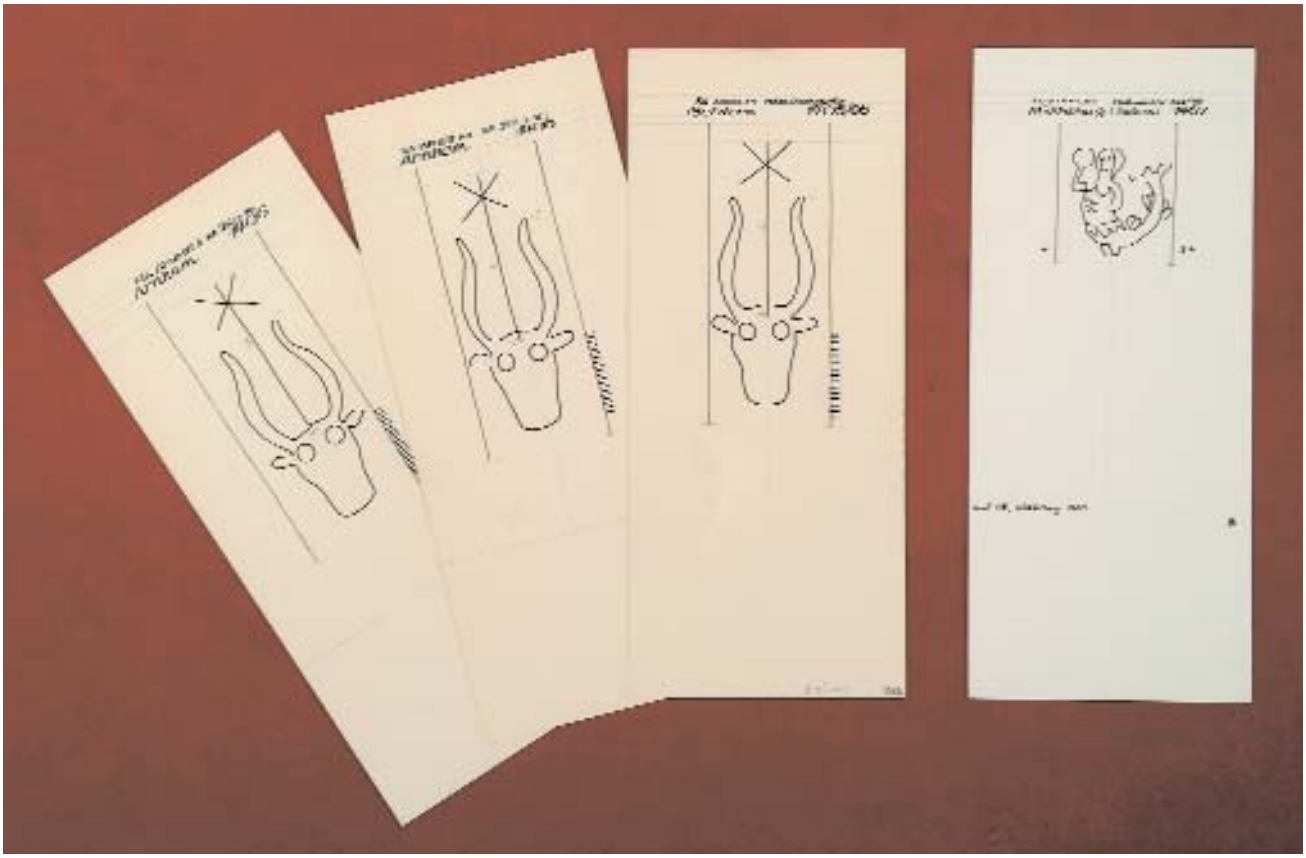
V 10 Gerhard Piccard

V 10 Gerhard Piccard

* 1909, artist and watermark scholar, 1961–1997 publication of seventeen "Findbücher" of watermark motifs based on his index of watermarks at the Hauptstaatsarchiv Stuttgart, important publications on watermark research as a historical aid, † 1989.

The largest collection of watermarks world-wide was put together by Gerhard Piccard; his watermark index in the Hauptstaatsarchiv Stuttgart contains approximately 92,000 samples. According to his own estimate, he made tracings of another 30,000 watermarks that were not transferred to index cards. Piccard published seventeen volumes of 'Findbücher', which include 4,540 different watermark types and 44,497 individual signs. Until recently more than half of his collection was still only available on cards in the Hauptstaatsarchiv Stuttgart (Bestand J 340). In the meantime, Piccard's entire collection of watermarks has been made available on the internet (http://www.piccard-online.de).

The first volumes of the registers ('Krone', 'Ochsenkopf' and for the most part also 'Turm') served merely as search aids and presented only watermark types, but the later volumes also included examples of individual watermarks. However, the watermarks reproduced in the card index and the published samples do not correspond exactly. In most cases the registers contain more examples, since Piccard did not transfer all of his tracings onto cards. In some registers, however, here are also instances of there being fewer examples, because he later collected many watermarks to supplement those he had published.



V 10a Index cards from Piccard's collection

In the introductions to his registers, Piccard describes each watermark motif and type, and provides information about their historical context. In addition, he records where and when he found each sample, these descriptions linked to the images classified according to type. As in the case of Briquet, the groups, classified according to outer characteristics, are not always convincing; as a rule, however, they enable a watermark to be classified according to a particular type and thus facilitate the search for identical examples or variants.

***

Peter Amelung: Nachruf auf Gerhard Piccard (1909–1989), in: Gutenberg-Jahrbuch 1990, S. 386–391.

Hermann Bannasch: Die wissenschaftliche Grundlegung der Wasserzeichenkunde. Weg und Wirken des Kunstmalers Gerhard Piccard (1909–1989) in der Wasserzeichenforschung, in: Peter Rückert/Jeannette Godau/Gerald Maier (Hg.): Piccard-Online. Digitale Präsentationen von Wasserzeichen und ihre Nutzung, Stuttgart 2007, S. 137–164.

Gerhard Piccard: Die Papiermarken des COD. CUS. 220, in: Mitteilungen und Forschungsbeiträge der Cusanus-Gesellschaft 7 (1969), S. 47–66.

Ders.: Papiererzeugung und Buchdruck in Basel bis zum Beginn des 16. Jahrhunderts. Ein wirtschaftsgeschichtlicher Beitrag, in: Börsenblatt für den Deutschen Buchhandel 76 (1966), S. 1819–1967.

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Ders.: Über die Anfänge des Gebrauchs des Papiers in den deutschen Kanzleien, in: Studi in onore di Amintore Fanfani, III: Medioevo, Mailand 1962, S. 345–401.

Ders.: Die Wasserzeichenkartei Piccard im Hauptstaatsarchiv Stuttgart, 17 Bde., Stuttgart 1961–1997.

Ders.: Die Datierung des Missale speciale (Constantiense) durch seine Papiermarken, in: Börsenblatt für den deutschen Buchhandel 14a (Sondernummer) 1960, S. 259–272.

Ders.: Die Wasserzeichenforschung als historische Hilfswissenschaft, in: Archivalische Zeitschrift 52 (1956), S. 62–115.

Ders.: Die Wasserzeichenforschung als historische Hilfswissenschaft, in: Der Archivar 4 (1954), Sp. 263–265.

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P.R. (C.P.-K.)

VI Digitalization of watermarks

Published Watermark Collections and the World Wide Web

The watermark collections that have been made available on the internet in the last few years already provide an indispensable aid for the dating of documents written on paper and also (to a lesser degree) for determining their provenance. Nevertheless, the value of published watermark collections has not diminished. The most important of these are the seventeen "Findbücher" of Piccard (see V 10) and Briquet's "Les Filigranes" (see V 4). At the Austrian Academy of Sciences, the Kommission für Schrift- und Buchwesen des Mittelalters plans to make also these collections available for research on the internet. The preliminary work of preparing the texts in the Piccard and Briquet collections for the internet has been undertaken in the framework of the EU project Bernstein, based on data provided by the project's partner, the Laboratoire de Médiévistique Occidentale de Paris (LAMOP).

It is planned to augment the online version of "Les Filigranes" in two ways: On one hand, the older collections that are most frequently cited by Briquet (cf. Les Filigranes, p. VIII-X) will also be put on the internet and linked to the respective Briquet numbers. Briquet integrated into his collection several thousand watermarks that were already published at the time of his work. Some he reproduced (cf., for instance, Briquet No. 452 = Likhachev 3493 f.), but more often he simply listed them as variants of the depicted watermark (cf., for example, Briquet Nr. 7, which mentions Keinz No. 365 and Briquet 600, and refers to Likhachev Nos. 154–156). It is planned, in addition, to link images of the variants (listed by Briquet but not reproduced) that he had collected and traced himself to each watermark in the "Les Filigranes" collection. These variants are found in his estate. They will gradually be made available on the internet site of the Thomas L. Gravell Watermark Archive (see V 4).

Another pressing need is to compare and then link the samples in the huge Piccard-Online collection, a total of 92,000 watermarks (see V 10), to the watermarks Piccard published in his registers. About 44,500 of the watermarks published in registers 3 to 17 correspond with regard to motif to ca. 40,000 watermarks in Piccard-Online. It is clear that linking the identical watermarks in the two resources will be of immeasurable help to the user.

A single categorization system that is valid for all watermark collections is a prerequisite for being able to search efficiently and comprehensively for individual watermarks of a particular motif. In the framework of the Bernstein project, the partners have agreed on designations for the main groups. It is only a longer term goal, however, for a general standardized system to be created for all watermarks of the Middle Ages and the early modern period.

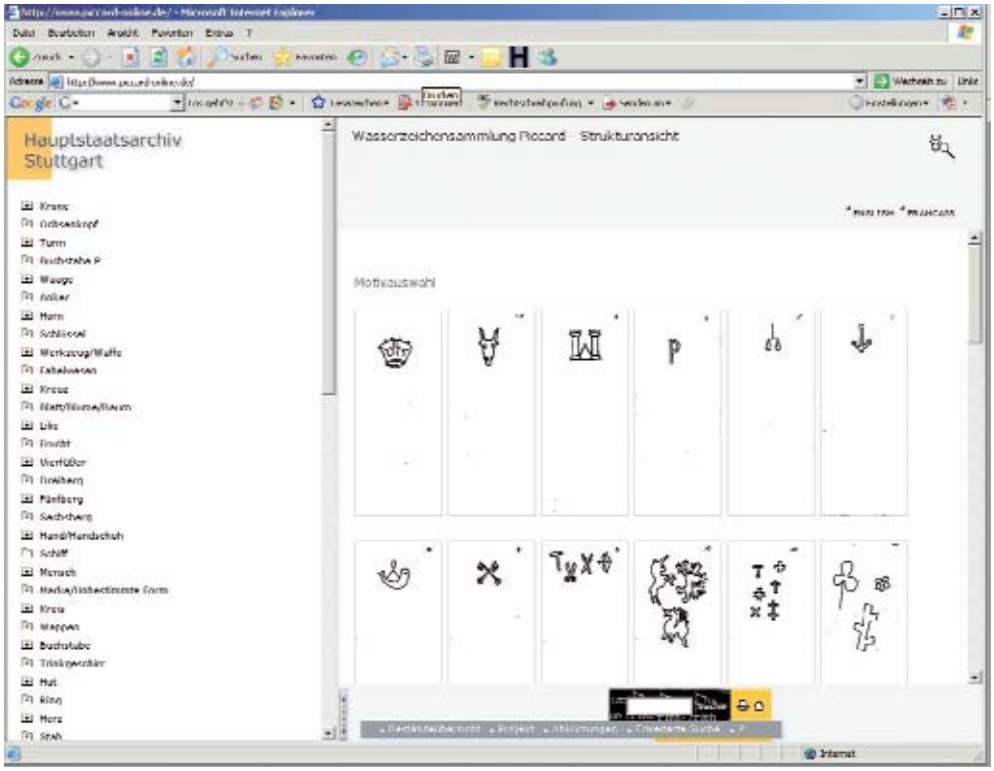
Literature: Internationale Bibliographie zur Papiergeschichte (IBP), Abschnitt 8. Wasserzeichenkunde (vol. 2, 1018–1085), in particular 8.1.1. Wasserzeichen-Alben (Vol. 2, 1018–1022); Verzeichnis der Wasserzeichen-Repertorien (published and online) with watermarks primarily from the Middle Ages: http://www.ksbm.oeaw.ac.at/wz/lit/rep.htm

A.H. (C.P.-K.)

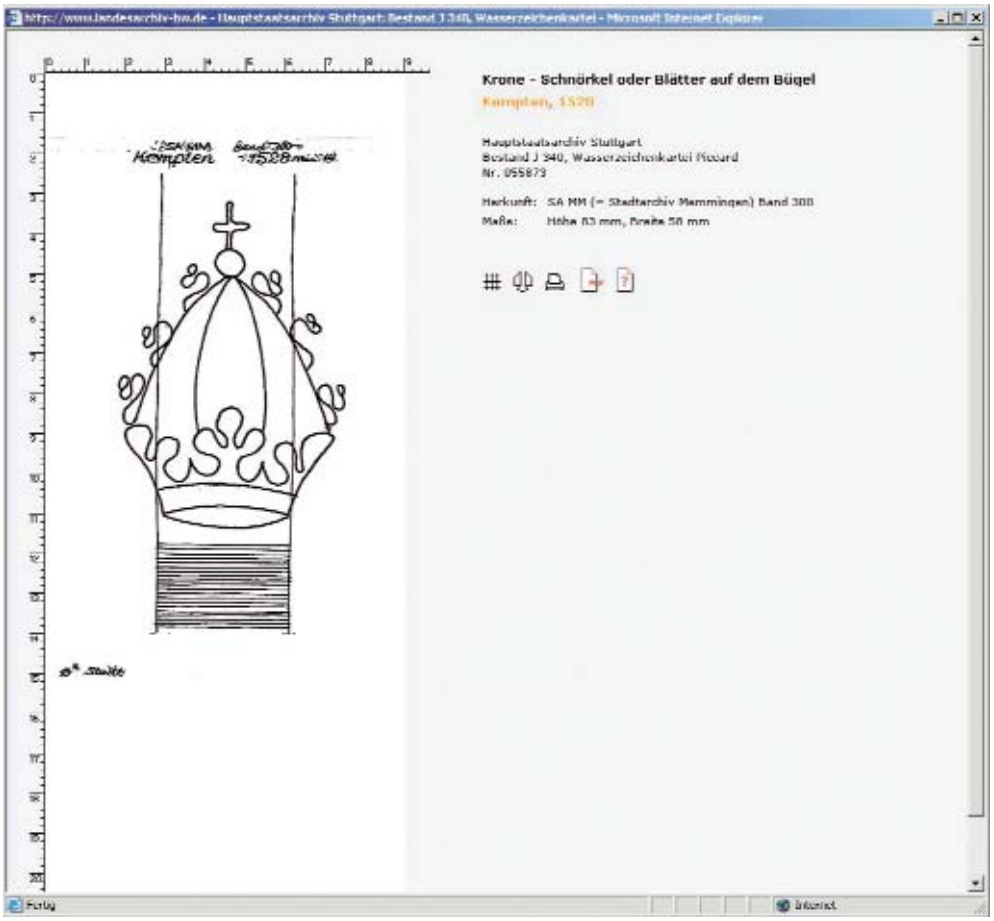
Piccard-Online

Piccard-Online (available at www.piccard-online.de) contains, adapted for the internet, the entire Piccard Index of the Hauptstaatsarchiv Stuttgart (Bestand J 340). In addition to the watermarks found in the seventeen registers of watermark types that were published by Piccard, his watermark index also includes watermarks that were not published. The digitalization project began by ordering, classifying, and digitalizing these unpublished examples. It was possible to form eighteen new groups in addition to those of Piccard's original classification. A second project, sponsored by the German Research Foundation (DFG), digitized most of the remaining samples in the watermark index and integrated them into the newly established structure. Piccard was very systematic throughout his many years of work: Each watermark is drawn on a standardized index card, and their position with respect to the laid lines has been portrayed. Each card also includes basic related data, such as the sample's provenance (i.e. its location and signature), the date and provenance of the manuscript (i.e. a date or place mentioned in the manuscript itself), in some cases the scribe or author of the text, as well as other comments. This data has been entered into an MS-Access database, which is now available for online research.

