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Herbs under Pressure

Plant Illustrations and Nature Printing in the First Half of the Fifteenth Century

Kniphof's Masterstroke of Commercialising Nature Printing

In 1733 the Erfurt physician Johann Hieronymus Kniphof (1704–1763) published the first edition of his *Botanica in originali, Das ist: Lebendig Kräuter-Buch*.[1] The book was a novel, textless, kind of botany atlas, containing only impressions taken from inked plants (ectypes) instead of painted illustrations, woodcuts or engravings (pl. 1). The book was bold and innovative in terms both of the illustrative material and the production method. For each illustration in each copy of the book, Kniphof took one impression of one single plant on a separate paper leaf. Hence, every plant illustration was unique. In spite of this time-consuming and labour-intensive process, Kniphof generated the spectacular number of 500 nature prints for his first edition and the last edition, published in 12 volumes from 1757 to 1764, included 1200 prints.[2]

Five years earlier, Kniphof laid the foundations of this new project when he had the unusual, and for him momentous, idea of a business concept based on an innovative plant stamping technique, which he was intending to develop and keep as a secret. The print-

* The ideas in this essay were developed during my stay at the Max Planck Institute for the History of Science in Berlin as a visiting scholar and the Gotha Research Centre of the University of Erfurt as a Herzog-Ernst-Fellow, funded by the Fritz Thyssen Foundation. The essay was completed when on a Start-Up grant from the University of Erfurt at the Gotha Research Centre. The author is grateful to these institutions for their support, particularly to Lorraine Daston, Sven Dupré, Martin Mulsow and Iris Schröder.

1 Kniphof's biography in Rudolf von Roth (ed.): Urkunden zur Geschichte der Universität Tübingen aus den Jahren 1476 bis 1550, Tübingen 1877, pp. 213–216; for *Botanica in Originali*, see Roderick Cave: Impressions of nature. A history of nature printing, London 2010, pp. 44–50; Ernst Fischer: Zweihundert Jahre Naturselbstdruck, in: Gutenberg Jahrbuch 4 (1933), pp. 186–213, here esp. pp. 196–198; Fritz Kümmel: Die hallesche Ausgabe des Werkes "Botanica in originali" (Naturselbstdrucke) von J.H. Kniphof, in: Schlechtendalia 24 (2012), pp. 53-71.

2 In later editions, Kniphof printed textual explanations of the plants in distinct volumes referring via numbers to the nature prints. For the different editions of *Botanica in Originali*, see Fischer 1933 (see n. 1), pp. 196–199; Claus Nissen: Die botanische Buchillustration. Ihre Geschichte und Bibliographie, 2nd enlarged ed., Stuttgart 1966, pp. 246f.

ing technique would allow him to effectuate high-precision plant ectypes at a rapid pace and in high numbers so that he would be able to bind the paper leaves carrying ectypes to books and sell as many of them as possible. In addition, his technique would ensure that the ectype of each plant would look about the same in every copy of his book so that Kniphof would be able to market them and scholarly readers could discuss the morphology of the same plant, even at a distance. There was in Erfurt and its surroundings, to all appearances, a market for precise botanic illustrations at this time. I will return later in this article to this production and marketing strategy, when discussing the medieval plant ectypes.

With this in mind, Kniphof started to collect hundreds of dried plants and, in the Erfurt print shop of Johann Michael Funcke, which he would later call the first botanical printing company in Germany, he began to impress plants on paper for his strategic purposes.[3] By December of the following year, Kniphof was confident that he had perfected his technique to such a degree that he announced a book for sale,

> "where to print all the vegetabilia to be obtained, here and elsewhere, and thereby to bring together, via this invention, one by one a complete herbarium which, for many reasons, may be of more use and convenience than those whose production, since ancient times, whilst painstaking, never overcame the problem of adequately preserving their original condition and beauty".[4]

For unknown reasons, however, it was not until 1733 that Andreas Elias Büchner, in this year's issue of his famous periodical *In miscellanea physico-medico-mathematicis*, publicly advertised and briefly described Kniphof's *Very convenient and useful way to print herbs and to present them following their shape*.[5] In the ensuing years, several copies of each single

3 Ilsabe Schaldach: Johann Michael Funcke (1678–1749). Editor, Verleger und Drucker in Erfurt. Seine Lebensleistung und sein Hauptwerk "Botanica in originali" von Johann Hieronymus Kniphof, in: Detlef Ignasiak (ed.): Beiträge zur Geschichte der Literatur in Thüringen, Rudolstadt 1995, pp. 20–40; for Funcke's printing office, see Fischer 1933 (see n. 1), p. 186. – Fischer refers to the following manuscript: "Karl Hermann, Nachrichten über Erfurter Buchdrucker, Handschrift zirka 1850", without stating where he read it.

4 Andreas E. Büchner (in the name of Johann H. Kniphof): Von einer sehr bequemen und nützlichen Art, die Kräuter abzudrucken und nach ihrer Gestalt vorzustellen, in: Andreas E. Büchner (ed.): Miscellanea physico-medico-mathematica (third and forth calender quarter of the year 1729), Erfurt 1733, pp. 779–782, here p. 779: "alle hier und anderwärts zu erhaltende Vegetabilia abdrukken zu lassen, und also mit der Zeit ein, so viel möglich, vollständiges Herbarium nach dieser Invention zusammen zu bringen, welches um vieler Ursachen willen vielleicht nützlicher und bequehmer seyn wird, als diejenigen, so man zeithero zu verfertigen sich die Mühe gegeben, und dennoch immer in einerley Stande und Schönheit zu conserviren noch kein Mittel gefunden hat." (my translation) – Büchner prints the announcement in the corresponding section for the month of December 1729; on p. 780, one finds the information on the initial experiments of printing plants in 1728.

5 See preceding footnote. For Kinphof's friendship with Büchner, see Kümmel (see n. 1), pp. 55–57.

edition of Kniphof's *Botanica in originali* were published, first in the city of Erfurt and later in Halle. However, even today it is not known how many nature prints Kniphof printed and sold in total. Yet judging by the volumes consulted by Ernst Fischer in 1933, it must have been a tremendously high number.[6]

Kniphof's initiative was interesting not only because of his highly original idea to mint books consisting of individual plant impressions and market them. The note printed by Büchner in 1733 elicited an immediate and forceful reaction by the Wolfenbüttel physician Ernst Brückmann, who described in detail the process of nature printing according to his own understanding and practice. Brückmann, a member of the Prussian Academy of Sciences, emphasized that he had been producing ectypes for a considerable time and intended to brief Kniphof of his own experience.[7] Brückmann's account was provocative and came close to being offensive, and was perhaps a response to Kniphof's claim to have "excolirt und perfectionirt", "developed and perfected" the technique. Kniphof was furious. He responded immediately to Brückmann, accusing him of promoting an immature method that did not match, in accuracy and efficiency, his own. Moreover, Kniphof went on to discuss what he saw as the shortcomings of Brückmann's procedure, whilst revealing little about his own technique.[8]

The scholarly dispute between Wolfenbüttel and Erfurt would have been only an amusing episode of two cavillers, had their correspondence not included one of the most finely detailed expositions of the *modus operandi* of printing plants ever seen in the print press. Its illustrative thoroughness was only surpassed by the commentary on nature printing by the Erlangen university apothecary Ernst Wilhelm Martius (1756–1849) in 1784.[9] Having previously discovered one of Kniphof's volumes and, having been fascinated by its plant illustrations, Martius intended to get hold of the mysterious printing method as a

6 See the copies listed by Fischer 1933 (see n. 1), pp. 196–199.

7 Franz E. Brückmann: Send-Schreiben an Tit. Hrn. Joh. Hieron. Kniphof..., in: Andreas E. Büchner: Miscellanea physico-medico-mathematica (third and fourth calendar quarter of the year 1730), Erfurt 1734, pp. 1346–1353; for Brückmann, see Rudolph Zaunick: Brückmann, Franz Ernst, in: Neue Deutsche Biographie (NDB), vol. 2, Berlin 1955, pp. 655f.