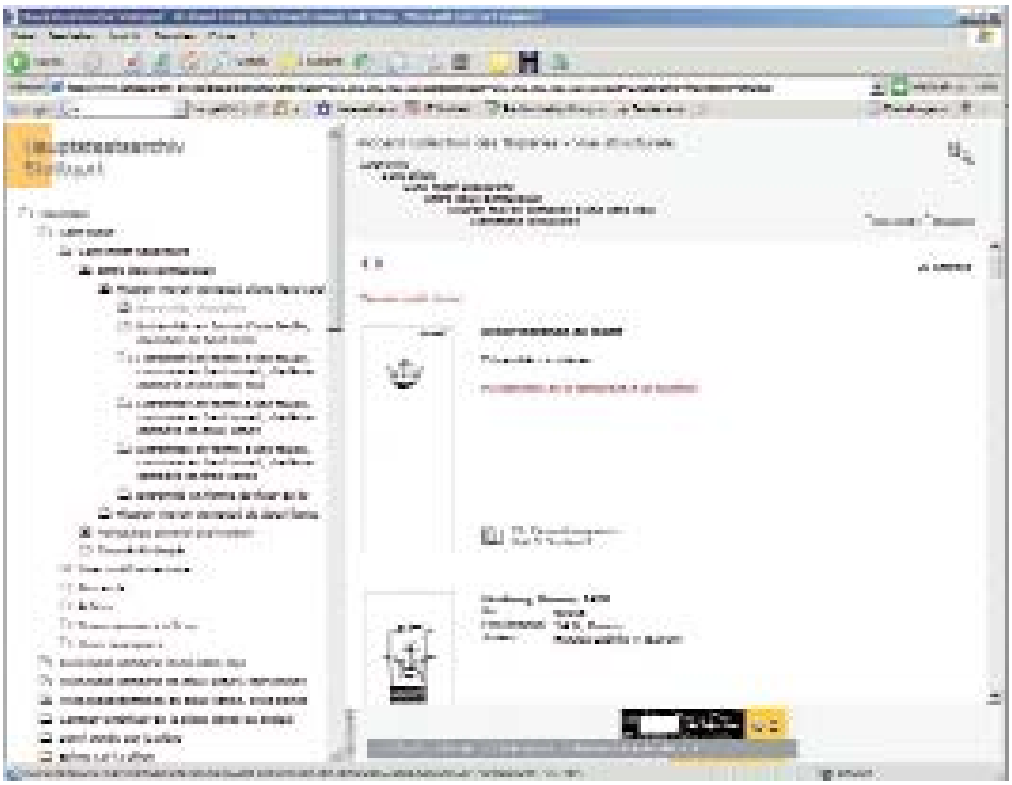
Piccard-Online is primarily based, however, on a visual presentation of the watermarks, just as conceived by Piccard in his publications. His registers make it possible to do research on watermarks with almost no knowledge of technical vocabulary or heraldry terminology. Each register be-



Ill. 1: Piccard-Online: Menu structure



Ill. 2: Piccard-Online: Print version



Ill. 3: Piccard-Online: Structural view (French)

gins with an overview of all the watermark motifs showing how the watermarks in the respective volume are ordered. This overview has been transferred into Piccard-Online as a cascading menu. As is common practice in archival listings, when beginning a search, a directory of the main motifs is provided on the left side of the screen (Ill. 1). On the right side of the screen are found thumbnails of the respective motifs. By clicking on a thumbnail, which is a proto-type of the watermarks classified within a particular group, its sub-groups then appear in the form of more finely differentiated drawings of the motifs. Parallel to these, a list of short texts describing the chosen watermark image opens on the left side of the screen, also in the form of a cascading menu. A sub-group opens with a mouse click on its name. Each group has a file icon, which has a plus sign if there are further sub-groups to be found. In this way the user can continue to navigate down the branches until finding a group of watermarks that match the example best. At the end of each group is found a list of the watermarks available in the Piccard Index. Each card can be individually opened, revealing an enlarged image that can be studied, measured, displayed as a mirror image, or printed (Ill. 2). Additional information held in the database can also be displayed, including Piccard's original remarks and further information such as the size of the watermark and the distance between the paper's chain lines. These details can be printed out with the watermark, or saved as a bookmark. A 1:1 reproduction of every watermark in the index is available in PDF format. By printing out two watermarks and laying them on top of one another, it can be determined whether they are identical.

In addition to an image-based search, it is possible in Piccard-Online to conduct a full text search, a decided advantage over the printed volumes. The full-text search is supplemented with lists of exhibition locations, exhibitors and dates. In addition, a multilingual version of Piccard-Online has recently been made available. The cascading menu, navigation bar and search mask are now in English, French and German, and searches can be conducted in all three languages (Ill. 3).

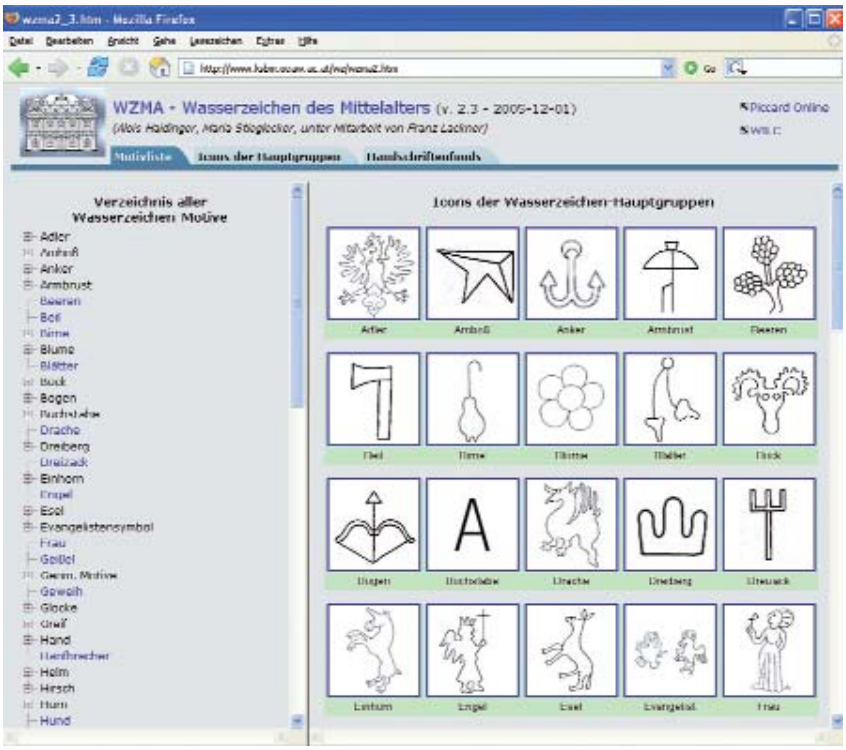
* * *

Piccard-Online – Digitale Präsentationen von Wasserzeichen und ihre Nutzung, hg. von Peter Rückert, Gerald Maier, Jeannette Godau (= Werkhefte der Staatlichen Archivverwaltung Baden-Württemberg, Serie A, Heft 19), Stuttgart 2007.

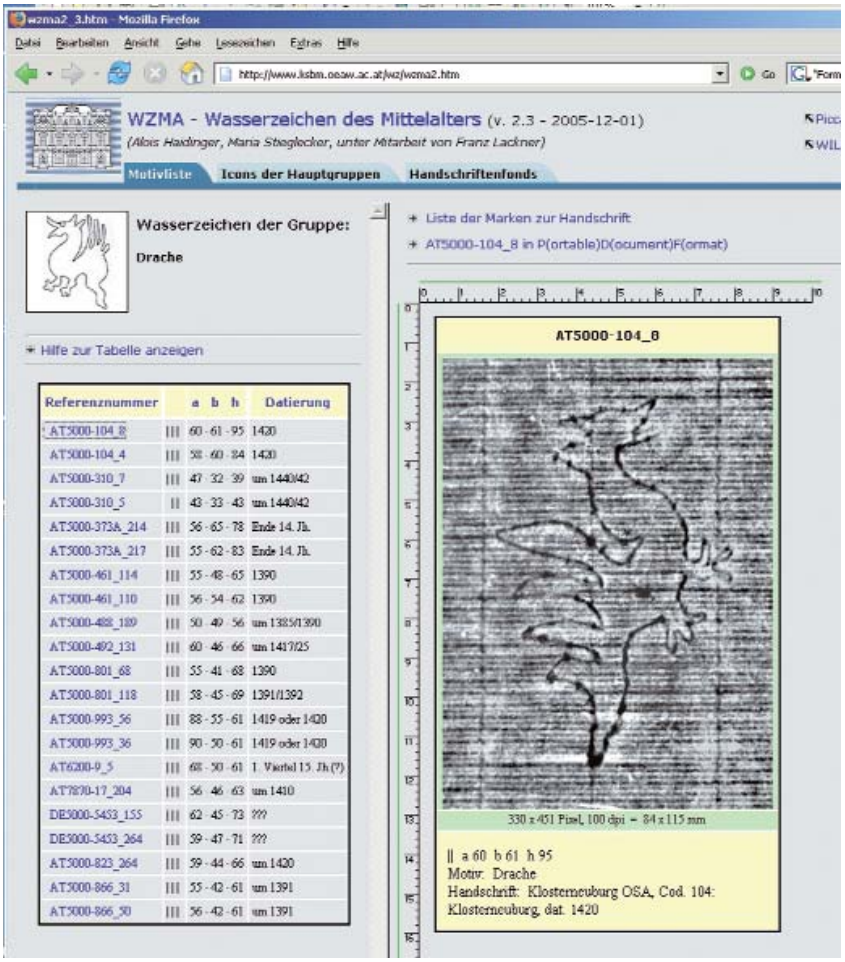
J.G. (C.P.-K.)

Watermarks of the Middle Ages ("Wasserzeichen des Mittelalters", WZMA)

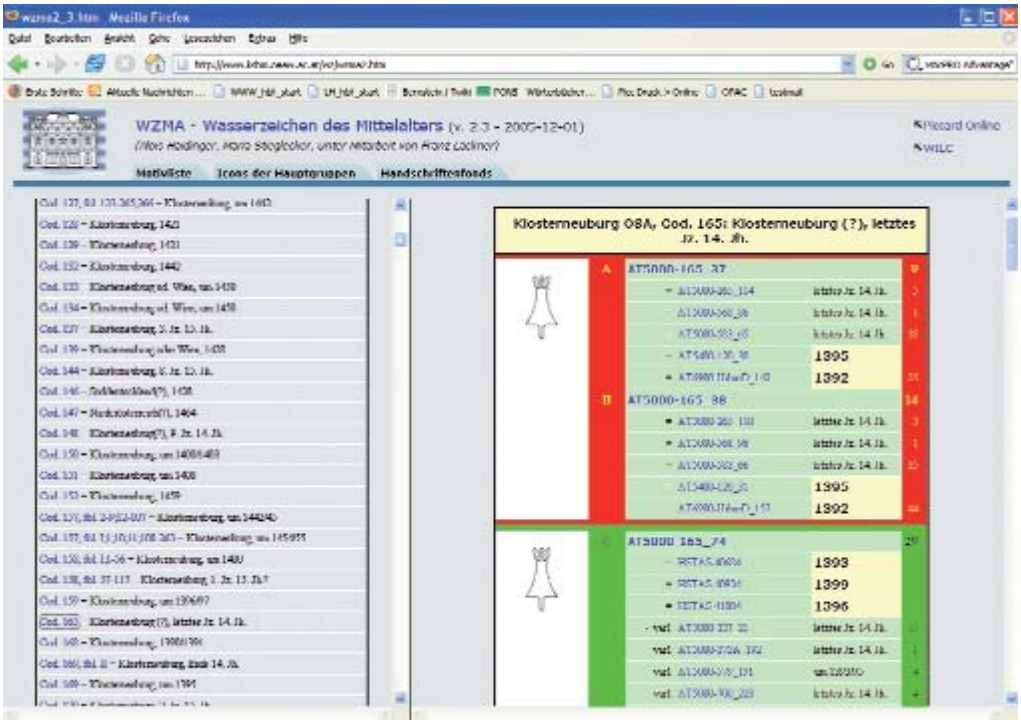
The main goal of the project "Watermarks of the Middle Ages" being conducted by the Kommission für Schrift- und Buchwesen des Mittelalters of the Austrian Academy of Sciences has been the chronological ordering of the undated paper manuscripts from the Middle Ages in Austrian libraries. This is being done by comparing their watermarks to those in dated manuscripts or in manuscripts whose dates can be restricted to a few years. This should complement related research, such as investigations concerning the development of handwriting.



Ill. 4: WZMA: Site structure



Ill. 5: WZMA: Watermark reference



Ill. 6: WZMA: Watermark list

Beta radiography photos of the watermarks in the WZMA collection as well as metadata on the marks and the concerning manuscripts have been available on the internet since 1999 (http://www.ksbm.oeaw.ac.at/wz/wzma/). This database (last visited 31 August 2008) contains images of about 9,000 watermarks from approximately 600 codices in Austrian manuscript libraries, dating from 1321 to the beginning of the 16th century. About 1,000 new images from manuscripts in the Vienna Schottenstift, the Innsbruck University Library and the Austrian National Library were added in March 2007, when the site was updated.

The WZMA database can be used like a printed collection: By choosing the name of a watermark motif in the menu list or an icon of one of the collection's watermark groups (Ill. 4), all the relevant watermarks are listed in a table; by clicking on the reference number of a particular watermark, its picture appears as well as details about the watermark and the manuscript it is found in (Ill. 5).

In addition, by clicking on a manuscript's signature, a list of its documented watermarks appears, also including identical watermarks and variants (Ill. 6). Photographs of related watermarks can be accessed by clicking on their reference number (for example AT5000–165_37, etc.) and compared to one another directly on the screen.

It is planned to incorporate, on a yearly basis, any newly documented watermarks from Austrian manuscripts from the Middle Ages into the WZMA online database. As well, in the immediate future it is planned to improve the links between the WZMA and other watermark online databases and published watermark collections. This will be undertaken by the Commission of Palaeography and Codicology of Medieval Manuscripts of the Austrian Academy of Sciences, in part within the framework of the EU project "Bernstein – The Memory of Paper".

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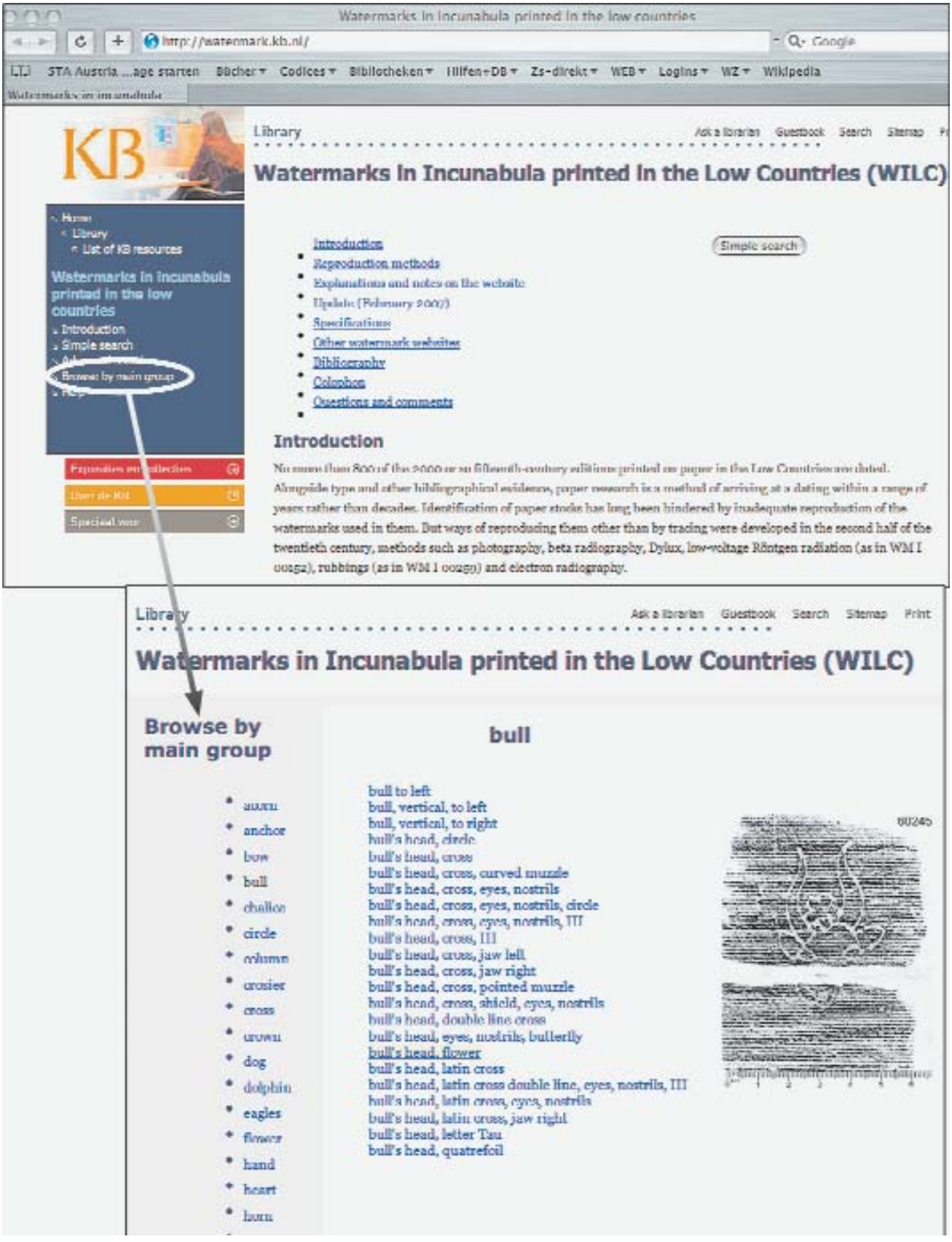
Alois Haidinger: Projekt "Wasserzeichen des Mittelalters" – Arbeitsstand und Perspektiven, in: Gazette du livre médiéval 47 (2005), p. 42–45.

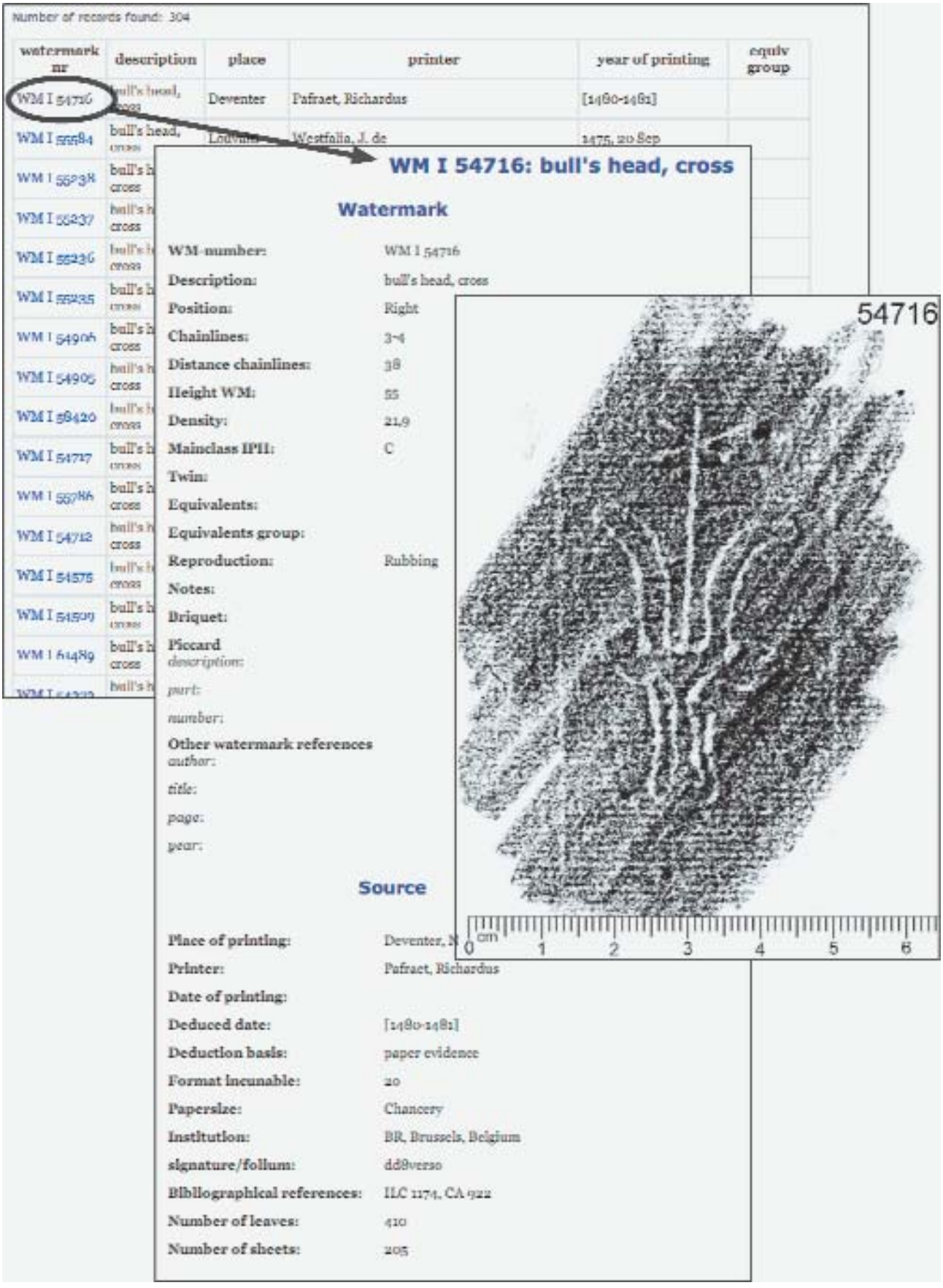
Alois Haidinger: Die Sammlung "WZMA – Wasserzeichen des Mittelalters" der Kommission für Schrift- und Buchwesen des Mittelalters, in: Piccard-Online – Digitale Präsentationen von Wasserzeichen und ihre Nutzung, hg. von Peter Rückert, Gerald Maier, Jeannette Godau (= Werkhefte der Staatlichen Archivverwaltung Baden-Württemberg, Serie A, Heft 19), Stuttgart 2007.

Alois Haidinger, Maria Stieglecker, unter Mitarbeit von Franz Lackner: WZMA – Wasserzeichen des Mittelalters. Online-Sammlung 'vorwiegend mittelalterlicher Wasserzeichen aus Handschriften österreichischer Bibliotheken, Wien 1999ff. (Last version: v. 3–2007–03-21).

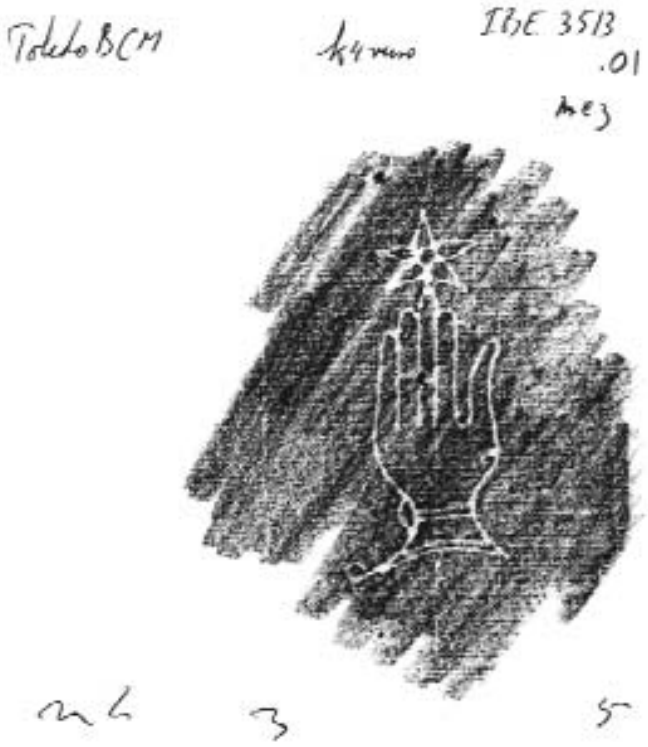
A.H. (C.P.-K.)


Watermarks in Incunabula printed in the low countries
http://watermark.kb.nl/
Google
STA Austria ...age starten
Bücher
Codices
Bibliotheken
Hilfen+DB
Zs-direkt
WEB
Logins
WZ
Wikipedia
KB
Library
Ask a librarian
Guestbook
Search
Sitemap
Watermarks in Incunabula printed in the Low Countries (WILC)
Home
Library
List of KB resources
Watermarks in incunabula printed in the low countries
Introduction
Simple search
Browse by main group
Introduction
Reproduction methods
Explanations and notes on the website
Update (February 2007)
Specifications
Other watermark websites
Bibliography
Colophon
Questions and comments
Introduction
Print
Browse by main group
bull
anchor
bow
bull
chalice
circle
column
crosier
cross
crown
dog
dolphin
eagles
flower
hand
heart
horn
bull to left
bull, vertical, to left
bull, vertical, to right
bull's head, circle
bull's head, cross
bull's head, cross, curved muzzle
bull's head, cross, eyes, nostrils
bull's head, cross, eyes, nostrils, circle
bull's head, cross, eyes, nostrils, III
bull's head, cross, III
bull's head, cross, jaw left
bull's head, cross, jaw right
bull's head, cross, pointed muzzle
bull's head, cross, shield, eyes, nostrils
bull's head, double line cross
bull's head, eyes, nostrils, butterfly
bull's head, flower
bull's head, latin cross
bull's head, latin cross double line, eyes, nostrils, III
bull's head, latin cross, eyes, nostrils
bull's head, latin cross, jaw right
bull's head, letter Tau
bull's head, quatrefoil

Ill. 7: WILC


Number of records found: 304
watermark nr
description
place
printer
year of printing
equiv group
WM I 54716
bull's head, cross
Deventer
Pafraet, Richardus
[1480-1481]
WM I 55584
bull's head, cross
Westfalia, J. de
1475, 20 Sep
WM I 55238
WM I 55237
WM I 55236
WM I 55235
WM I 54906
WM I 54905
WM I 58420
WM I 54717
WM I 55786
WM I 54712
WM I 54576
WM I 54509
WM I 64489
WM I 64313
WM I 54716: bull's head, cross
Watermark
WM-number: WM I 54716
Description: bull's head, cross
Position: Right
Chainlines: 3-4
Distance chainlines: 38
Height WM: 55
Density: 21,9
Mainclass IPH: C
Twin:
Equivalents:
Equivalents group:
Reproduction: Rubbing
Notes:
Briquet:
Piccard
description:
part:
number:
Other watermark references
author:
title:
page:
year:
Source
Place of printing: Deventer, N
Printer: Pafraet, Richardus
Date of printing:
Deduced date: [1480-1481]
Deduction basis: paper evidence
Format incunable: 20
Papersize: Chancery
Institution: BR, Brussels, Belgium
signature/follum: dd8verso
Bibliographical references: ILC 1174, CA 922
Number of leaves: 410
Number of sheets: 205
54716
cm
0
1
2
3
4
5
6

Ill. 8: WILC



Ill. 9: IBE 3513.01,
Folder 1: images of the entire A5 format sheets, with library, fol.nr, mL (mark left), mR (mark right), number of chain lines from the left or the right side of the incunable sheet.

WILC

The database "Watermarks in Incunabula in the Low Countries" (WILC) contains 16,000 watermarks (Ill. 7, 8) from almost all of the 2,000 incunabula that were printed in the Netherlands in the 15th century. The database was designed and developed by Gerard van Thienen, the former curator of incunabula at the Koninklijke Bibliotheek, the National Library of the Netherlands in The Hague. After his retirement, work on the WILC has been carried on by his successor, Marieke van Delft.

The database was developed to enable the dating of the circa 1,200 undated incunabula of the museum's collection. In addition to an analysis of an incunabulum's type and other bibliographic means, the paper of these incunabula offers possibilities of restricting the probable date a work was published to a number of years instead of a number of decades.

Until the second half of the 20th century, the identification of paper was difficult because watermark reproduction through the common method of tracing was too imprecise. Tracing has now finally been replaced by new methods such as photography, beta radiography, Dylux, low-voltage X-radiation (as in WM I 00152), rubbings (as in WM I 00259) and electron radiography. The last method particularly – a special technique using X-rays – gives very good results. Over the last fifteen years, images of the watermarks in incunabula from all over the world have been made in this manner. Although most of the 16,000 images in the WILC have been made by rubbings, images of the watermarks of the hundred dated folios owned by the Koninklijke Bibliotheek, numbering about 4,300, have been made by means of electron radiography.

The descriptions of the images include all the information that is essential for research on paper: a short, standardized description of the watermark, the position of the watermark in the sheet and the distance between the chain lines, the IPH classification and references to the most important published sources, such as Piccard and Briquet. Moreover, all identical watermarks have been brought together in groups. The description of the watermarks is primarily based on the "English Typological Index" in Briquet (1968).

The database is available on the Internet (www.kb.nl/watermark) and queries can be made freely, using a simple or advanced search. A search result provides an image combined with the watermark's description. Visual navigation is possible through the descriptions of the motifs. Metadata on the incunabulum under consideration are also included, such as author, title and printing location. A link to the Incunabula Short Title Catalogue in the British Library (http://www.bl.uk/catalogues/istc) is also provided.

M.v.D. (M.v.D. / C. P.-K.)

WIES – Watermarks in Incunabula printed in España

The WIES collection (http://www.ksbm.oeaw.ac.at/wies/) (Ill. 9, 10) contains nearly 6,000 images of rubbings of watermarks in incunabula printed in Spain. Thanks to the hospitality of the Austrian Kommission für Schrift- und Buchwesen des Mittelalters and Alois Haidinger, it has been made possible to present this sample of watermarks, selected from the 9,100 rubbings that have been made from copies of more than 900 editions of the total of 1,000 incunabula printed in 15th century Spain.

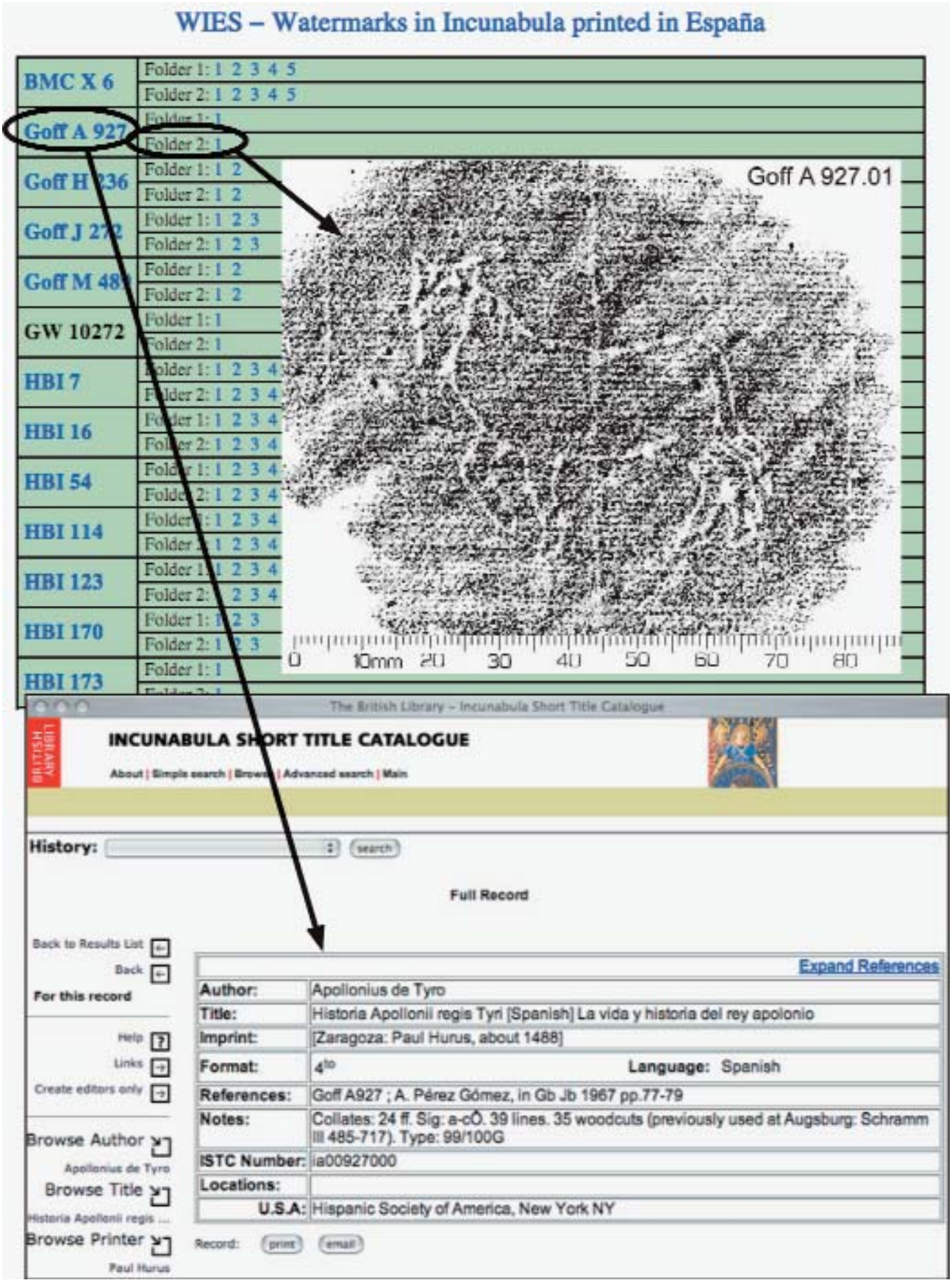
The research was started in 2000, and more than one hundred libraries have been visited, mainly in Spain but also in the USA (New York Hispanic Society and others), Portugal, Belgium, and the Netherlands, as well as in London, Munich, Paris, St. Petersburg, Vienna, and elsewhere.

In this provisional presentation – put online in January 2007 with 2,800 records – the images are arranged not by watermark motif but by bibliographical number, mostly the IBE (Catálogo general de incunables en Bibliotecas Españolas) or the HBI (Haebler, Bibliografia Iberica) numbers, or a few other bibliographical reference works, including BMC X and Goff.

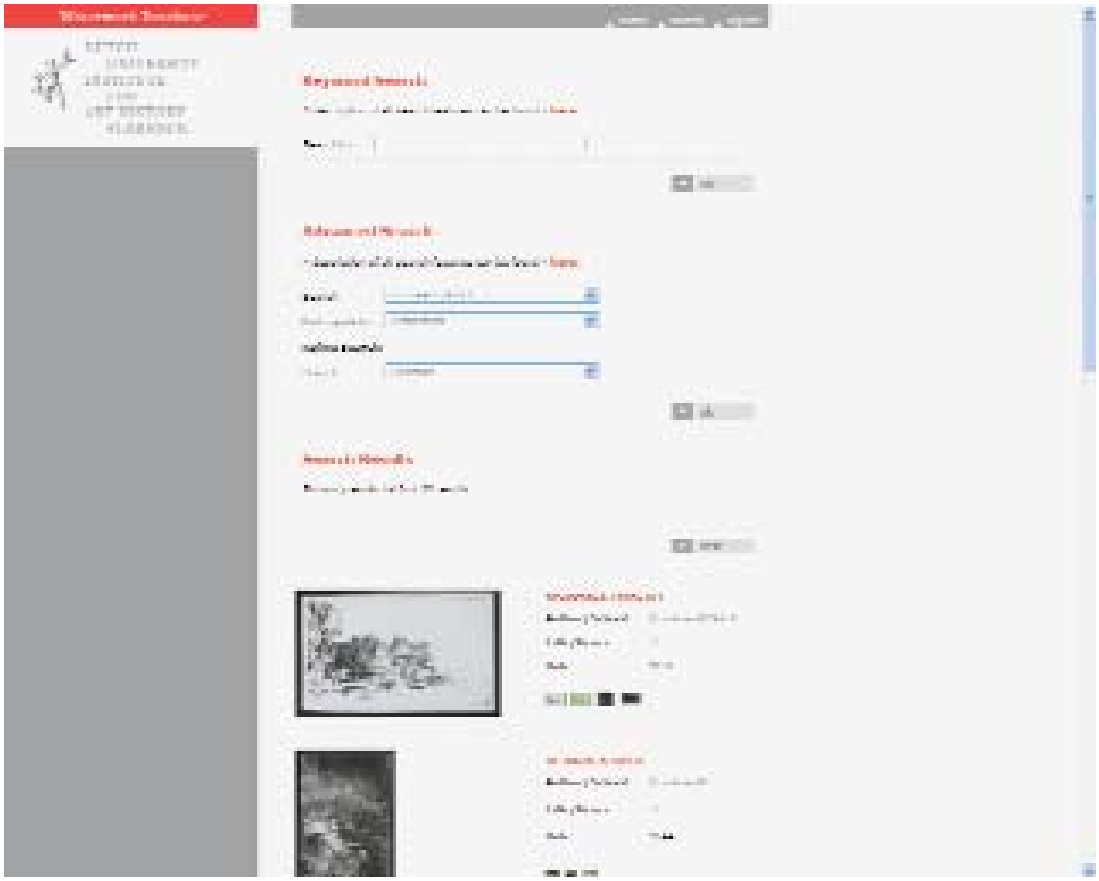
All of the watermarks found in the investigated editions have been scanned.