8 Johann H. Kniphof: Antwort auf Tit. Herrn Franc. Ern. Brückmanns [...] Send-Schreiben..., in: Büchner 1734 (see n. 7), pp. 1353–1360.

9 Alois Auer was to coin the German term "Naturselbstdruck" and, as it seems, also the English expression "nature printing". In his 1853 publication, he prints his thoughts in four different languages and describes nature printing as "the discovery of the natural printing-process" or as "the discovery, how Nature itself furnishes a process for printing", in German, "die Entdeckung, wie die Natur selbst zum Drucke sich hingibt". Auer developed a process in which the objects to be printed were pressed into a lead plate, from which a harder printing plate for multiple prints could be produced by electroplating; Alois Auer: Die Entdeckung des Naturselbstdruckes [...] vorgelesen in der mathematisch-naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften zu Wien, Vienna 1853, here the second title page and p. 4.

result, with success![10] He tried out assiduously different methods until he found the right one.

Martius' analytical compendium, published together with the controversy between Kniphof and Brückmann, stands as the most comprehensive description of nature printing to this day. Containing references to concrete practises and specific plants, it serves as a directory providing deep insights into the diverse ways ectypes were executed in ancient times. Martius' compilation would deserve being cited in its entirety. In the following, at least, the most noteworthy aspects of the printing technique can be specified. Except for specific details, the three comments published in Martius' treatise, i.e. Martius' own, Brückmann's and Kniphof's, agree in the basic tenor of the epistemic role of ectypes, which I shall now briefly reproduce.

Martius' compendium accentuates the epistemic function of plant prints. It considers them independent of the painter's craft and his lack of botanical judgment, since the natural plant itself is printed – as if "the wise hand of the Almighty Creator has drawn it".[11] For botanists, this was a crucial advantage. Back in antiquity, Pliny the Elder had sharply criticized the use of plant illustrations in herbalism. Among other things, Pliny had argued that their production required excellent artists and, furthermore, the plants were, regularly, incorrectly copied because of the lack of botanical knowledge of the painters.[12] Yet as the compendium by Martius highlighted, ectypes reflected the "natural size" and the precise outline so that "between the original and the imprint not the smallest difference, except the colour, can be observed".[13] With regard to these qualities, ectypes surpassed even the most elaborate and correct copperplate print, which could not achieve such precision.[14]

All three botanists, furthermore, combined the epistemic quality of plant prints with aesthetic aspects. In their view, nature prints perfectly displayed even the tiniest details which the art and technique of woodcuts and engravings could not achieve with the same accuracy. As Brückmann put it, nature prints were "so beautiful, so fine, and accurate [...] that no painter or copperplate engraver, with his most delicate brush, colour and sharpened graver, can paint, draw, or cut so tenderly and delicately".[15] However, Kniphof and

10 Ernst W. Martius: Neueste Anweisung, Pflanzen nach dem Leben abzudrucken, Wetzlar 1784. – Martius discovers Kniphof's volume in 1774 and in 1779 publishes already plant prints of the highest quality. According to the subtlety of these prints, Martius was able to imitate Kniphof's technique; for Martius discovering the volume, see Ernst W. Martius: Erinnerungen aus meinem neunzigjährigen Leben, Leipzig 1847, p. 38.

11 Büchner (in the name of Kniphof) 1733 (see n. 4), p. 779.

12 Plinius: Naturalis Historia, XXV.4; for a discussion of Pliny's criticism, see David Freedberg: Failure of colour, in: John Onians (ed.): Sight and Insight. Essays on Art and Culture in Honour of E.H. Gombrich at 85, London 1994, pp. 245–262.

13 Büchner (in the name of Kniphof) 1733 (see n. 4), p. 780.

14 Büchner (in the name of Kniphof) 1733 (see n. 4), p. 780.

15 Brückmann 1734 (see n. 7), p. 1346.

his confreres also emphasized the skilled workmanship required for taking impressions of smooth, hard, thorny, thick, bushy, delicate and other similarly challenging plants.

Finally, the scholars stressed the dried plants' suitability for being reused in multiple prints. According to Kniphof, delicate herbs such as *Poppy* may only be printed four to six times, whereas vigorous plants may support up to 150 prints. Therefore it can perhaps be concluded that Kniphof's business idea was based on a supply of herbs that he had gathered and dried and that he constantly used to build up a reserve stock of paper sheets with ectypes. Occasionally, Kniphof generated ectypes of specific plants on demand, but his main marketing concept consisted in drawing on the ectypes of his collection, arranging them in the right order, binding the sheets of paper into booklets and, in this way, producing copies of his book in order to sell them to interested clients, thereby creating, in effect, a new market. It is clear that – even if difficult plants were not suitable for long series of successive prints – Kniphof tried to increase the stock of ectypes by executing as many impressions of any single plant as possible.

In spite of reusing plants for multiple prints, the quality of the illustrations in *Botanica in originali* was superior to that generated by other imaging techniques. If Kniphof, Brückmann and Martius accentuated this point at the time, close inspection of Kniphof's impressions today confirms a delicacy and accuracy of the printed texture barely conceivable of other forms of production. Furthermore, the price that Kniphof's volumes realised at auctions at the end of the eighteenth century provide a reliable indicator of their excellence, acclaimed by the public for their quality, as well as for the enigmatic aura surrounding them. In 1791, two copies of the edition of 1757–1764 were sold at auction in France for 370 and 441 francs respectively, whilst a 36-line Gutenberg Bible was sold in London for the equivalent of 367 francs. Another 42-line Gutenberg Bible was sold in 1793 in France for 60 francs and bought by the printer Firmin Didot in 1803 for 400 francs.[16]

The discussion of Kniphof's enterprise presents a parallel to the main subject of this essay and leads to it: the earliest known European ectypes as a part of pictorial naturalism. Through a discussion of such ectypes, this essay proposes to shed light on the pictorial imitations that occurred during the fifteenth century and to show that today's notion of *naturalism* does not comprehend all the forms of late medieval pictorial reproduction. To put it differently, as early as the first quarter of the fifteenth century, forms of artistic studies of nature did not always lead to pictures that we would today describe as *naturalistic*. Following the general consensus, I apply the terms *naturalism* and *naturalistic* to pictures that aim to evoke *lifelikeness* and to produce a *pictorial illusion* in which the depicted appears to be *natural*.[17] Albrecht Dürer's and Hans Hoffmann's depictions of

16 Fischer 1933 (see n. 1), p. 187.

17 See for instance the discussion of naturalism in Otto Pächt: Early Italian Nature Studies and the Early Calender Landscape, in: Journal of the Warburg and Courtauld Institutes 13 (1950), pp. 13–47; Jean A. Givens: Observation and image-making in Gothic art, Cambridge 2005, *passim* and particularly chap. "Gothic Naturalism".

Hares are examples of this latter definition of naturalism. As Karin Leonhard demonstrates in her contribution to this volume the multiple copies that Hoffmann made of Dürer's *Young Hare* nuanced and played with the suggestion of the *living*, *life-like* or *realistic* and, furthermore, they confirm the observational capacities of both artists.

In contrast, the ectypes discussed hereafter document how at the beginning of the fifteenth century nature could be scruntinized through an interest in botanical aspects of plants. The depictions resulting from these efforts demonstrated the surface texture, the morphology and the habit (the form of growing) of plant parts to the beholder. Their approach to *representation* was clearly dominated by epistemic aspects. These pictures were produced *via* the herbs themselves, by inking them and printing them on paper. Therefore, by enlarging the sense of the term *naturalism* to include depictions that relayed on careful observations of nature as well as to pictures that were produced *via* plants themselves, the ectypes may also be called *naturalistic.*

Europe's Oldest Plant Impressions. A Salzburg Charade

Analyses of medieval manuscripts are reminiscent of small-scale detective investigations. In this section, I invite the reader to accompany me in such an investigation. A fascicle from the fifteenth century, today preserved in the university library of Salzburg, contains the oldest plant prints ever executed in Europe that we know of.[18] 83 ectypes are distributed in an extremely clean and orderly manner on 12 bound sheets of paper (pl. 2). The booklet was originally more extensive and was seemingly added shortly after its execution to a compilation of manuscript texts, which the doctor Konrad von Butzbach autographed in 1425 in Hessian Laubach.[19] Konrad's compendium of various kinds of astrological, mantic,

18 MS M I 36, Universitätsbibliothek, Salzburg; cf. Anna Jungreithmayr (ed.): Die deutschen Handschriften des Mittelalters der Universitätsbibliothek Salzburg, Vienna 1988, pp. 8–19; Hermann Fischer: Mittelalterliche Pflanzenkunde, Munich 1929a, pp. 125f.; Hermann Fischer: Naturselbstdrucke von Pflanzen aus dem 15. Jahrhundert, in: Berichte der Oberhessischen Gesellschaft für Natur- und Heilkunde zu Giessen 13 (1929b), pp. 27–30; for Konrad of Butzbach, see Gundolf Keil: Konrad von Butzbach, in: Werner E. Gerabek et al. (ed.): Enzyklopädie Medizingeschichte, Berlin 2005, p. 773. – Two older, isolated examples of ectypes are to be found in a Syrian paper manuscript (Istanbul, Library of the Topkapi Museum, MS Ahmet III, Cod. 2127). The Christian physician Binham b. Mūsā b. Yūsuf al-Mawsilī copied this Arabian translation of Dioscorides' *Materia medica* in the year 1228; see Sergio Toresella: Il Dioscoride di Istanbul e le prime figurazioni naturalistiche botaniche, in: Atti e Memorie dell'Accademia Italiana di Storia della Farmacia (Belluno) 13.1 (1996), pp. 21–40; Minta Collins: Medieval herbals. The illustrative tradition, London 2000, pp. 127–129.

19 In the lower right corner of the recto there is an old foliation, which was partially truncated by cut and now no longer corresponds to any order. It suggests a loss of leaves for the fascicle. Toresella's examination of the watermarks showed the year 1427 with a margin of ± 5 years; see Sergio Toresella and Marisa Battini: Gli erbari a impressione e l'origine del disegno scientifico, in: Le Scienze. Edizione Italiana di Scientific American 239 (1988), pp. 64–78, here p. 75.

1 Anonymous: *Three long-stemmed plants*, nature print/paper, 238 × 173 mm, ca. 1427; Salzburg, Universitätsbibliothek, MS M I 36, fol. 175r

alchemical and medical texts, calculation tables, pigment mixtures and recipes for distillates reflects the wide and diverse horizon of interests of a well-educated physician in the fifteenth century. Accordingly, the impressions are taken from contemporary plants used as drugs and next to them were added plant names in Latin, an Italian dialect and a German dialect.[20]

20 Nearly all plants can also be found in the *Historia stirpium* (1542) of Leonhart Fuchs. The identifications of the plants in the Salzburg fascicle follow Fischer 1929b (see n. 18) and were examined by me.

The present interpretation of the fascicle and its ectypes is not entirely conclusive. While almost a century ago Fischer believed the prints to be arranged in an indiscriminate layout, Reeds' recent study assumes that a doctor, perhaps Konrad himself, made them, apparently, for his own use. Reeds emphasizes what she considers to be an orderly set of prints that testify to a "considerable previous experimentation and skill with inking and printing" and to a "deliberate, systematic approach to collecting and studying medicinal plants".[21]

Reeds adequate interpretation of the Salzburg nature prints may be nuanced and deepened to arrive at a fuller understanding of the ectypes. The impressions consistently show leaves, twigs or above-ground plant parts.[22] Almost all printed plants exhibit a flawless condition without blemishes, their contours are clear and uninterrupted, and thus manifest the greatest care in their selection.[23] This conjecture is reinforced by the fact that many of them are arranged axially on the paper.[24] Reeds also noticed that some plants are grouped according to morphological criteria. Though there is no overall ordering of the plants, neither with regard to their form nor to their healing effects, for the prints on certain pages, the plants were undoubtedly chosen according to their form. For example, three similar plants were printed together on one page and another page unites three types of geranium (fig. 1).[25]

Skilled Craft in the Salzburg Nature Prints

According to the explanations in the Martius compendium, the Salzburg ectypes indicate a rich technical expertise on the part of the practitioner. Although the anonymous printer-illustrator was confronted with plants requiring considerable proficiency, he nevertheless

21 Karen Reeds: Leonardo da Vinci and botanical illustration. Nature prints, drawings, and woodcuts ca. 1500, in: Jean A. Givens, Karen M. Reeds and Alain Touwaide (ed.): Visualizing medieval medicine and natural history, 1200–1550, Aldershot 2006, pp. 205–237, here p. 216. – Reeds' essay inspired the present contribution. See also Cave who also sees in Konrad von Butzbach the author of the ectypes. Roderick Cave: Impressions of nature. A history of nature printing, London 2010, p. 21.

22 However, they do not show roots.

23 Only four plants are affected by slight damage: "herba album minor" (*Euphorbia Lathyris*, fol. 156r), "virga pastoris" (*Dipsacus Silvestris*, fol. 167v) "liquiricia" (a twig of *Licorice*, fol. 173r,), "lingwa avis" (*Cerastium silvaticum*, fol. 174v).