Author, title, imprint and other short-title data can be found in the printed reference books (HBI, IBE, etc.) but also in the international database of incunabula of the British Library: http://www.bl.uk/catalogues/istc

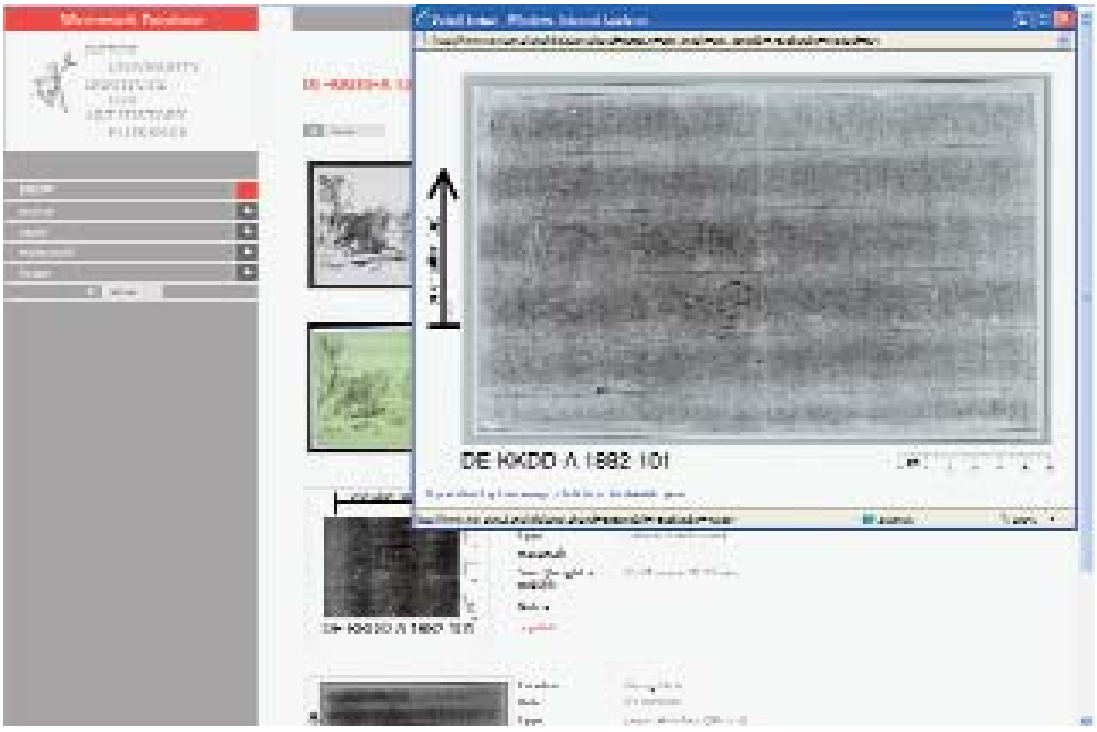
In September 2008, the Council of the Bibliographical Society, London, approved support for the completion of a database of watermarks in Spanish incunabula: WIES. A first step has been 3,100 scans being made at Multiscan, a firm based in the Dutch village of Urk, which will be added to the 2,800 already presented in 2007.


WIES – Watermarks in Incunabula printed in España
BMC X 6
Folder 1: 1 2 3 4 5
Folder 2: 1 2 3 4 5
Goff A 927
Folder 2: 1
Goff H 236
Goff J 272
Goff M 48
GW 10272
HBI 7
HBI 16
HBI 54
HBI 114
HBI 123
HBI 170
HBI 173
Goff A 927.01
0 10mm 20 30 40 50 60 70 80
The British Library – Incunabula Short Title Catalogue
INCUNABULA SHORT TITLE CATALOGUE
About | Simple search | Advanced search | Main
History:
search
Full Record
Back to Results List
Back
For this record
Help
Links
Create editors only
Browse Author
Apollonius de Tyro
Browse Title
Historia Apollonii regis ...
Browse Printer
Paul Hurus
Expand References
Author: Apollonius de Tyro
Title: Historia Apollonii regis Tyri [Spanish] La vida y historia del rey apolonio
Imprint: [Zaragoza: Paul Hurus, about 1488]
Format: 4to
Language: Spanish
References: Goff A927 ; A. Pérez Gómez, in Gb Jb 1967 pp.77-79
Notes: Collates: 24 ff. Sig: a-cO. 39 lines. 35 woodcuts (previously used at Augsburg: Schramm III 485-717). Type: 99/100G
ISTC Number: ia00927000
Locations:
U.S.A.: Hispanic Society of America, New York NY
Record:
print
email

Ill. 10: WIES



Ill. 11: Screenshot of the search mask and search results of the NIKI database



Ill. 12: Display of search results with an open detail image from the NIKI database

The Koninklijke Bibliotheek, The Hague, the National Library of the Netherlands, will make the software from the WILC available and provide facilities for keyboarding into the database.

WIES is part of the European Union-funded project Bernstein – The Memory of Paper: http://www.bernstein.oeaw.ac.at

Literature: Gerard van Thienen, Astrid Enderman, Maria Dolores Diaz-Miranda Macías: El papel y las filigranas de los incunables impresos en España, a través de los diversos ejemplaros conservados en las bibliotecas del mundo, in: Syntagma, Revista del Instituto de Historia del Libro y de la Lectura, 2, 2008, pp. 239–261.

G.v.T. (G.v.T. / C.P.-K.)

Database of Watermarks and Paper Used for Prints and Drawings Developed by the Dutch University Institute for Art History in Florence (NIKI)

In September 2001, the Dutch University Institute for Art History in Florence (NIKI) launched an initiative to develop a database for storing and publishing the watermarks and paper structures of paper used by artists for prints and drawings in the period 1450–1800. Thanks to the data now included and the planned addition of new data in the years to come, the database is becoming a unique tool for the art historical and scientific analysis of prints and drawings. It will offer a centralized collection of large numbers of watermarks, will give detailed information on the different kinds of paper used by individual artists, and will make important data available for dating and authenticating these works of art. Watermark data from museums and collections around the world will be stored in the database and made available for public use. The database will be particularly useful for art historians, art collectors, art dealers and all others interested in this kind of material.

The NIKI has photographed, X-rayed and collected in its database watermark images and data that have been generated in the framework of a number of research and exhibition projects on artists of the Italian Renaissance, including Fra Bartolommeo (1472–1518) and Michelangelo (1475–1564). Thanks to the generous cooperation of art historians and print collections in Europe and the United States, the NIKI database project has also been able to include watermarks of a number of other artists, such as Lucas van Leyden (1494–1533) and Rembrandt (1609–1669). Currently, nearly 2,400 X-ray images of watermarks found in the paper of Rembrandt's etchings have been incorporated into the database.

Moreover, the NIKI is participating in a number of research projects in which watermarks play an important role. Together with the University of Leiden and the Dresdner Kupferstich-Kabinett, it is undertaking a study of the paper and watermarks of the early Dutch and Flemish drawings from between 1450 and 1600 owned by these two institutions. In the near future, the watermarks of the Dürer prints held by the Hessisches Landesmuseum Darmstadt will be retrieved and also included in the database.

Earlier research has shown that much of the paper that was used for early prints and drawings does not have a watermark at all, or contains watermarks that are only partially visible. This makes it necessary to retrieve not only watermarks, but as far as possible also to record the entire paper structure of each sheet.

The NIKI database is interlinked with those of the other partners in the Bernstein project through the same classification of watermark types and motifs, as well as by other paper parameters such as chain line distance, watermark measurements, etc.

As the artistic and geographic focus of the NIKI watermark database is not only Germany, Italy and the Netherlands, but extends to the whole art-on-paper production in Europe in the period between 1450 and 1800, new project partners willing to cooperate with retrieving, furnishing and/or adding new paper and watermark data to the database are welcomed.

NIKI retrieves watermarks and paper structure with a soft X-ray device and with image subtraction technology. As both are mobile, it is able to offer its services to retrieve watermark and paper images in museums or any other public or private owner of prints or drawings. The retrieved images will be included in the database and the owner of the work will receive a set of images in digital form.

G.D. / B.W.M (B.W.M. / C.P.-K.)

Corpus Chartarum Italicarum (CCI)

Research has been carried out at the *Istituto centrale per il restauro e la conservazione del patrimonio archivistico e librario* on the approximately 5,000 watermarked sheets that compose the Corpus Chartarum Italicarum with the goal of identifying dimensional and typological characteristics, and of measuring useful parameters that might provide useful information on the quality of sheets and the methods used to manufacture them. The research project – launched in 2006 – was divided into three distinct phases:

The first activity involved the thorough dusting of all sheets composing the Corpus, which were generally found to be in a good state of preservation. Dust removal was effected using a professional-grade vacuum cleaner suitable for performing conservation work. Next, the sheets were removed from their old folders and these were replaced with folders made from an archival quality material (lining card made from pure cellulose fibre of neutral pH). All data, both printed and handwritten, were transferred from the old folders to the new ones.

In the second phase, instrumental readings were taken relating to thickness, permeability, surface texture (i.e. roughness/smoothness), and whiteness levels.

The third and final phase of the project consisted in the digital reproduction of sheets, in both raking light and in transparency. Watermark motifs were identified, their subject matters were defined, and they were traced in repertories. An online database has been created and is accessible via the ICPAL's website (which can be visited at: http://www.patologialibro.beniculturali.it). The data bank contains images of all the watermarks, together with historical data and the aforementioned instrumental data.

The sheets are now stored in new containers that were custom-made to house the Corpus; the containers are made from archival materials suitable for the long-term conservation of paper-supported cultural heritage.

P.F.M. / V.N. (M.L.)

Bernstein – The Memory of Paper

The "Bernstein – the memory of paper" Project is being sponsored by the European Union within the framework of the *e*Content*plus* programme. The name of the project derives from a metaphor: Just as amber that encloses an insect is valuable, historical paper contains watermarks that are a special sign and mark of quality. If one holds either amber or paper containing a watermark up to the light, its treasure is divulged to the viewer.

The project, which began in September 2006, is planned to run for thirty months. The goal is to create an integrated European internet site containing information about historical paper. Of key interest are the watermark databases that are already available online (Piccard-Online: http://www.piccard-online.de; the Viennese "Watermarks of the Middle Ages": http://www.oeaw.ac.at/ksbm/wz/wzma2.htm; the collection of "Watermarks in Incunabula printed in the Low Countries": http://watermark.kb.nl; NIKI's "International Database of Watermarks and Paper Used for Prints and Drawings (ca. 1450–1800)": http://www.iuoart.org/wmdb.-htm). It is planned to create a multi-lingual watermark portal that will enable research with coordinated and standardized terminology. The goal is also to offer links to research tools and digital sources for research on paper.

The basic idea of the Bernstein Project is, above all, the creation of a technical infrastructure that will allow the greatest number of users access to information on paper and watermarks. The main groups of users will be historians, art historians, researchers of manuscripts and incunabula, conservationists, the art market, and last but not least, the paper industry. Taking part in the project are some of Europe's most eminent figures in the field of watermark collecting and digitalization, who are working together with specialists in historical paper – a joint effort between the humanities and information sciences.

Bernstein project partners:

- *Austrian Academy of Sciences*, Vienna: Project management, digital image processing tools, database systems (WZMA), research on manuscripts.
- *Landesarchiv Baden-Württemberg*, Stuttgart: Database systems (Piccard-Online), watermark nomenclature and watermark classification.
- *Laboratoire de Médiévistique Occidentale de Paris*: Quantitative history of paper, prints of the Renaissance.
- *Deutsche Nationalbibliothek*, Leipzig: International bibliography of paper history.
- *Dutch University Institute for Art History*, Florence: Paper in art history (NIKI).
- *Delft University of Technology*, Delft: Intelligent digital image processing.
- *Koninklijke Bibliotheek*, The Hague: Database systems (WILC), incunabula printed in the Netherlands.
- *Institute for Information Systems and Computer Media, University of Technology*, Graz: Integration of software (implementation), user interface, knowledge management systems, digital libraries.
- *University of Liverpool*: Distributed search functions, disambiguation of names, cross-domain resource discovery, text mining.

http://www.bernstein.oeaw.ac.at/
http://www.thememoryofpaper.eu

C.K. (C.-P.-K.)

BERNSTEIN THE MEMORY OF PAPER

VII Bernstein

The Bernstein Project

The importance of watermarks for the identification and dating of paper has been known for more than two hundred years and is now accepted without hesitation. This kind of dating is accomplished by comparing undated watermarks with those that are dated. Since it is comparatively simple, many individual researchers have collected dated watermarks and printed them in catalogues. Thus, in the two hundred-year history of collecting watermarks, an appreciable number of catalogues of varying provenance and quality have been published. For the most part, the time period that has been focussed on is the Middle Ages. For traditional medieval sources in paper form, palaeographic or art historical methods often fail to determine accurately the period they were written or to categorize them. In such cases, a comparison of watermarks allows more accurate dating. The most important collectors and collections are presented in Chapter V, 'Watermark Imaging Technologies, Watermark Collectors and their Collections'.

The catalogues generally contain true to scale tracings of the outlines of the watermarks, and also include other information such as date, place of use, etc. Many of the catalogues are arranged according to motifs. Searching for a particular watermark in a catalogue is often very laborious, because some motifs occur in countless variations. If the search ends with a negative result, one can never be sure whether a watermark has not been overlooked. Another disadvantage is that most of these catalogues contain only drawings, which by their very nature are subjective and often not exact.

New perspectives for watermark research opened due to two developments. In the 1950s, the Russian scientist Dmitry P. Erastov showed for the first time that good images of watermarks and mould structure can be made using beta radiography. The method has the additional advantage that any writing masking a watermark and making it difficult to recognize disappears to a large extent in such images (see Erastov 1958). Using radiography methods, it became possible for the first time to create not only exact copies of watermarks but also make images of the structure of the paper mould (chain lines and laid lines). The results of the radiographic procedures are grey-scale images similar to medical X-rays as we all know them. A second push came through the development of computer technologies, especially those of databases and the internet. It was obvious that with the growing volume of data on watermarks, watermark databases should be created to hold them, and that the processing speed of computers could be used to search for and compare them. Such databases have now been established, in which the watermark images (e.g. rubbings, beta or electron radiographies) are scanned, saved, and stored. If necessary the images can be improved for viewing (for example, by contrast enhancement), and then enlarged with measurements. It is possible to ascertain the width and height of the watermarks, their position and spacing between the chain lines, as well as the number of laid lines per predetermined width. The data can be further enriched with additional metadata.

The next step has been to make the available online databases accessible on the internet to ensure the widest possible use of the data. The largest online databases at present are Piccard-Online, WILC and WZMA, which are presented in Chapter VI.

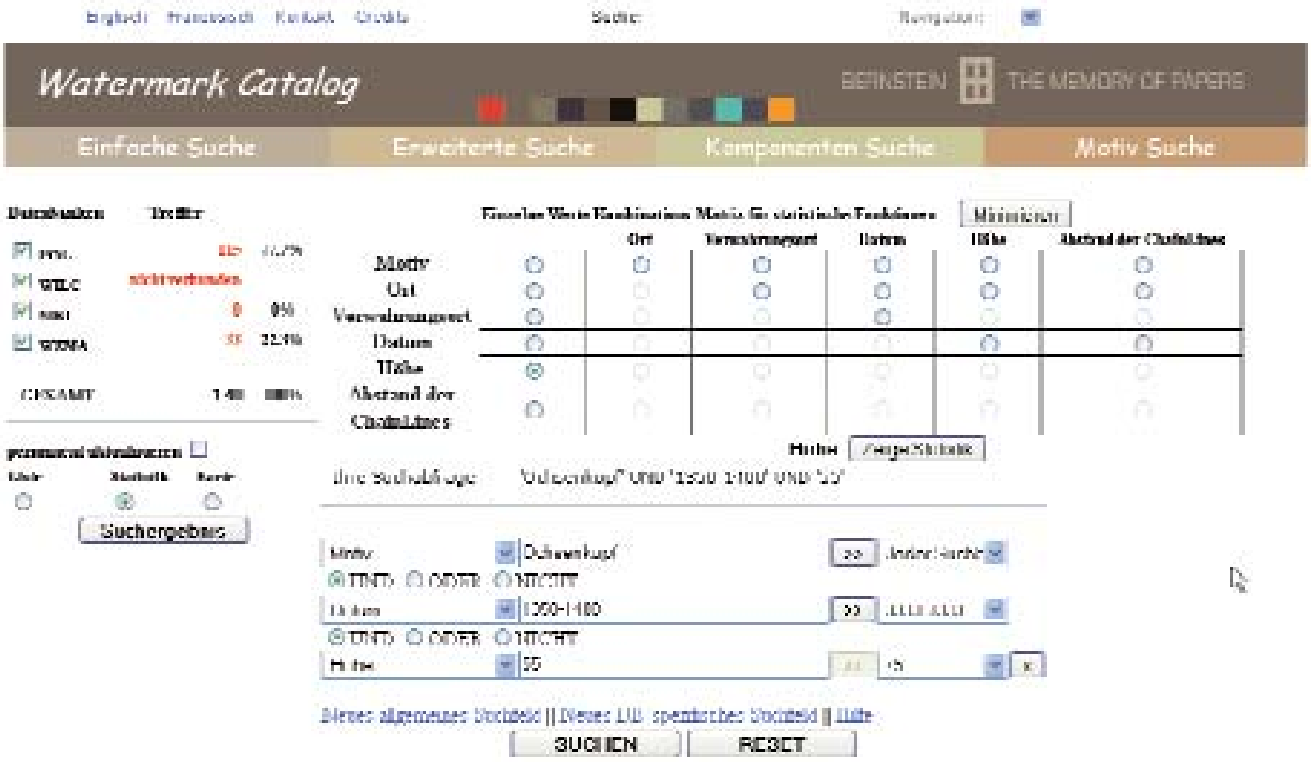
Databases are more powerful and more useful the more data they contain. A centrally managed and accessible data pool containing all the data from the separate databases can be generated by using an interconnected network. The aim of the Bernstein Project has been the creation of such a portal, which initially links the four watermark databases Piccard-Online, WILC, NIKI, and WZMA.