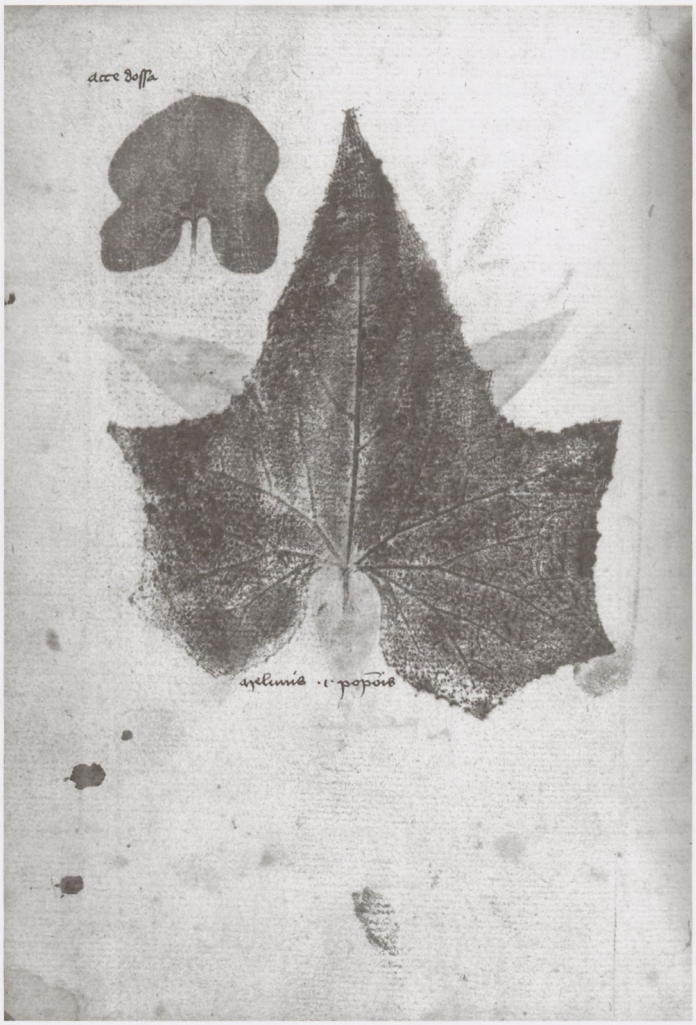
24 "Ameos" (fol. 173r), "consolida minor" (fol. 168r), "absinthio wirmudt" (fol. 168r) or "epatica terestris" (fol. 164v), to name but a few, seem almost unnatural in their symmetry. Of "virga pastoris", two impressions of the same leaf are arranged axially so that they spring from a common point and extend diagonally outward (fol. 167v).

25 On fol. 171r, two long-leaved branches are printed on the same page: "farn filix" and "polipodium Stoinwurz". On fol. 175r, the three long-stemmed plants look similar: *Cerastium Sylvaticum*, *Shepherd's Purse*, *Common Knotgrass*. Three representatives of the same genus of plants were printed on fol. 177r, three types of geranium: "pes columbinus" (*Geranium Molle*), an unmarked leaf (*Geranium columbinum*), "herba ruberti" (*Geranium Robertianum*).

2 Anonymous: *Turk's Cap Lily*, nature print/paper, 238 × 173 mm, ca. 1427; Salzburg, Universitätsbibliothek, MS M I 36, fol. 172r

achieved high quality images that precisely visualised contours and inner structures, for instance of thorny leaves such as those of the *Field Eryngo* and of particularly smooth leaves, such as those of *Turk's Cap Lily* and *Solomon's Seal* (fig. 2).[26] Following Martius' instructions, he produced multiple prints with individual botanical samples, firstly, to increase the number of details recorded on the paper by reducing the ink used in sub-

26 Fol. 176r, 172r, 164r.



3 Anonymous: *French Sorrel* (left), nature print/paper, 238 × 173 mm, ca. 1427; Salzburg, Universitätsbibliothek, MS M I 36, fol. 172v

sequent prints, and secondly to create visual symmetries.[27] Furthermore, he used different colour solutions to cope with the various leaf textures and to create adequate impressions. For example, *Cowslip* was printed with an ink that barely reproduces the internal

27 Ink has been visibly reduced from the first nature print to the second, and more details were printed at "herba edra terrestris" (fol. 161r), "tapsus barbatus" (fol. 162r), "virga pastoris" (fol. 167v), two unnamed impressions (fol. 169r). Symmetries show: "salvia" (fol. 155r), "accidossa" (fol. 167r), "virga pastoris" (fol. 167v), "consolida minor" (fol. 168r).

structure of the leaf, but emphasizes its outline.[28] *Common Hollyhock* was printed with a mixture of linseed oil and soot, which well reflects the venous system, while for *French Sorrel* on the same page the ink was blended with a green pigment close to its natural colour (fig. 3).[29] As Kniphof would later advise, the plants, probably all of them, were first dehydrated and individually prepared for the print, for instance, being flattened, as evidenced by the fact that the shape and the venous structure of the repeated impressions are identical and, furthermore, that some plant parts have been shifted like a set piece.[30]

A German Studies Natures Prints in Northern Italy

The accurate arrangement and execution of the Salzburg ectypes turned them into a tool satisfying specific requirements of clarity. The medicinal herbs occupy their own defined space on the paper sheet, as if they filled the compartments of surviving drug cases from the period or as though they were the pictures in a botanical catalogue or atlas.[31] All intervals between the prints are almost identical; only once do two prints touch each other: that this was accidental is suggested by both leaves being reprinted a second time.[32] The first user of the booklet regularly wrote down the plant names in cursive script, often together with synonyms. Aside from two short morphological descriptions and one notice related to dropsy, other inscriptions by this individual do not exist.[33] Thus the primordial purposes of the booklet were to allow visual scrutiny and study of morphological characteristics and to enable memorising and transmission of the plant names and synonyms.

In 1929, Fischer noted that many of the illustrated plants must be assigned to the Italian area. In fact some belong to the coastal region of the northern Adriatic.[34] His observation concurs with Toresella's assignment, who detected in the mentioned inscriptions

28 "Prima lavenderis" (fol. 164v).

29 "Arelunis. i. poponis" (fol. 172v), "acce dossa" (fol. 172v).

30 The split on the left side of the leave of "virga pastoris" (fol. 167v), produced by a break, is identical in both prints. The two lowest leaves of *liquiricia* (*Licorice* = *Glycyrrhiza glabra*, fol. 173r) do not start in the same place on the stem, as is the case in nature, so that one of them must have been broken off and postponed retroactively next to the stem.

31 See for instance the wooden drug case of a physician or pharmacist from about 1500 in the Germanisches Nationalmuseum, Nuremberg, reproduced in Danièle Alexandre-Bidon: Dans l'atelier de l'apothicaire. Histoire et archéologie des pots de pharmacie, XIIIe–XVIe siècle, Paris 2013, p. 100.

32 Fol. 169r.

33 "lanciola id est plantago minor vel quinque nervia." (fol. 154v), "Apium emoroidale id est apium fluviale vel nintilla habet folia maculata id est rotich." (fol. 170v). The notice about dropsy is on fol. 154v: "ydropsis…".

34 Fischer 1929a (see n. 18), p. 126 and Fischer 1929b (see n. 18), p. 30. – *Beach Morning Glory* ("corrigeola marina", *Calystegia soldanella*, fol. 173r) and *Licorice* (*Glycyrrhiza glabra*, fol. 173r) grow both in coastal areas, *Cerastium sylvaticum* ("lingwa avis", fol. 174v) grows south of the Alps as far as Central Italy.

idioms of the vernacular of Belluno, a region north of Venice.[35] The inscriptions are particularly interesting because of their faulty spelling: for the plant *convalium*, the first user noted "lielie confalium", *primula veris* became "prima lavenderis", the plant *pes asini* he named "besasini", etc.[36] Even when taking into account contemporary Italian dialects, the discrepancies seem exceptionally large.

Furthermore, this person also tagged some nature prints with German names. Under the impression of *Male Fern* ("Farn") he wrote "fern", to *Motherwort* ("Herzgespann") he added "herz span", to *Perfoliated Hare's Ear* ("Durchwachsenes Hasenohr") he wrote "durch" and to *Traveller's Joy* ("Gewöhnliche Waldrebe") he wrote "winde".[37] In addition, German influences can be discerned in his phonetic transcriptions, e.g. "ie" for a pronounced "I" ("lielie" for *lily*) as well as in the frequent use of the letter "w", unknown to Italian and Latin, for a "u", such as "lingwa canis" or "lingwa avis".[38]

To sum up the linguistic aspects, peculiarities such as the inaccuracies of the transcribed Italian names, the typical expressions of the Belluno dialect, the use of German names and German writing allow for conjecture concerning the first user of the Salzburg booklet: a German who visited northern Italy and attempted to take notes of the vernacular plant names and synonyms.[39] He was lettered and active in the paramedical field because he knew Latin and employed a specific medical vocabulary, for example the expressions for dropsy and gout ("ydropsis"; "guta").[40]

An Italian with Expertise in Nature Print Illustration

Impressions from plants taken by a German in the Belluno, in the immediate vicinity to Padua, bring instantly to mind the city's medical university which was, in 1425, together with the university in Bologna, the most progressive in Italy.[41] Indeed, the Salzburg fascicle does not appear to be the result of one person's effort, as has been hypothesised.