Bernstein is supported by the European Union, fifty percent of its financing coming from the *e*Content*plus* program. *e*Content*plus* is a five-year EU program that has aimed at making data distributed online more easily accessible for users. In 2005 the Bernstein Project was granted funding for a period of thirty months. The project was launched in September 2006 and is scheduled to end in February 2009.

The name Bernstein is not an acronym, but a metaphor referring to amber, fossilized resin, which contains (as does paper!) information from the moment of its creation. For amber this might be insects, while in paper it is the traces of the tools (the mould and its watermark figures) and the raw material used in its production.

As already mentioned, a common means of accessing databases is via a portal, which means a unified webpage must be created. The Bernstein portal (www.memoryofpaper.eu) is an integrated workspace that allows access to watermark data, associated reference data (bibliographies, incunabula catalogues), as well as to advanced analysis and expertise modules (e.g. statistics, GIS, image processing programs, surveying tools).

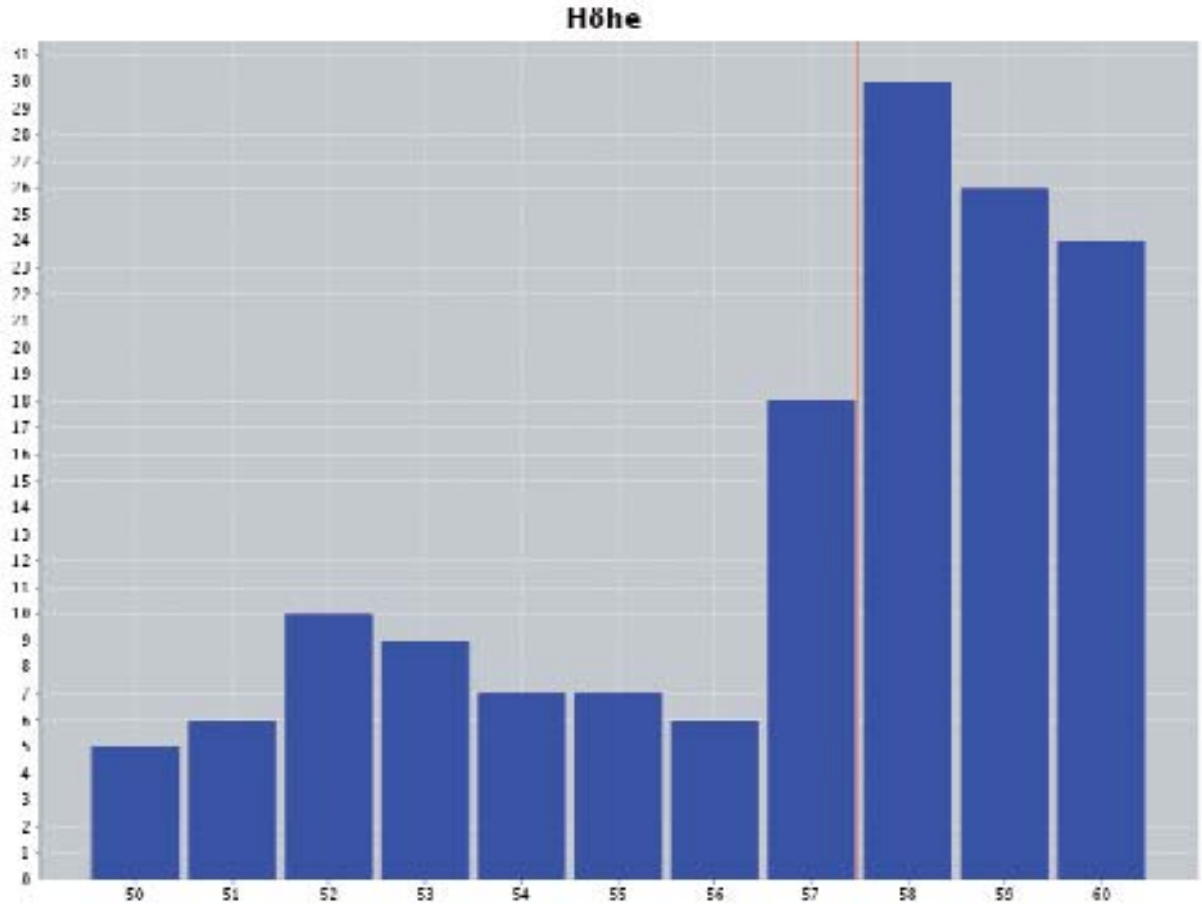
Ill. 1: Screenshot of the input window for a query in the bibliographical database



Ill. 2: Input window for statistics

The original databases are remaining where they are and are not being copied. On one hand, copyright questions thus pose no problems, and, on the other, the data available through the portal is always up to date. The access to the technically diverse databases is being realized via a SRU gateway. Common access requires the greatest possible unification of the various databases in terms of structure and terminology. For example, single motifs carrying different names – such as "Ox Head" and "Bull's Head" – have had to be unified. In addition, the Bernstein Project has drawn up a mandatory word list (Watermark terms – Vocabulary for watermark description; see www.bernstein.oeaw.ac.at/twiki) that is in six languages: German, English, French, Italian, Russian, and Spanish, these being the languages used in the various lines of watermark research that have developed over the years.

Networking alone is not enough for an *e*Content*plus* project. The Bernstein Project therefore offers a real work-



Ill. 3: Bar chart containing the absolute frequencies of watermarks' height. The red line marks the mean.

ing platform that allows not only access to the watermark databases, but also contains a variety of additional information and tools for paper research.

The German Book and Scripts Museum of the German National Library (DNB) in Leipzig has long recorded, documented, and collected publications in various languages about paper. The resulting bibliography is by far one of the largest on this topic. Although its bibliographic database was originally conceived as multinational, both its classifications and subject headings, as well as all geographical terms are only in German. A new database scheme was therefore needed for Bernstein in order to provide multilingual access. In cooperation with the DNB Leipzig, the integration of the bibliographic database into the Bernstein Workspace is now using the Cheshire3 search engine from the University of Liverpool. Cheshire3 is a fast XML search engine that has been jointly developed by the Universities of Berkeley and Liverpool (see www.cheshire3.org) (Ill. 1).

It should also be noted, as a further example for Bernstein's networking with contextual data, that a cross-linking has been created between the Incunabula Short Title Catalogue (ISTC) and the incunabula database in Bernstein (WILC).

Statistical graphs are an important tool for transmitting and gaining insight into large amounts of data. With more than 120,000 records and an expected annual growth of ten percent, the Bernstein platform provides extensive opportunities for statistical analysis. For any data selection, basic statistical parameters, such as mean and standard deviation, can be calculated and also numerically and graphically displayed. In the individual databases this is not possible.

A frequency chart can be created for each search item. Furthermore, two parameters can be correlated and their mutual dependence illustrated as a chart (Ill. 2).

Export functions for the statistical data and the possibility to use the individual diagrams by means of copy and paste complete the statistical features (Ill. 3).

Geographical indications such as 'place of use' or 'depository' are contained in the metadata of the individual records. The geographical positions can be marked on maps and thus visualized. Bernstein offers a GIS module with extensive functionality for the visualization of geographical data. Geographical maps can be created for any given selection of data records (Ill. 4).

The current link between four databases in Bernstein only makes sense if other databases participate in the project in the future. The WIES (Watermarks in Incunabula printed in España) database will be the fifth to be integrated into Bernstein during its implementation period. A major concern is to ensure the further growth of the integrated data so that Bernstein can become strongly established and develop into the main source for information on paper and watermarks. In order to facilitate the creation of new wa-

Ill. 4: The 4,475 sites appearing in the Bernstein databases where paper was produced, written on or used in other ways between the 14th and 19th century.

termark databases, a so-called Bernstein 'dissemination kit' is being offered. It allows the easy installation of a preconfigured database, augmented with programs for image enhancement and measurement. This enables holders of watermark data to create their own, Bernstein compatible watermark databases. The 'dissemination kit' is free, multilingual and user-friendly.

New watermark databases have been created and some of them also made available online since the application for the Bernstein project in 2005. A list of such collections can be found in Bernstein's document management system (http://www.bernstein.oeaw.ac.at/twiki/bin/view/Main/PaperDatabases).

The aim of a follow-up project to Bernstein is, of course, the inclusion of additional datasets, but also the digitalization of the most important printed watermark catalogues, which still remain important sources of reference material.

Bernstein is a partner in the project 'Europeana – The European digital library, museum and archive'. Europeana's goal is to create a portal website that offers direct access to millions of digital objects (film footage, photographs, paintings, music, maps, newspapers, manuscripts, etc.) (see http://europeana.eu).

Literature: Erastov, The Beta-radiographic Technique.

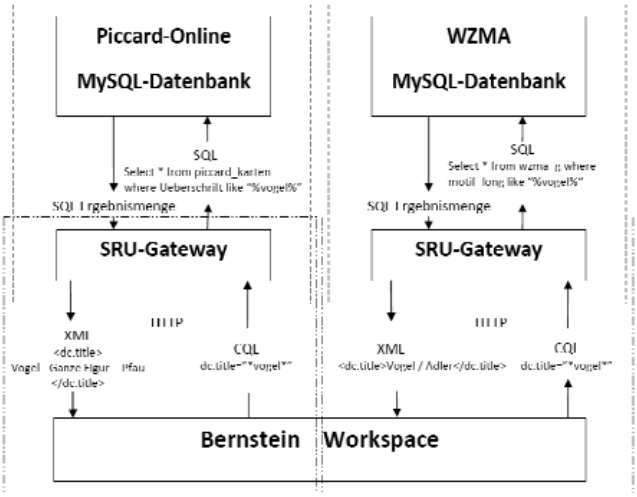
M.S. / E.W. (M.S. / E.W. / L.D. / C.P.-K.)

Bernstein Technology

The objective of the Bernstein Project is to create an integrated European digital environment for the history of paper.

The following four watermarks databases were already available online via the internet before the start of the project: Piccard-Online, WILC, WZMA and NIKI.

In order to create an integrated system (the Bernstein portal), these existing watermarks databases have been connected by means of a common and uniform workspace to allow a synchronous search within all four databases.



Ill. 5: Bernstein database architecture

Architecture

After detailed discussions with the different partners in the project, it was decided that a new large database with copies of the existing databases should not be created, but searches should take place directly in the original databases.

For this approach various protocols were investigated, and with "Search/Retrieval via URL" (SRU) an appropriate solution was found. To realise this protocol, a SRU-gateway was implemented that could be easily configured for each database. It was specified that MySQL- und Microsoft Access-databases should be supported by this SRU-gateway (Ill. 5).

As shown in the figure above, the SRU-gateway can be installed either near the original database (dashed line) or directly on the Bernstein server (dashed dotted line).

SRU/SRW Protocol

SRU (Search/Retrieval via URL) und SRW (Search/Retrieve Web Service) are standard search protocols for Internet search queries. They were developed and published by the United States Library of Congress (see http://www.loc.gov/standards/sru/). The actual requests use CQL (Contextual Query Language), a standard syntax for representing queries and the results are returned in XML (eXtensible Markup Language).

Since August 2007, SRU version 1.2 has become the current standard version; it no longer distinguishes between the SRU and SRW protocols, but includes both.

The search queries are sent via HTTP (HyperText Transfer Protocol) using simple GET or POST requests, or enveloped in XML using SOAP (originally for Simple Object Access Protocol).

The following operations are specified in the SRU protocol:

- explain: provides a description of the facilities available on the SRU server
- scan: enables the range of available terms at any given point to be listed in ascending order
- searchRetrieve: allows a search to be submitted and a request to retrieve matching records in a specific sort order

CQL allows a search with logical operators (AND, OR, NOT) and numerical relations (=,?, <, >, =, =), as well as an exact search and a search for substrings. Furthermore, the sort order of the results can be specified in advance.

The response to a search request is returned in XML. As default schema, "Dublin Core" with fifteen elements is used. A response can either consist only of the number of hits, or can include an explicit number of matching records starting with a specific one.

SRU Gateway

The SRU-gateway was developed as a servlet in Java and is therefore independent from the platform. All the functions of the SRU version 1.2 that are necessary for searches in watermarks databases have been implemented. The technical requirements are a Java runtime environment (JRE = 1.6_3), a servlet container (Apache Tomcat = 5.5.23) and read access to the respective MySQL- or Microsoft Access-database.

The individual databases are configured by the use of an XML file ("config.xml") that includes the data for the database access and the mapping of all database fields. The following example shows an extract of the configuration file for the WZMA database:

```
<mapping>
  <dc.title lang="ge">bernstein_wzma_g.motif_long</dc.title>
  <dcx.refnr>bernstein_wzma_m.refnr_wm</dcx.refnr>
  <dcx.distance>bernstein_wzma_m.parA</dcx.distance>
  <dcx.height>bernstein_wzma_m.parH</dcx.height>
  <dcx.width>bernstein_wzma_m.parW</dcx.width>
  <dcx.originplace>bernstein_wzma_m.origin</dcx.originplace>
  <dc.date>bernstein_wzma_m.date_begin</dc.date>
  <dc.date>bernstein_wzma_m.date_end</dc.date>
  <dcx.location>bernstein_wzma_m.source</dcx.location>
  <imgpath>bernstein_wzma_m.path_wm</imgpath>
  <id>bernstein_wzma_m.id</id>
</mapping>
  <thumbnails>http://www.ksbm.oeaw.ac.at/imgjpg/%img
  path%%dcx.refnr%.jpg</thumbnails>
  <urls>http://www.ksbm.oeaw.ac.at/_scripts/php/loadW-
  markImg.php?id=%id%</urls>
```

In the case of a "searchRetrieve" request, the transmitted fieldnames are first mapped onto the fieldnames of the specific database according to the configuration file, and the CQL is transformed into SQL. Then the individual items of the result set are transformed into XML with regard to the mapping (and according to the SRU protocol) and returned.

In the following example we assume that an advanced search for the motif "vogel krone" was executed via the Bernstein portal, which results in 107 hits in the Piccard-Online database:

At first the number of hits is retrieved via an according search request to the Piccard-Online SRU-gateway:

```
http://bernstein.iicm.tugraz.at:8080/GateWayPOL/sru?operation=se
   archRetrieve&
version=1.2&query=(dc.title="*vogel*" AND dc.title="*krone*")&
startRecord=1&maximumRecords=0&extraRequestData=ge
```

As a response, the following XML file with the number of hits is returned:

```
<searchRetrieveResponse xmlns="http://www.loc.gov/zing/srw/">
<version>1.2</version>
<numberOfRecords>107</numberOfRecords>
</searchRetrieveResponse>
```

After this, the first ten records according to the specified sort order are requested:

```
http://bernstein.iicm.tugraz.at:8080/GateWayPOL/sru?operation=se
   archRetrieve&
version=1.2&query=(dc.title="*vogel*" AND dc.title="*krone*")
   sortBy dc.title/sort.ascending dc.date/sort.ascending&
startRecord=1&maximumRecords=10&extraRequestData=ge
```

As a response, the following XML file with the first ten records is returned:

```
<searchRetrieveResponse xmlns="http://www.loc.gov/zing/srw/"
   xmlns:dc="http://purl.org/dc/elements/1.1/"
   xmlns:dcx="http://bernstein.iicm.tugraz.at/bernstein/elements/dc
   x.html">
<version>1.2</version>
<numberOfRecords>107</numberOfRecords>
<records>
<record>
<recordPosition>1</recordPosition>
<recordSchema>info:srw/schema/1/dc-v1.1</recordSchema>
<recordPacking>xml</recordPacking>
<recordData>
<dcx:distance>57</dcx:distance>
<dcx:originplace>Bologna</dcx:originplace>
<dc:date>1533</dc:date>
<dcx:refnr>42345</dcx:refnr>
<dcx:height>53</dcx:height>
<dc:title>Vogel – Ganze Figur – Darüber Krone</dc:title>
<dcx:location>HHStA Wien</dcx:location>
<dcx:shelfmark>PA 29</dcx:shelfmark>
<dcx:width>33</dcx:width>
<dcx:thumbnail>
http://maja.bsz-bw.de/piccard/bilder/vorschau/042345.png
</dcx:thumbnail>
<dc:identifier>
http://www.piccard-online.de/detailansicht.php?PHPSESSID=&klas-
   si=033.002.005&ordnr=42345
</dc:identifier>
</recordData>
</record>
...
<record>
<recordPosition>10</recordPosition>
...
</record>
</records>
</searchRetrieveResponse>
```

P.K. / A.P. / W.S. (C.P.-K.)

Piccard-Online and its Incorporation into the Bernstein-Workspace

Piccard-Online is one of the watermark databases that is being integrated into the Bernstein-Workspace within the framework of the EU project "Bernstein – The Memory of Paper". It is based on the Piccard watermark collection and has been available online since September 2006 (www.piccard-online.de). With its 92,000 samples it is the largest collection of its kind. The digital entries are based on the index cards that Gerhard Piccard assembled with arduous attention to detail. The watermark images have a resolution of 400 dpi (bitonal). They can be printed, at 1:1 scale with the original, in PDF format for comparisons with undated watermarks, which enables an accurate dating of manuscripts.