35 "folium ovarum" may refer to *Acer campestris*, that is in the Belluno dialect *ovol*; see Toresella and Battini 1988 (see n. 19), p. 75. – The first user employed a dark, almost black ink, which is easy to recognize.

36 Other faulty spellings are: "acce dossa" (fol. 172v) instead of *acetosa*, "cinglussa" (fol. 155v) instead of *cinoglossa*, "mirr rubium" (fol. 156v) instead of *marubium*, "Marsilium vel faba lobina" (fol. 158r) instead of *faba lupina*.

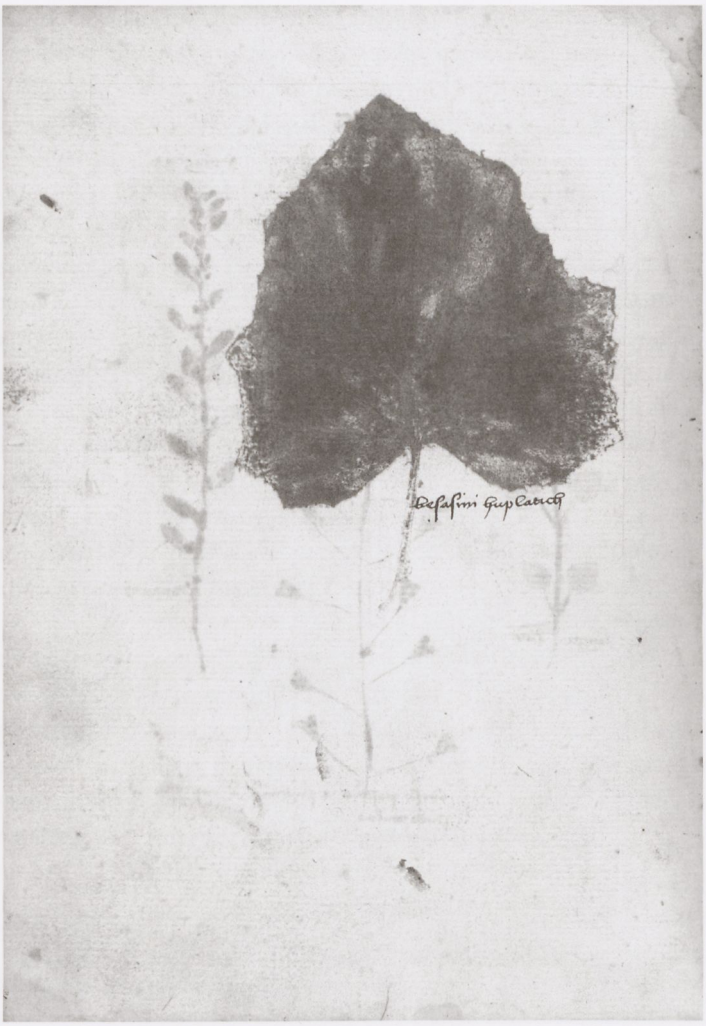
37 Fischer 1929b (see n. 18), p. 29. – The similarity to today's German names is striking: "farn" (fol. 171r), "winde" (fol. 170r), "herz spann" (fol. 174r), "durch" (fol. 174v). I could not find anywhere else the German Name "Winde" for the *Traveller's Joy*. However, the name is conclusive since climbing plants as *Traveller's Joy*, which twist around the tree trunk, are still called *Winder* in German.

38 "lingwa canis" (fol. 155v), "lielie confalium" (fol. 165r), "winde" (fol. 170r), "lingwa avis" (fol. 174v), "sangwina" (fol. 175r).

39 Toresella and Battini 1988 (see n. 19) p. 75, also assume this.

40 Fol. 154v.

41 Lucia Rossetti: Die Universität Padua. Ein geschichtlicher Querschnitt, Triest 1985.



4 Anonymous: *Coltsfoot*, nature print/paper, 238 × 173 mm, ca. 1427; Salzburg, Universitätsbibliothek, MS M I 36, fol. 175v (ruling at top right)

Rather, its form suggests that it is the outcome of an organized process of manufacture that could be related to university teaching or studies. To start with, the booklet pages carry a barely visible frame defining the print space, delineated prior to the nature prints. A first blind ruling has been done with a sharp metalpoint stylus scratching the paper and a leadpoint ruling has been added on top of this (fig. 4).[42] This practice is known to have been employed in bookshops when producing manuscripts. Indeed, the nature prints con-

42 Best seen on fol. 170r, 174v, 175r, 175v.

scientiously respect the leadpoint ruling on all four margins, by aligning themselves centrally within the framed space, or by reaching exactly to its markings, but in no case beyond.[43] Essentially, with regard to the nature prints, the Salzburg booklet expresses a peculiar dualism, the poles of which are marked by an extremely skilled, professional plant printer and a second individual, unfamiliar with the Italian dialect and rather inexperienced in phyto-knowledge. Some plant prints, that the second individual obviously could not identify, were left without names.[44]

The idea of a specialized plant printer appears to be confirmed by the fact that lead white was employed on several pages to cover tiny ink stains.[45] Certainly, at the beginning of the fifteenth century, lead white was readily available in pharmacies.[46] But the utmost accuracy of the impressions' execution and the almost exaggerated diligence – the covered spots do not really contribute to a better perception of the prints – meet the requirements of a professional, commissioned work rather than that of a handbook for personal use. Originally, the booklet would not have included plant names and would have provided the buyer with the opportunity to add his own terminology. Plant names could vary from place to place within a region.[47] Later added synonyms in one's own vernacular dialect are often found in herbal books, thus making a booklet with plant prints without names a conceivable product.

Furthermore, study and recognition of plant morphologies via ectypes seem to have been a common practice towards the beginning of the Renaissance. In a 1524 Nuremberg *Quodlibetarius* manuscript containing instructions for diverse activities, ranging from fishing with bait to bloodletting, 16 different plants are illustrated by 18 nature prints under the heading "All kinds of herbs and roots search on the pages [of this manuscript]" (fig. 5).[48] Impressions of the same plants, i.e. the same ectypes, later reappear on five other

43 On following pages the prints reach exactly to one or several ruling lines: fol. 154v (top left, bottom right), 156v (left), 159r (left and right), 160r (left), 160v (top left), 163r (left and right) 168r (top), 170r (top), 171r, 172r, 174r, 175v, 176r.

44 Fol. 156v, 160v, 163v, 169r, 176v, 177r.

45 Fol. 159r, 166v, 167r, 169r.

46 Mark Clarke: Mediaeval painters' materials and techniques. The Montpellier "Liber diversarum arcium", London 2011, p. 55.

47 Compare the names in the Salzburg booklet with the names in the illustrated manuscript produced in 1441 in Feltre (MS MA 592, Biblioteca Civica Angelo Mai, Bergamo), and the 1487 dated manuscript with ectypes (MS 326, Musée national d'histoire naturelle, Paris), all three produced in Belluno. Some names match, others, however, are completely different for the same plant.

48 MS H62/MS B 200, Universitätsbibliothek, Erlangen-Nuremberg, fol. 56r: "manigerlay kreyter undt wuertzen such im blatt"; see Hella Frühmorgen-Voss et al. (ed.): Katalog der deutschsprachigen illustrierten Handschriften des Mittelalters, vol. 6/5 (Heiltumsbücher – Herzog Ernst), Munich 2015, pp. 466–473; see also Stephanie Leitch: Visual Acuity and the physiognomer's art of observation, in: Oxford Art Journal 38 (2015), 2, pp. 189–208, here pp. 198–203. – I am thankful to Stephanie Leitch, Department of Art History, Florida State University, for having pointed out these nature prints to me.

5 Benedictus Rughalm: *Liber Quodlibetarius*, paper, ca. 290 × 210 mm, 1524; Erlangen, Universitätsbibliothek, MS B 200, fol. 56r

manuscript pages. In this edifying search game, the reader was therefore encouraged to detect and recognize the plant prints within the manuscript, and thus to learn them.

Finally, the iconography of some ectypes in the Salzburg fascicle is so exceptional that it hints at a specialist possessing knowledge of older illustrative material produced in the Belluno. High-quality illustrated herbals were manufactured in the Belluno region from the end of the fourteenth century.[49] It is to these illustrations or copies of them that the

49 Examples are the several copies of the *Codex Bellunensis* (Add. 41623, British Library, London), dating from the end of the fourteenth century; the illustrated herbal of Antonius Guarnerinus,

6 Sweet Spurge in natura

Salzburg ectypes refer. Two analogies are particularly striking. The ectype of the *Turk's Cap Lily* does not show a single foliage leaf, but an entire whorl with six leaves, thus creating an illustration in birds-eye view of the plant's leafage. In doing so it adopts an iconographic novelty that first appeared in the so-called *Codex Bellunensis*, a herbal painted and repeatedly copied in Belluno at the end of the fourteenth century (fig. 2 and pl. 3).[50] In the *Codex Bellunensis* and its copies, the plant is shown in profile, yet two whorls have been illustrated in top-down view, as in the Salzburg fascicle. I know of no other illustration in top-down view of this plant's whorl anterior to the Salzburg booklet. Hence, a connection between both images can be assumed – even more so because the illustration in top-down view serves, in both cases, as a didactic tool to elucidate the plant's particular morphology.

finished 1441 in Feltre; the MS with nature prints in Paris dated 1487 (MS 326, Musée national d'histoire naturelle, Paris). For the copies of the *Codex Bellunensis* see Giordana M. Canova: Il "Codex Bellunensis" nella storia del manoscritto botanico e della sua illustrazione, in: eadem (ed.): Codex bellunensis. Erbario bellunese del XV secolo, Londra, British Library, Add. 41623, 2 vols., vol. 2, Feltre 2006, pp. 1–34, here pp. 29–34.

50 "Pubium maiorum", fol. 172r; *Codex Bellunensis*, Add. 41623, British Library, London, fol. 66v.

A similar dependency on the visual material of the *Codex Bellunensis* may be asserted for the ectype of *Sweet Spurge* (pl. 2 and 4).[51] As with *Turk's Cap Lily*, the iconography of *Sweet Spurge* in the *Codex Bellunensis* was novel, demonstrating the condition of the plant in the second year of growth, when it forms a wreath of four to five leaves at the end of the stem, from which grow four or five radial stalks wearing leaves at their end (fig. 6). Accordingly, the printer of the Salzburg ectype chose to take an impression of a plant of the same age, bearing the same morphological characteristics, and he arranged the herb for the print in a layout following the layout of the painted illustration. From this, thus, it can perhaps be assumed that the printer knew the illustrative material of the *Codex Bellunensis* or its derivatives.

Conclusions. Nature Printing, Scientific Images, and Naturalism

Detailed analysis of the Salzburg booklet, while comparing it with the details on nature printing provided by Martius' compendium, affords a more concrete understanding of the execution context of its plant impressions. On balance, the results of the investigation point to a German visiting northern Italy who acquired the prints, assigned them local names, wherever he felt capable, and finally brought them home across the Alps. The didactic display of the impressions demonstrates a learning-oriented process of production. Travels of Germans to Italy were common in the fifteenth century, especially in connection with the University of Padua. To give an example, the German physician Hartmann Schedel, highly esteemed for his *Nuremberg Chronicle* (1493), studied medicine in the city between 1463 and 1466.[52] A glance at the university's enrolment lists confirms the high number of German medical students in Padua.[53]

The fact that, at least in Padua, herbalism can be associated with university education, well before the introduction in 1539 of the first *Cattedra* for medicinal plants at the University of Bologna, can only be briefly sketched within the scope of this essay.[54] For this, the case of Hartmann Schedel is instructive. During his stay in Italy, Schedel drew up a

51 Fol. 156r; *Codex Bellunensis*, Add. 41623, British Library, London, fol. 94r.

52 Juliane Trede: Das drit alter. Hartmann Schedel als Student in Padua, in: Bettina Wagner (ed.): Welten des Wissens. Die Bibliothek und die Weltchronik des Nürnberger Arztes Hartmann Schedel (1440–1514), exh. (Bayerische Staatsbibliothek, Munich), Munich 2014, pp. 46–50.

53 For these lists, see Gaspare Zonta and Giovanni Brotto (ed.): Acta graduum academicorum Gymnasii Patavini ab anno 1406 ad annum 1450. Cum aliis antiquioribus in apprendice additis, iudicio historico collecta ac digesta, Padua 1922.

54 For the study of samples at medieval and Renaissance universities, see Karen M. Reeds: Botany in medieval and Renaissance universities, New York et al. 1991; for Luca Ghini, the holder of the first *Cattedra*, see Franco A. Meschini: Ghini, Luca, in: Dizionario biografico degli italiani vol. 53, Rome 1999, pp. 767–771; Dietrich von Engelhardt: Luca Ghini (um 1490–1556) und die Botanik des 16. Jahrhunderts. Leben, Initiativen, Kontakte, Resonanz, in: Medizinhistorisches Journal 30 (1995), 1, pp. 3–49.

manuscript in which he included transcriptions of several texts related to his studies. Within this volume, he accorded a prominent place to the transcription of the treatise *Aggregatio simplicium medicinarum* (*Aggregation of medicinal simples*), composed in 1453 by his professor Mathaeus Bolderius.[55] Schedel's transcription is the only extant copy of Bolderius' text and may be called sensational, because it indicates that, as early as in the mid-fifteenth century, some university professors did study officinal herbs and were amongst those scholars interested in personally observing the various characteristics of plants. Bolderius grouped the herbs (and other simples) known to him, according to their characteristics, and effects, and discussed morphological and sensual peculiarities, like taste and odour.[56] Rubrics call the reader's attention to practically oriented details: whether the plants should be gathered in spring or summer; whether they are flammable; whether they can be administered to children, etc.[57] Therefore, Bolderius had not only a theoretical, but also a practical approach to herbs, his knowledge was not only bookish but based on extensive personal experience.