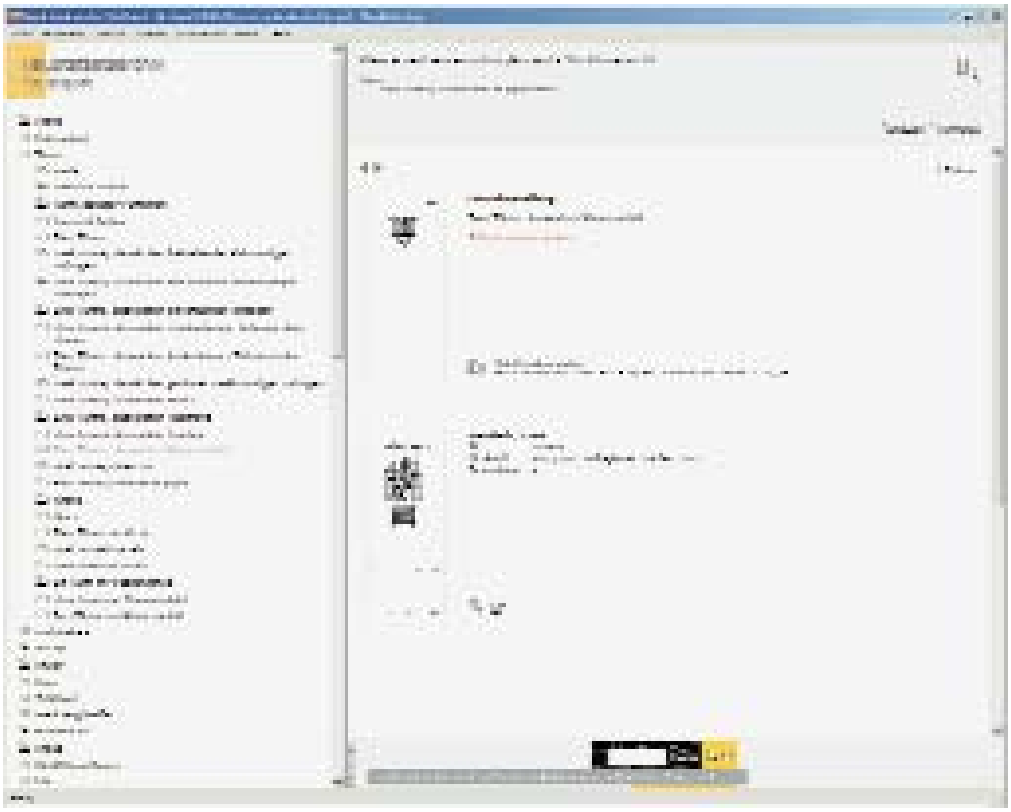
It is possible to do research in two ways in Piccard-Online – systematic visual searches are possible as well as classic keyword searches. The classification is hierarchical, with thirty-eight main groups dividing into as many as six levels of sub-groups. Both the main groups, which delineate the different major watermark motifs, and the lower levels are organized according to the motifs' various characteristic features. Thus, the main motif emphasizes the more clear-cut differences, which are then differentiated in more detail at the lower levels. The motif "Tower", for instance, has in its first sub-group a division of twenty-five further characteristics, under which there are up to four more sub-classes (see Ill. 6).

In the text search of Piccard-Online one can choose between a simple search and an advanced search. By means of the search field, the search engine is initially set to examine all fields. By clicking on one or more search fields, the search can be refined. Both truncation as well as "and" or "or" searches are possible. In addition to this, watermark images can be found by means of indices (cf. Ill. 7). The keywords are based on the descriptions of the watermarks within their classifications and are offered in three languages. The terminology is based on that used by Gerhard Piccard for his register of watermarks ("Wasserzeichenkartei"; see Bestand J 340 in the Hauptstaatsarchiv Stuttgart).

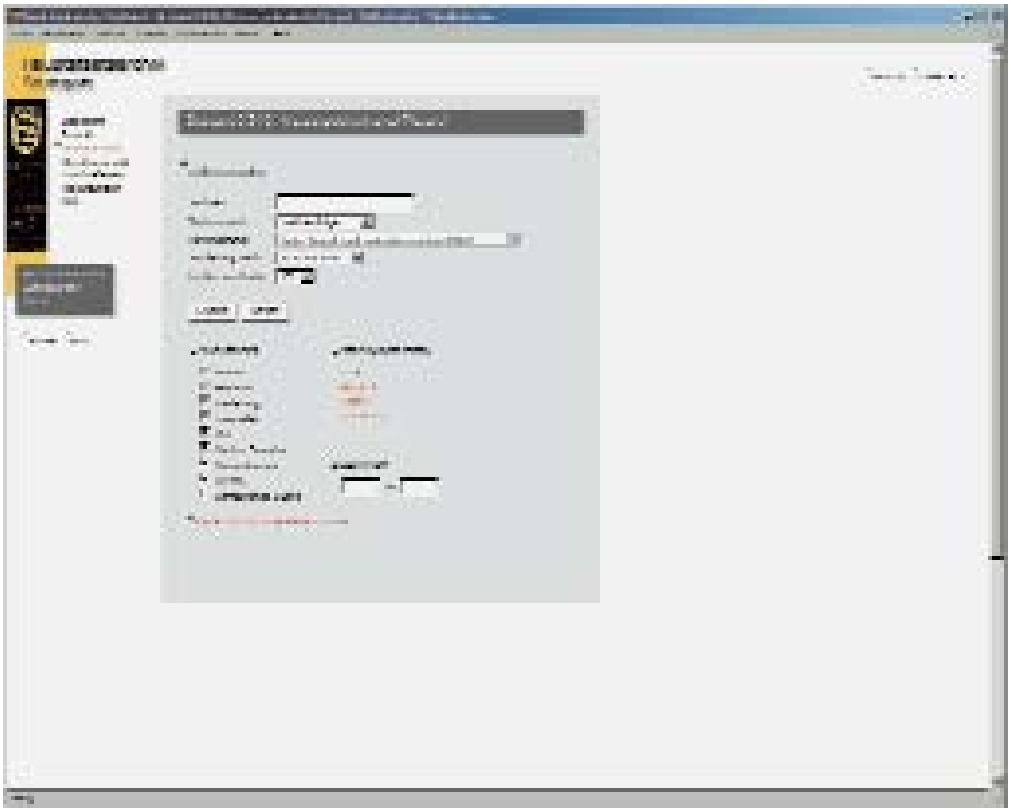
The window for the search result has been designed so that both the metadata and the thumbnails of the individual watermarks are immediately visible. The single hits can be opened in an extra window and, as already mentioned above, be printed at 1:1 scale of the original index card.

Research options in the Bernstein-Portal

As in Piccard-Online, in the Bernstein-Workspace, it is possible to conduct a keyword search as well as a systematic search. At the different search levels it is generally possible to recognize the database that has been integrated into the Bernstein-Workspace. This allows one to choose, among other things, to use a particular database. Currently these databases are: POL for "Piccard-Online" of the Landesarchiv Baden-Württemberg in Stuttgart; WILC for "Watermarks in Incunabula in the Low Countries" of the Royal Library of the Netherlands in The Haag (http://watermark.kb.nl/); WZ-



Ill. 6: Piccard Online: Structural view



Ill. 7: Piccard-Online: Text retrieval

MA for "Wasserzeichen des Mittelalters" of the Austrian Academy of Sciences in Vienna (www.ksbm.oeaw.ac.at/-wz/wzma.php); and NIKI, the database of the Dutch University Institute for Art History Florence.

The simple search and the advanced search each have their own search mask, as is common on all sites that offer a free text search. The simple search has a so-called Google slot that is used to search in all fields. In the advanced search, the user can freely choose and combine the individual fields and additionally, can navigate special search fields in the individual databases. As in Piccard-Online, in the Bernstein-Portal, it is possible to truncate watermark motifs and to query by means of an "and" or "or" search; this is augmented by a non-link. In addition, one can open drop-down menus to find indices in the various search fields, including motifs, location, archive, date, and card number, in order to select a search term (see Ill. 8).

The query results are listed first in an abbreviated form, from which one can choose individual hits. Based on the defining parameters, this short list contains abridged metadata and, in some cases, thumbnails of the watermarks to give a first visual impression. In the single hit display, the exact metadata of the chosen watermark is given; from here one is able to return to the original database. In addition, one can generate additional statistical and geographical information.

Integration of Piccard-Online into the Bernstein-Portal

In order to integrate Piccard-Online into the Bernstein-Workspace it is necessary for the two to be terminologically and technologically correlated. Since the Bernstein collaboration partners decided to leave all data in their individual local servers, queries and responses are through the SRU interface. SRU stands for "Search/Retrieval via URL" and is based on the Z 39.50 interface that is commonly used for library links, as for example the library portal Bibnetz (www.bibnetz.de). It was developed further for archival purposes and is already being used in a British archive portal (www.archiveshub.ac.uk/).

In the Bernstein-Portal, a decentralised data administration is used instead of a data warehouse, an administration that has advantages and disadvantages. The main advantage of a decentralised data administration is that the sovereignty over the data remains in the individual institutions. The disadvantages include occasional slow responses for queries, consequences for the searches after possible data fields changes in the original databases, and result hits that are merely based on the databases' lowest common denominator. In order to avoid such problems, a correlation at the terminological level has been worked out between Piccard-Online and WZMA and WILC, the so-called Bernstein-Thesaurus. It already exists in English, German, and French, and is just being translated into other languages, as for example into Russian.

In addition to a unification of terminology, a prerequisite for an overall search in the databases is also a correlation between the databases or their comparable fields. The overall goal is to develop a system for watermark classification that allows the incorporation of new databases. In the Bernstein-Workspace, "Dublin Core Extended" is used to define the fields. In the participating databases WILC, WZMA and Piccard-Online, there are currently thirteen data fields that are underlying the Bernstein-Portal.

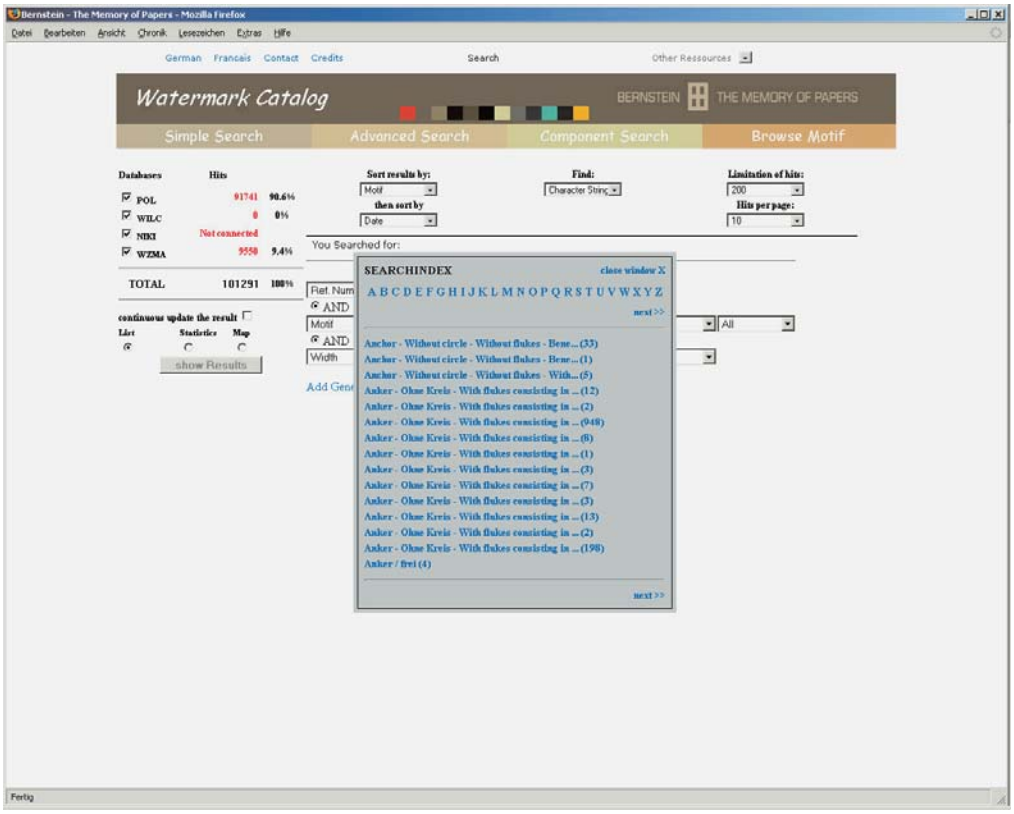
Piccard-Online is a relational database and is based on a MySQL database. In order to be integrated in the Bernstein-Portal, the data model of Piccard-Online has been modified. A query from the Bernstein-Workspace uses CQL (Contextual Query Language), which is converted through the SRU-gateway into SQL. The results from Piccard-Online are then presented in XML format from SQL over the SRU interface. In the process, the following specific data fields are mapped in the data query:

Piccard-Online	*Bernstein*
KartenNr	Ref. Number
Ueberschrift	Motif
Ueberschrift_en	Motif
Ueberschrift_fr	Motif
Abstand_Bindedrähte	Distance of ChainLines
Hoehe	Height
Ort	Place
Datierung_Anfang	Date
Datierung_Ende	Date
Herkunft_Archiv	Depository
Aussteller	Creator
Herkunft_Signatur	Shelfmark
Breite	Width

The planned hierarchical visual search in the Bernstein-Portal will result in some optical changes, since in contrast to the Piccard online classification of thirty-eight upper classes, in Bernstein it is thought to have, for the time being, twelve upper classes. The second level is divided into as many as ninety-nine lower classes. The reduction in number of upper and lower classes is based on already existing watermark collections that have influenced the Bernstein classification system. Nonetheless, the reduction of the upper classes in Bernstein does not result in Piccard-Online changing its normal hierarchy. The upper and lower classes are merely defined differently, such as the upper class "Lily" in Piccard-Online becoming a lower class of Bernstein's classification "Flora", to mention only one example.

The Bernstein-Portal allows the user to undertake a systematic navigation as well as a meta-search of watermarks by means of the linked databases. During the search, the user should always be able to return to the original system, in order to have the possibility of seeing the conventional embedding of the watermark under consideration, or be able to evaluate its traditional classification as has arisen historically.

C.P. (C.-P.-K.)



Ill. 8: Bernstein: Query mask including search index

Ill. 9: Bernstein: Component search

Watermark Terminology

In some way, the "Bernstein Project" is reminiscent of the Tower of Babel. At the end of the failed project in the Old Testament, the building of the tower succumbed to the confusion of languages. In the "Bernstein Project", the language confusion is at the beginning, since the various project partners have, with their watermark collections, each brought their own terminology to the project. The large number of different watermark forms is reflected in the wide variations in the terminology used to describe them; moreover, the collections are often based on completely different classification systems.

When integrating the different watermark collections, as the Bernstein-Portal plans to do, settling such terminological differences plays an important role. The confusion of languages, to pick up our opening metaphor again, must be eliminated in order to create a solid foundation. Watermarks with the same motif and the same characteristics must be described with the same terms if research in a common database is to be possible. For such an integrated database, the terminology being used is an important operator.

The main goal in forming a unified terminology is, in the end, to have standardized descriptions for watermarks, descriptions that can also be used in the future to record newly discovered watermarks and integrate them into the Bernstein-Portal.

An important step towards a general descriptive standard as foreseen by the "Bernstein Project" is a comparison of the terminology used by the large watermark collections that already exist: Piccard-Online, WILC, and WZMA. A comparison of this sort was already conducted between Piccard-Online and WZMA a number of years ago; in order to realize the planned integration of WILC into the Bernstein-Portal, it was also necessary to compare its various motif groups to those of Piccard-Online. A short sketch of the process will illuminate what sort of difficulties this presented. First, for each motif group of the WILC a corresponding motif was sought in Piccard-Online. Of the approximately 540 motif groups (descriptions), in nearly 70% of the cases it was possible to correlate WILC with Piccard-Online. The main criterion that was applied was the motifs being identical, which disregarded terminological differences. For this large group of hits, it was necessary to unify the terminology. The following description shows a few samples of such inconsistent terminology.

Piccard-Online	**WILC**
four-leaved	four-petalled
cloverleaf trifoliate	trefoil
conch	shell
straight orientated	horizontal
star with eight rays	eight-pointed

In many cases a common terminology could be found; it was more difficult when there were fundamental differences between the databases. The various names used for heraldry is one example. In Piccard-Online, the expression "coat of arms" is used, whereas the WILC uses the term "shield". Since a change would have affected several thousand entries, a compromise was reached in which a unified terminology ("coat of arms") is only used at the first level. Steps in unifying the watermark terminology has already left its mark in scholarly research, as can be seen in an article by Carmen Kämmer on "city coats of arms" in Piccard-Online.

How complex such terminological problems can be has been shown by Nigel Palmer, who uses the example of the motif names "Vierfüßer" and "Vielfüßer". And indeed, Palmer's observations were not unique, as work on the Thesaurus has shown. Piccard categorizes a long list of animals under the motif "Vierfüßer", including not only deer, bear, lion, donkey, horse, but also monkey and rabbit, as well as the Christian symbol of the Easter lamb. Additional confusion is caused by the fact that the printed version of Piccard (Findbuch Vol. 15) speaks of "Vierfüsslern", whereas Piccard-Online uses the homonym "Vierfüßer". In the English version of Piccard-Online, this has been translated as "tetrapod", a word that is not found, however, in standard dictionaries. In English, the prefix "tetra" (four) is used only in chemical or mathematical compounds. In the Thesaurus, the term "quadruped" has been used. As a consequence, the term in Piccard-Online has had to be changed.

Still trickier is "Vielfüßer", which in Piccard-Online has been defined as a new motif. The main watermark motifs in this group are crabs, scorpions, and spiders, that is, creatures with several legs. When looking for an English translation for this classification term, in standard dictionaries one finds "multiped", "multipede" and "polypod". If one does not want to fall back on an expression like "animal with more than four legs", a more intensive search for a suitable word is needed, since only older editions of the Langenscheidt dictionary clearly refer to "polypod" as a zoological term. "Multiped" was chosen for the English version of Piccard-Online, the latest version of the Thesaurus now offers "polypod"; also here a new up-date in Piccard-Online should be taken into consideration.