There are other important aspects to Schedel's manuscript. Schedel placed a full-length portrait of Bolderius at the beginning of the treatise, showing him in upright position, holding plants in his outstretched hand and inspecting them carefully (fig. 7).[58] Thus, both text and picture establish a direct connection between herbalism and university teaching in Padua: On the one hand, the text explicitly discusses herbal properties, on the other, the portrait commissioned by Schedel shows the professor emphasising the importance of plants in medicine and the centrality of their personal observation for their study. Hence, Schedel's university manuscript can be understood as an early instance of the practice of *autopsia*, i.e. the personal examination of plants, within the context of university teaching.[59] This point of view is confirmed by the inclusion in Leonhart Fuchs herbal *De historia stirpium* (1542) of a portrait of the author.[60] Incorporated at the book's beginning on the verso of the title page, Fuchs' portrait was meant as a programmatic statement of the book's scientific methodology. It was similar to the image of Schedel in

55 The composition date appears in the colophon of the treatise's index. MS Clm 13, Bayerische Staatsbibliothek, Munich, fol. 28r. For the *Aggregatio* see Tiziana Pesenti: Professori e promotori di medicina nello studio di Padova dal 1405 al 1509. Repertorio bio-bibliografico, Trieste 1984, p. 62.

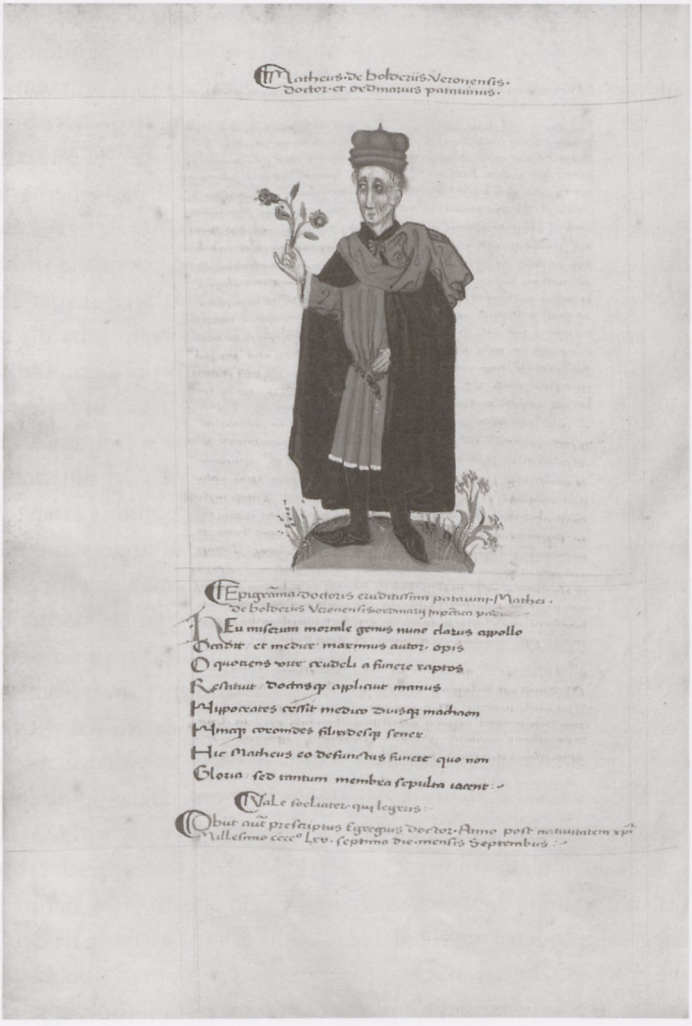
56 See for instance the descriptions in MS Clm 13 (see n. 55), fol. 27r–37r, for instance 32v for taste. On fol. 28v, subchapters were meant to discuss different parts of a plant.

57 For the gathering seasons, see fol. 28v. For the flammable plants, see fol. 30r.

58 MS Clm 13 (see n. 55), fol. 17v.

59 This kind of phytologic lessons did not necessarily take place in the university's lecture halls, but could be performed in the professor's housing. See Cordus' 1534 description of his class in his private garden (Euricius Cordus: Evricii Cordi Simesusii medici Botanologicon, Cologne 1534); cf. Peter Dilg: Das Botanologicon des Euricius Cordus. Ein Beitrag zur botanischen Literatur des Humanismus, Marburg 1969. – *Autopsia* is commonly described as typical for scholarly practises since the Renaissance. Amongst the rich literature on *autopsia* as a principle of science, see Lorraine Daston and Elizabeth Lunbeck (ed.): Histories of Scientific Observation, Chicago 2011.

60 Fuchs 1542 (see n. 19), reverse of the title page.



7 Anonymous: *Portrait of Mathaeus Bolderius*, in: Hartmann Schedel: Compendium of writings, paper, 1463-1466; Munich, Bayerische Staatsbibliothek, MS Clm 13, fol. 17v

his book, depicting the upright author, dressed in representative clothing, holding a herb in his hand. The book was in its time a demonstration of *autopsia* as a scientific method, which Fuchs discussed in his book.[61] In adopting the same type of frontispiece portrait employed earlier by Schedel, Fuchs therefore corroborates *a posteriori* the reference to *autopsia* in Bolderius' likeness.

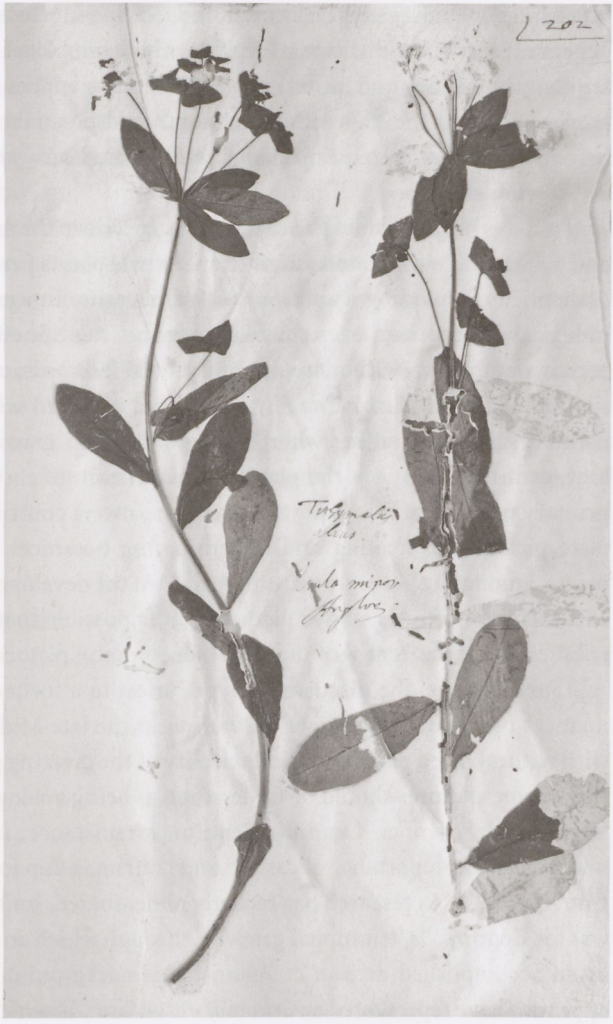
61 Fuchs 1542 (see n. 19), p. 5 of his introduction.

Returning to the Salzburg ectypes, it is important to note that the process of exsiccating the plants in preparation for the nature printing manifests considerable craftsmanship. As indicated in the instructions, descriptions and comments in Martius' manual, the booklet illustrator's competence involved long-acquired knowledge of practical matters to create such complex images. The exsiccated specimen of *Sweet Spurge*, which naturalist Ulisse Aldrovandi (1522–1605) included after 1551 in his herbarium, provides an idea of the complexity of the drying-out-process (fig. 8). In spite of the use of a dried plant for the Salzburg ectype, Aldrovandi's specimen can hardly compete with the latter with regard to the visualization of the plant's morphology and overall shape: The leaves of the stem are not nearly horizontal as they are in nature, the wreath is hardly recognisable as such, the stalks, growing radially in nature, are in upwards position. Additionally, the reference to older herb illustrations in the Salzburg fascicle speaks in favour of the producer being a knowledgeable artisan. It is barely conceivable that a German with poor knowledge of the Belluno dialect had such a complete knowledge of older illustrations in Belluno herbals.