These examples also show that the Thesaurus is not a finished dictionary, but rather can only be seen as a "work in progress" that is constantly undergoing improvements and checks. Continual editorial supervision will therefore be needed.

The relevance of editorial supervision is also apparent if looking at the newly developed component model within the Bernstein-Portal. The various project collaborators have already put the planned research module through an intensive test phase, using selected watermarks of the bull's head motif. In the process, a series of terminological problems appeared that still need to be resolved. Both coordination in terminological discrepancies and the incorporation of new terms into the Thesaurus need to be undertaken in this regard. The sample in the following table gives an impression of this sort of problem.

Component model	Thesaurus
elongated to the jaw	elongated to the muzzle / mouth
stem	rod
bevel	oblique
2-lobed flower or leaf	two-petalled
4-lobed flower or leaf	quatrefoil
templar's cross	maltese cross
threefoil	trefoil
brokeness	brokenness / angularity
curl	noch nicht im Thesaurus
alignment	noch nicht im Thesaurus
lateral	noch nicht im Thesaurus

The final revision of the trilingual Thesaurus was undertaken by comparing it with the main motif groups of Briquet. More than thirty terms that had not yet been recorded were added to the Thesaurus: amphora (amphore; Amphore), board game (damier; Brettspiel), dolphin (dauphin; Delphin), bagpipe (cornemuse; Dudelsack), lizard (lézard; Eidechse), sickle (faucille; Sichel), candlestick (chandelier; Kerzenleuchter), currycomb (étrille; Striegel), to name just a few. In addition, terms that were already included had to be adapted, as for example "escargot" (snail), which the Thesaurus had already listed as "limarçon". The importance of editorial supervision can also be seen here, as the later change also had to be taken into account in Piccard-Online.

Through the editorial work sketched above, the Thesaurus now includes 725 terms, in German, English, and French, that represent the key vocabulary needed to describe watermarks. The advantage of the Thesaurus is clear: watermarks with the same motif can now be described with equivalent terms in English, German, and French, which fulfils the conditions needed for comprehensive searches in the various databases. In the framework of the project, a PDF-file of the trilingual Thesaurus has been made available on the *Bernstein* homepage so that research in all three languages is now possible.

Literature: Palmer, Verbalizing Watermarks; Kämmerer, Städtewappen.

E.F. (C.P.-K.)

Digital Watermark Detection and Retrieval

Introduction

Watermarks and paper features are important sources of information to determine the dating and authenticity of incunabula and artworks. For instance it is possible to determine the artist and creation date of an artwork by discovering identical pieces of paper. Assume e.g. two etchings of Rembrandt. The one has been printed in 1648 and the other has an unknown date. However, since both have been made on the same paper, it is reasonable to suppose that also the other one has been made in 1648. The reason is that in the 16th-18th century paper was sold in stocks of paper sheets coming from the same paper mill and mould, which implies an identical paper structure and watermark. For that very reason watermarks and paper structures are collected all over the world by national libraries, archives, museums and art historical institutes, and watermark catalogues are published everywhere.

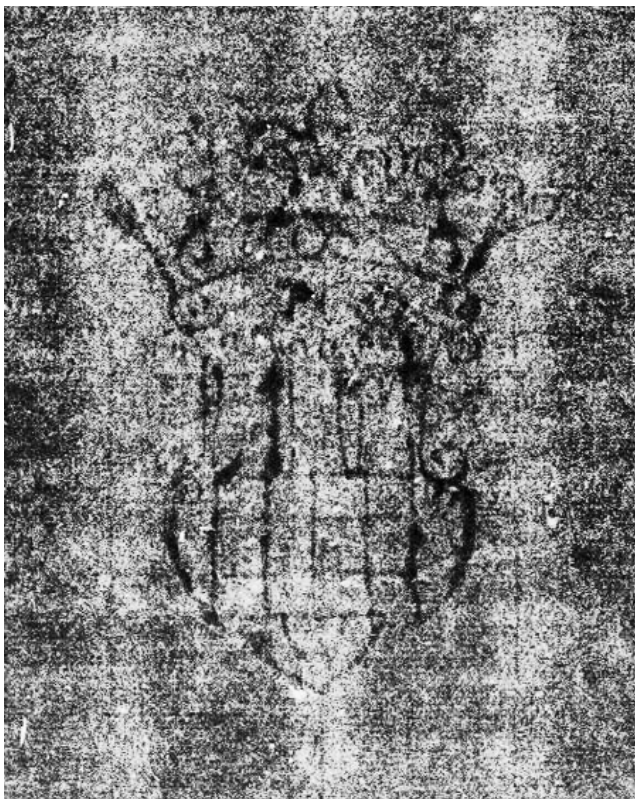
Until now most collections of watermarks are in the form of line-drawings, rubbings, backlight and x-ray imagery. A part of them are now digitized. In the Bernstein project one tries to combine these digital databases to one large virtual repository of watermarks. As a matter of fact this will be a very powerful help for experts in the field of (art) history and incunabula. However, the generation of all these digital databases is an enormous task if it should be done manually. And furthermore, the question is: when this large database is available how to find the appropriate information searched for? At the Delft University of Technology, research is performed how far the usage of computers can assist in these complex tasks. In this paper some examples are given.

Watermark detection

Before a computer can handle imagery of watermarks all the line-drawings, rubbings, backlight and x-ray images should be in a digital form. In practice this means that each picture element (the so-called pixel) should be represented by a number, in general between 0 and 255, representing the grayscale values of the various picture elements. At this moment most of the new watermark images are digitized directly, since most of the present image generation techniques are digital. In case of printed watermarks and 'analogue' photographs they should be digitized first. Until now watermark extraction was primarily be done manually by using transparencies and tracing off with as a result a line-drawing. In fact it simple, but taking into account the large amount of watermarks a tedious drudgery. Furthermore, as a matter of fact the final result is not exact and differs sometimes a little bit from the original real watermark. However, for a computer watermark extraction is a complex task (with the exception of binary imagery which only has black and white pixels). Considering the X-ray images they are in general very noisy. This holds especially for 16th and 17th century paper. Ill. 10 gives an example; even for the expert it is difficult to determine which points belong to the watermark and which ones do not. And this holds the more for the computer since it has only a huge amount of numbers, representing the image, and in which it should detect the watermark pixels.

Our goal is the development of a method which could detect automatically as many watermarks as possible without any user interaction. The basic idea is that watermarks are formed by lines and have specific properties. In the present case we considered five properties:

a) the line profile: the one-dimensional representation of the section in terms of intensity,
b) the line contrast: the contrast difference with the background,
c) the line width,
d) the spatial connectivity: lines exist from connected points,
e) and the line length.



Ill. 10: Coat of arms

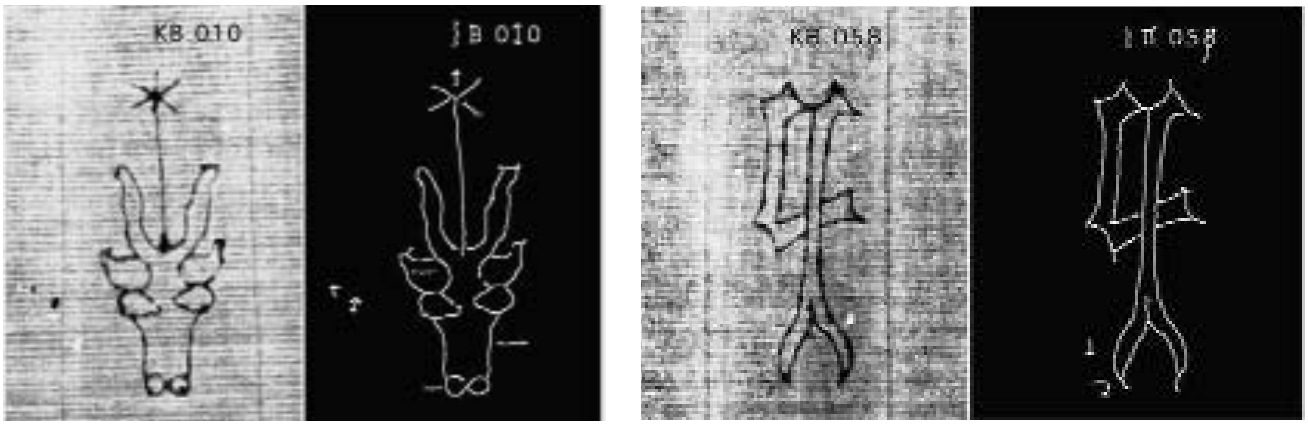
All these properties are exploited in order to extract the watermark. In practice this means that all kind of mathematical operations are performed and that thresholds are applied to detect those points which belong to the watermark and which ones not. For finding the appropriate thresholds a training set is used. It consists of a representative set of watermarks, reflecting all kind of difficulties, like poor contrast of the watermark lines, white spots produced by metallic particles in the paper, large variation in background intensity values et cetera. With the help of this training set the optimal thresholds are determined.

For imagery with relatively little noise the results are quite well (Ill. 11). The results are even better than until now known in literature.

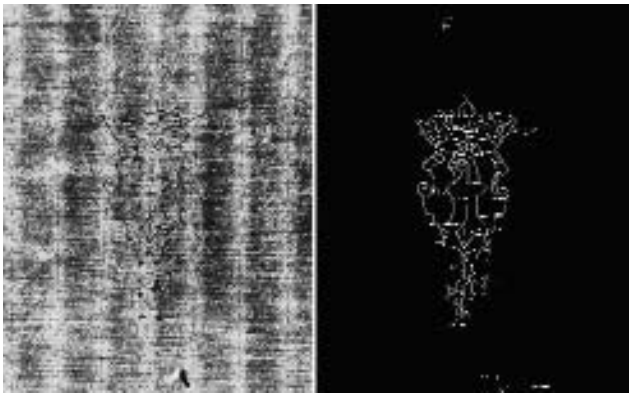
However, in case of very noisy imagery (Ill. 12) the results are more problematic, although it depends on the application. For matching (finding identical watermarks) most of the time this result is sufficient. But as a matter of fact not in the case that one wants to use the watermark for the generation of watermark catalogues. It may not be expected that the method will work for all watermarks in all cases. That means that it can be completely automatic. And this moment research is performed how to combine automatic methods with semi-automatic methods for the difficult watermarks in very noisy imagery.

Watermark extraction in the Piccard-Online database and the printed Piccard

As mentioned above watermark detection is rather easy in case of binary imagery, e.g. linedrawings. Here it is sufficient to use a rather simple method like thresholding. That means all pixels above that threshold are assumed to belong to the watermark and all pixels below that value belong to the background. In this case it is easy to generate a digital image of the watermark. However, in practice this is less simple. Consider for instance the Piccard-Online database at the Hauptstaatsarchiv Stuttgart (see also Chapter VI). It is the largest watermark collection in the world. It contains 92,000 different records. They are classified according to 38 categories, representing e.g. crown, bull's head, tower, cross, horn. Every single watermark within the Piccard-Online database is stored in a separate digital image file. But this digital representation does not mean that for computer applications it is a priori known which point belongs to the watermark and which one not. Here, simple thresholding is not sufficient. In addition to the watermark itself there is also extra information. Surrounding the watermark there are different elements (Ill. 4) as chain lines, laid lines and some text and numbers which give extra information about the watermark and about where the paper comes from. For a computer it is in the beginning not clear to distinguish between the watermark and the other informa-



Ill. 11: Detection of two watermarks from the watermark database of the Royal Library of the Netherlands



Ill. 12: Watermark detection in a very noisy image

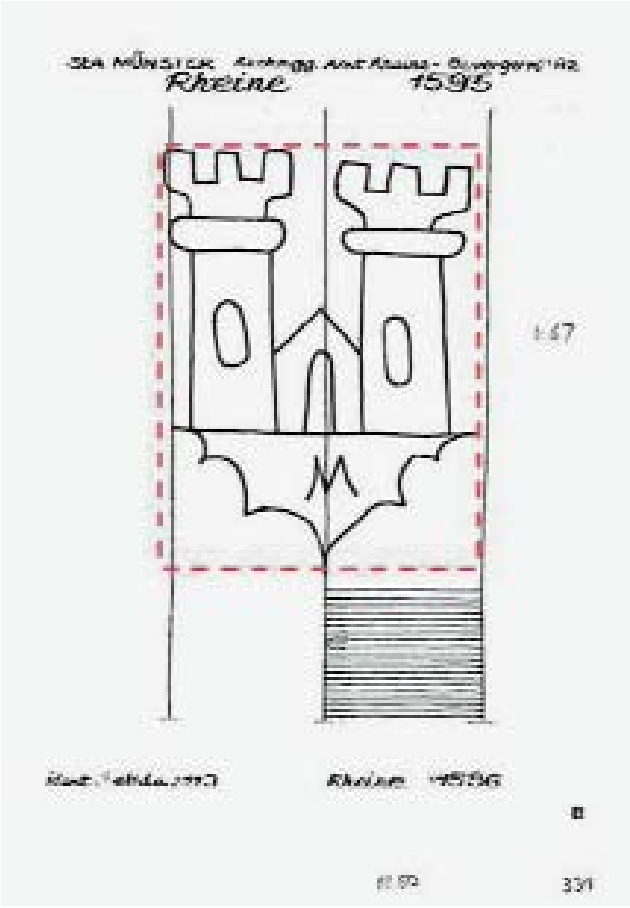
tion. All these elements need first to be identified in order to properly isolate the watermark. The main problem for the computer is to decide what belongs to the watermark and what not.

In our method first groups of connected black pixels are detected, the so-called Blobs (binary large objects). E.g. a window in the castle of Ill. 13 is a blob, the group of laid lines is a blob et cetera. Thereafter all these blobs are studied by the computer by looking to their size, their mutual distances et cetera. Specific properties like many lines with a certain length are for the computer an indication that it probably has to do with a blob with laid lines. This blob is then removed. In the same way blobs with text can be detected and removed et cetera. The final result will be the isolated digital watermark without all its additional information. In experiments the performance was 84%. Of course, sometimes it is going wrong; e.g. a chain line is detected as a part of the watermark.

With respect to the printed collections we have similar problems. The printed Piccard (see Chapter V) consists of 45,000 watermarks, represented in 17 volumes. As a matter of fact these watermarks should also be in the digital database. All the pages are now scanned, but since there are a number of watermarks on each page, further digital processing of the individual is impossible without a method that first isolates the individual watermarks. Of course this can be done manually (e.g. by using Photoshop), but for 45,000 watermarks this is a time consuming job. Also here the computer can assist. First the number of watermarks is determined by locating the numbers of the watermarks in a way as done for Piccard-Online and then counting them. And since these numbers are always below the watermark the positions of the watermark can be determined and finally the watermark which then can be isolated. In about 88% of the cases this goes correct. In the other cases the user has to correct the result manually. But still this method saves much time (Ill. 14).

Matching and retrieval of watermarks

Once the digital watermarks have been extracted they can be stored in a database and used for retrieval purposes. Assume you have an artwork with a watermark and want to

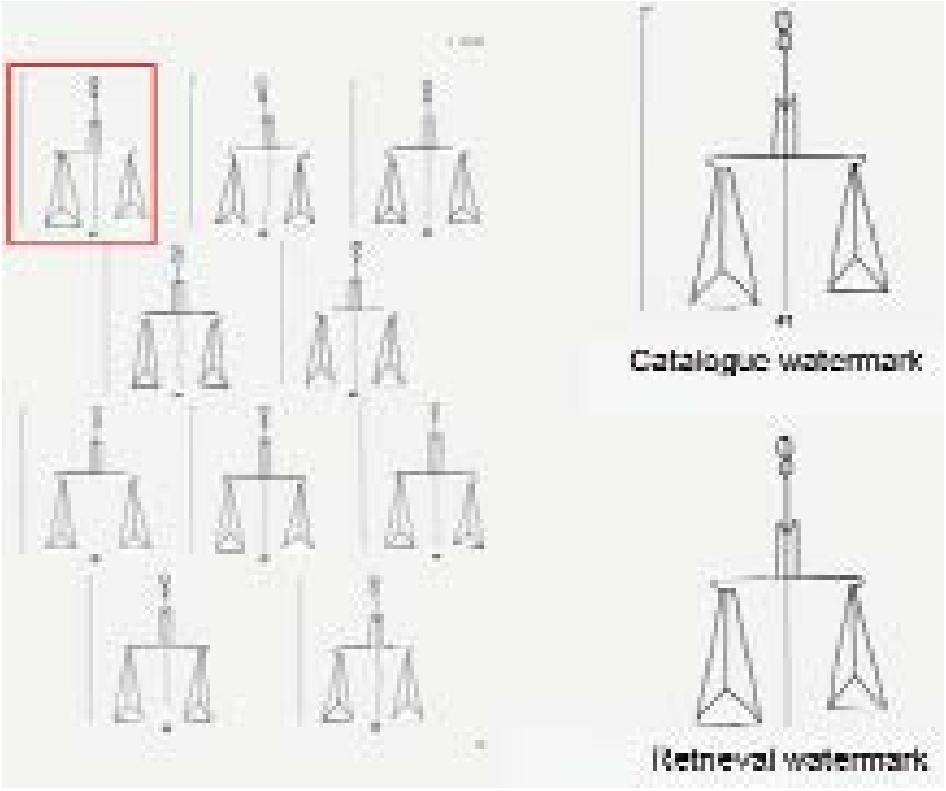


Ill. 13: Watermark with additional information, from the Piccard-Online database

know whether there is an identical watermark in Piccard. For the expert it is a time consuming task, even if he should only compare it with watermarks of the same category. Their amount can be large and the differences small. For the human eye it is rather difficult to decide whether two watermarks are identical. A very simple method is the following. The computer puts a grid on the watermark, consisting of blocks of a certain size. Within each blocks the number of pixels belonging to the watermark are counted. By doing this for all blocks a series of numbers is obtained, a so-called vector. And this is again done for all watermarks. By comparing the series of numbers – which goes very fast – identical or nearly similar watermarks can easily be detected. From experiments with the Piccard database it works out for 91% of the cases.

Chain lines and laid lines

Although according to the experts watermarks are the most important paper feature in order to discover identical pieces of paper, they are not always present in a piece of paper. If a sheet of paper with one watermark is divided in smaller pieces, e.g. in the case of making prints of an etching plate, in general just one piece of paper contains a watermark, the other ones do not. For that very reason one also consid-



Ill. 14: A page from the printed Piccard collection with one of the isolated watermarks in two forms

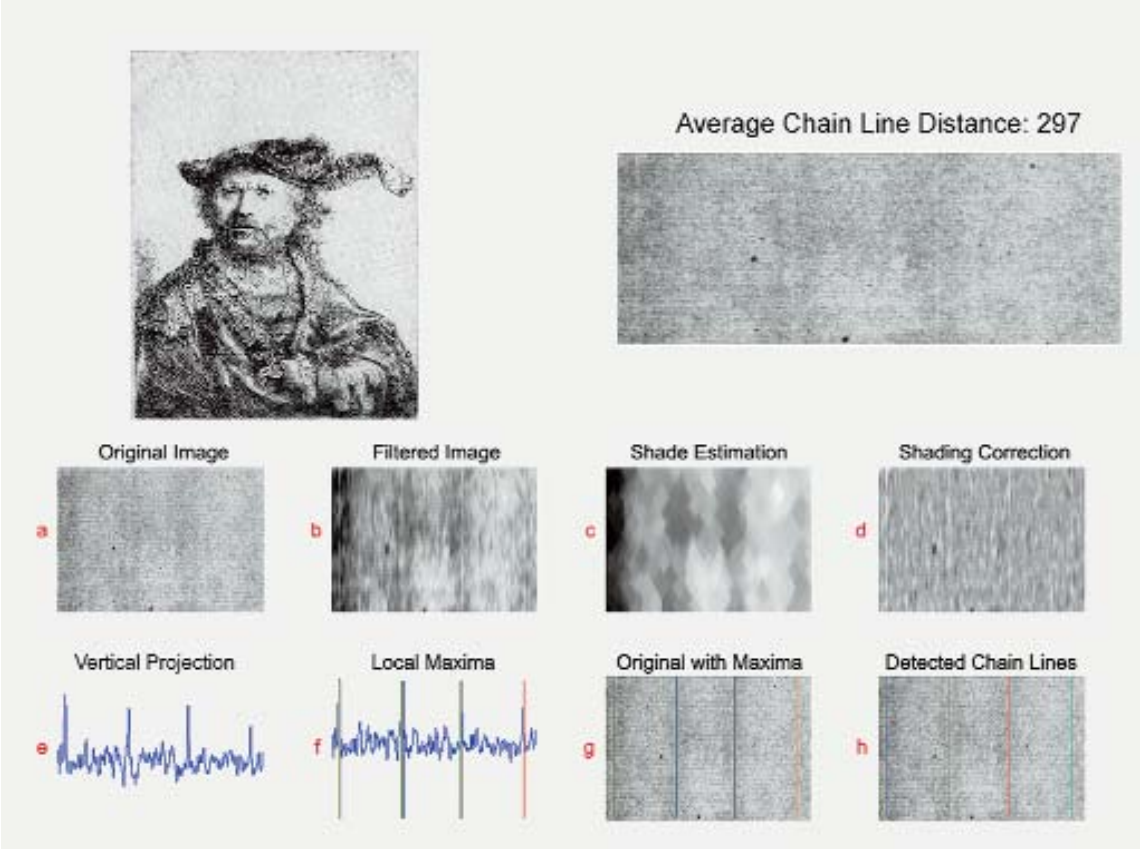
ers other paper features like the paper structure, since this is present in all pieces of paper, like chain and laid lines. Especially, the laid line density (the number of laid lines per centimetre) as well as the chain line distances (the distances between the chain lines) are important features. Until now these features were extracted manually by simple measuring them with a ruler.

Doing this with a computer is also now far from simple. Also here we have to do with noise. Advanced image processing techniques are needed to extract the relevant parameters. The following two illustrations show a process of chain line detection. Illustration 15 shows how in a number of various steps (a-d), the X-ray image is processed in such a way that the resulting image is more suitable for a computer to look for the chain lines. Then the image d is scanned line by line. For each line the grayscale values are represented by numbers and these are translated into a signal (e). It is a bit like an electrocardiogram; with the heartbeats showing up as high point that may be indicate the position of a chain line. By subjecting all the resulting 'heartbeat' signals to a logical algorithm enables the computer to pinpoint the exact positions of the chain lines (f-h).

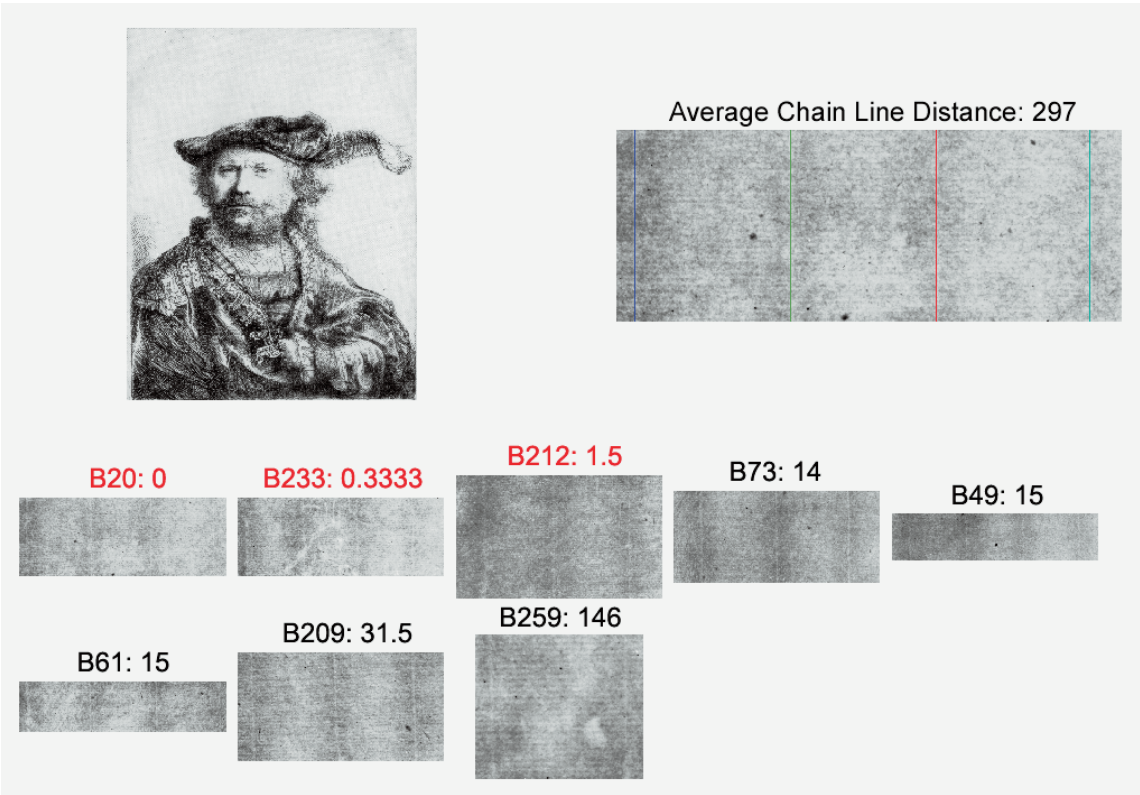
Having obtained the line patterns and the corresponding chain line distances retrieval is now rather simple. The chain line distances are compared with other series of numbers in the database. On the basis of some similarity measure the computer comes up with a number of possibly identical papers with a decreasing degree of certainty (Ill. 16).

As a matter of fact the best results are obtained when the information of watermarks as well as of laid line density and chain line distances are used at the same time.

J.C.A.v.d.L. / H.M.O.



Ill. 15: Chain line detection



Ill. 16: Matching: finding similar papers

A Selected Bibliography on Paper History and Watermarks

by Erwin Frauenknecht, Martin Haltrich and Carmen Kämmerer

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Glossary

Additional Motif – Beizeichen
Secondary parts of a watermark motif, e.g. the flower above a bull's head.

Beta Radiography – Betaradiographie
A type of X-ray photography that reveals differences in a paper's thickness. A thin, slightly radioactive plate is placed on one side of the paper and on the other side, x-ray film. The structure of the screen and the watermark are reproduced as dark lines, since here the paper is thinner, therefore letting the radiation pass through easier.

Chain Lines – Binde-, Steg- oder Kettdrähte
The wires used to re-enforce the laid lines in a paper mould's screen. See *Mould*.

Electron Radiography – Elektronenradiographie
A type of X-ray photography that reveals differences in a paper's thickness. A piece of lead foil is placed on one side of the paper and on the other, X-ray film. X-rays produce electrons on the lead foil, and according to the thickness of the paper, these are absorbed by the film in different amounts, thus making the structure of the mould's screen and the watermark visible as dark lines.

Filigranology – Filigranologie
A complementary field in historical studies: the study of watermarks (Fr. *filigrane* – watermark). The French word *filigrane* is related to how wire figures for watermarks were produced, i.e. usually with silver wire. See *Wire Watermark Emblem*.

Großregalformat
A historical paper format (also called Imperial or Großformat) usually measuring 500 x 740 mm. This format was recorded as early as 1308 in Bologna. See *Kanzleiformat*.

Identical watermarks – Identische Wasserzeichen
Watermarks that are absolutely identical.

Image Subtraction – Bildsubtraktionsverfahren
A method for reproducing watermarks. A top light and a rear light photo are taken. By means of photo editing software, the first image is subtracted from the second. The only differences between the two photos lie in the paper's structure and the watermark, and thus this is what remains when one image has been subtracted from the other.

Kanzleiformat
A historical paper format (*carta reçute*) usually measuring 315 x 450 mm. The size of this very common format can be traced back to a well-known Bolognese format that dates to around 1300.

Laid Lines – Boden- oder Rippdrähte
The tightly parallel wires in a paper mould's screen, which are re-enforced by means of perpendicular chain lines that are spaced at wider intervals. See *Mould*.

Motifs of Watermarks See Type of Watermarks

Mould – Schöpfsieb
A form for making paper that is made of a removable frame (the deckle) and a screen made of wire that is attached to a fixed wooden frame. This wire screen is made of parallel tightly running laid or ribbing wires, to which perpendicular chain lines or warp wires are attached. These are placed above wooden cross pieces that stabilize the screen. A wire figure is attached to the screen's surface to form a watermark.

Wooden Frame; Removable Deckle Frame; Wire Watermark Emblem; Cross Piece; Chain Line or Warp Wire; Laid Line or Ribbing Wire

Pastedown – Spiegel
In bookbinding, a piece of paper that is glued to the inner side of the front and back covers of the book.

Ream – Ries
A unit to measure a quantity of paper (Ger. *Ries*; from Arab. *rizma* = a bundle). Originally a ream was 480 sheets of paper; from about 1500 and the introduction of printing, it became 500 sheets; finally from the 19th century it counted 1,000 sheets. One ream contains 20 quires, each of 24 or 25 sheets, and 10 reams forms a bale.

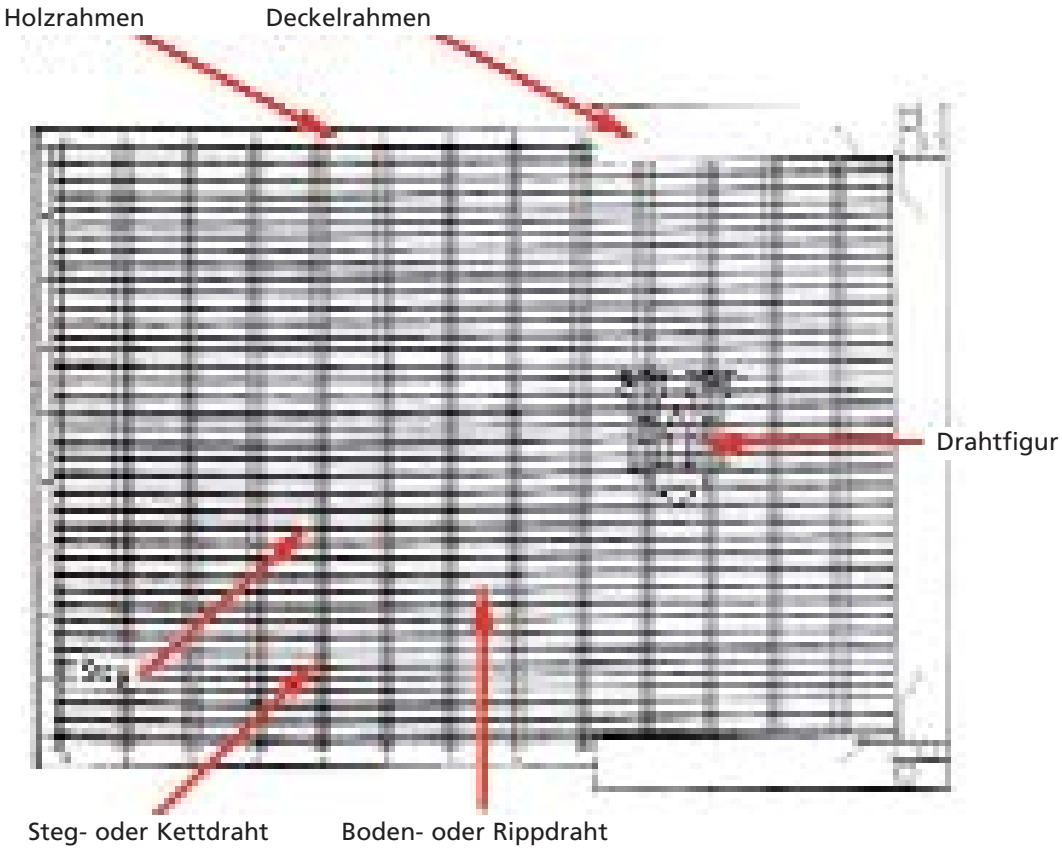
Ribbing Wire See Laid Line

Rubbing – Abreibung
Placing a thin piece of paper over a watermark and carefully rubbing with a soft piece of graphite or a pencil produces a copy of the watermark. The uneven surface of handmade paper enables the shape of the watermark to be transferred to the rubbing paper.

Sheet of Paper – Papierbogen
A sheet of paper that is formed in the paper mould out of the paper pulp.

Tracing – Durchzeichnung
A watermark copy made by tracing its shape onto thin paper.

Twinmarks – Wasserzeichenpaar
Paper was usually made at a vat with two alternating moulds. Wire watermark forms of the same shape would be attached to both. Although these were often very similar, they were never the same. Because of the pair of paper moulds, watermarks always are found in pairs ("Watermarks are Twins").



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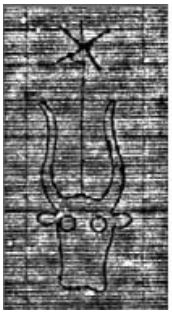

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placed over each other

Variants of Watermarks – Varianten von Wasserzeichen
Watermarks that are, although different in shape or in their position on the screen, clearly prints from the same wire figure, this figure having gradually changed its form during the paper production process.

Vellum Paper (Wove Paper) – Velinpapier
A type of paper produced since the 18th century with a smooth, even surface, the result of its mould being made of tightly woven metal. By means of relief-like graduated stamps, differing thicknesses in the sheet of paper can be created. When the paper is held up to the light these differences can be seen as so-called shadow watermarks.

Type of Watermarks – Wasserzeichentyp
Watermarks that are the same with regard to their motif, form, and size are considered as a watermark type. Corresponding to the period of time the individual watermarks of a particular group were in use, undated watermarks can be dated by means of their type.

Warp wire See Chain Line

Wire Watermark Emblem (Wire Figure) – Drahtfigur
Watermarks are produced by a figure formed out of wire that is attached to the paper mould's screen. When paper is made, less paper pulp accumulates here, thus the watermark is visible because of its higher transparency. See *Mould*.

M.S. / E.F. (C.P.-K.)

Abbreviations

CCI	Corpus Chartarum Italicarum
Cod.	Codex
col.	column
ed.	edited / edition
ed./eds.	editor /editors
et seq./seqq.	and the following
fig.	figure
fol./fols.	folio / folios
HHStA	Haus-, Hof- und Staatsarchiv (Austrian State Archives)
HStA	Hauptstaatsarchiv
ICPAL	Istituto centrale per il restauro e la conservazione del patrimonio archivistico e Librario
Ill.	Illustration
IPH	International Association of Paper Historians
KB	Koninklijke Bibliotheek, The Hague
LexMA	Lexikon des Mittelalters
NIKI	Dutch University Institute for Art History Florence
no/Nos.	number / numbers
ÖAW	Österreichische Akademie der Wissenschaften (Austrian Academy of Sciences)
ÖNB	Österreichische Nationalbibliothek (Austrian National Library)
p./pp.	page / pages
r / v	recto / verso
suppl.	supplement
VL	Das Verfasserlexikon. Die deutsche Literatur des Mittelalters, 2nd ed.
vol./vols.	volume / volumes
WIES	Watermarks in Incunabula printed in España
WILC	Watermarks in Incunabula printed in the Low Countries
WLB	Württembergische Landesbibliothek
wm	watermark
WZMA	Wasserzeichen des Mittelalters (Watermarks of the Middle Ages)

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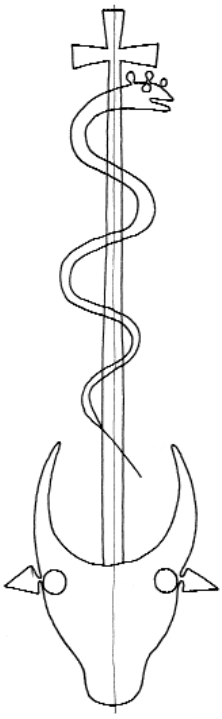

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