I would like to relate the considerations made in this essay to two different, although mutually related, contexts. Firstly, I would like to understand the plant prints discussed as evidence for a reawakening of interest in personal, empirical, observation of the flora. Recent scholarship has drawn attention to the changes occurring in phytologic studies before the sixteenth century.[62] Indeed, the importance of sensory examination for establishing new knowledge about the study objects increased from the end of the fourteenth century onwards. This new scholarly approach contrasted with the position of previous herb specialists, tending to accept only bookish knowledge. As the nature prints in Salzburg focus on the plants' morphology and on a learning-oriented visualisation, optical scrutiny must have been an important factor as early as 1427, at least for some of those interested in plant studies. Considering that, in the fifteenth century, visual examination became an important movement in the field of herbalism, nature prints like those in Salzburg seem to have provided adequate tools for satisfying its demands and consolidating the method. Indeed, the plant impressions in Konrad's booklet are the oldest ones preserved in a series of nature prints that, for a certain time, appear to have competed with painted plant illustrations and the first phytologic woodcuts.

Obviously nature prints have disadvantages: flattening the plant; partially distorting the natural overall shape; lack of colour, etc. However, this should not obscure the fact that, in the fifteenth and far into the eighteenth century, as evidenced in Kniphof's editions, ectypes provided enormous advantages for recording and disseminating botanical knowledge. Another advantage included their providing a cost-effective means of reproduction. Taking the two extremes, given by Kniphof, of four impressions, for extremely

62 For instance Brian W. Ogilvie: The science of describing. Natural history in Renaissance Europe, Chicago 2006; Claudia Swan: The uses of realism in Early Modern illustrated botany, in: Jean Givens, Karen M. Reeds and Alain Touwaide (ed.): Visualizing Medieval Medicine, 1200–1550, Aldershot 2006, pp. 239–250.



8 Ulisse Aldrovandi: *Dry Sweet Spurge* (left), glued inside paper herbarium, after 1561; Bologna, Orto Botanico ed Erbario dell'Università di Bologna, Erbario, vol. 2, fol. 202r

delicate plants, and 150 impressions, for vigorous plants, as a benchmark for the reproductive capacity of nature printing, it seems that craft specialization in this field would have been reasonably efficient. Ectypes allowed, indeed, an exchange of illustrations based on original plants, and, in this sense, a transmission of an "exactly repeatable pictorial statement", a status that William Ivins claimed for images printed after the invention of the book press.[63] The highly specialized character of the Salzburg nature prints suggests that this kind of image production and exchange could already have been in place for a considerable time by 1427. In his review of Ivins' book, Gombrich emphasized that the era

63 William Ivins: Prints and visual communication, Cambridge 1953, p. 2.

preceding Gutenberg's invention was, indeed, one in which it was (technically) possible to generate reproducible images. He gives the example of "stamping images on wax or another substance", and indeed, repeatability also applies to nature printing.[64] Gombrich emphasized that the knowledge generation and practical uses of informative books like herbals, bestiaries, astronomical texts, etc., created early and strong demands for "facsimile" reproduction.

What is more, besides the capacity to reproduce the same nature print, between four and 150 times, taking impressions from natural plants furnishes the resulting image with authenticity, providing a specific sort of scientific image. This authenticity, created by indexical print contact, even contributes to the scientific efficiency of nature prints, within certain parameters, without replicability. In other words, one scholar receiving an impression taken from a *Turk's Cap Lily* whorl, and a second scholar provided with a different nature print from another whorl of *Turk's Cap Lily*, may reasonably discuss its morphology, as if they had seen the plant's whorl in each of their gardens. It has not been the primary purpose of this study to contest the strong contribution of woodcut and copperplate pictures in creating and disseminating botanical information. However, nature prints, amongst other early pictures, heralded the development of the idea of transmission and exchange of informative pictures.[65] It is possible that nature printing strongly contributed to the awareness of the need of a common pictorial basis for scientific exchange.

Furthermore, the discussed ectypes attest to a form of pictorial representation that nuances our understanding of *naturalism* in the late Middle Ages. Ectypes were created with natural dried plants. The indexicality of the creating process (print on paper) signals that ectype-pictures should be understood as being analogous to other forms of indexical images and artworks. Cennino Cennini, for instance, in his *Libro dell'arte* (ca. 1400) underlined the importance of casting and craftsmanship for "copying and imitating things from nature".[66] As research has recently remembered, imitating nature, as well as casting, was for Cennini, "a 'triumphal gateway' through which an apprentice must pass to emerge as an accomplished artisan".[67] Against this background, the Salzburg ectypes, indeed, appear to have represented a *variant of naturalism*, in which *life-likeness* was subordinated to the *documentation of the botanical characteristics* of plants. As for today's botany atlases,

64 Ernst H. Gombrich: Review of William M. Ivins, Jr., Prints and Visual Communication, in: British Journal for the Philosophy of Science 5 (1954), pp. 168f., here p. 169.

65 For informative images, see Givens 2005 (see n. 17), *passim* and particularly chap. "Images and information".

66 Cennino d'Andrea Cennini: The Craftman's Handbook [Il Libro dell'Arte c. 1400], ed. and transl. by Daniel V. Thompson Jr., New York 1960 (1st ed. 1933), p. 123.

67 For Cennini's castings, see Pamela Smith: Artisanal Knowledge and the Representation of Nature in Sixteenth-Century Germany, in: Therese O'Malley and Amy R. W. Meyers (ed.): The Art of Natural History. Illustrated Treatises and Botanical Paintings, 1400–1850, New Haven, 2008, pp. 15–31, here p. 17. See also Norberto Gramaccini: Das genaue Abbild der Natur – Riccios Tiere und die Theorie des Naturabgusses seit Cennino Cennini, in: Natur und Antike in der Renaissance, exh. (Liebighaus Skulpturensammlung, Frankfurt/M.), Frankfurt/M., 1985, pp. 189–223.

the demonstration of morphological aspects, for studying and recognizing plants, is not necessarily linked to the optical illusion of a three-dimensional "likeness" of a herb.

Finally, the role of craftsmanship in the process of creating impressions of nature is significant. As Martius' compendium with its descriptions of the different techniques and their complexities, as well as the discussion of the Salzburg ectypes, have shown it was craft and skill that lead to suitable illustrations in the botanical books discussed here. Even though nature prints may have initially appeared to be an almost intuitive, effortless form of image making to an inexperienced reader, this essay has emphasized the experience and artifice that was necessary for their creation from the fifteenth to the eighteenth century – similar to the masterfulness that was necessary for Cennini in his castings. In contrast to earlier interpretations of the Salzburg nature prints, it is now clear that it required specialized training and expertise rather than the random initiative of an individual to produce them. In so doing, these examples flag the need to take different forms of *naturalism* and *imitations of nature* from the beginning of the fifteenth century into consideration.

For Cennini as well as for nature castings in the sixteenth and seventeenth century, see Robert Felfe: Naturform und bildnerische Prozesse. Elemente einer Wissensgeschichte in der Kunst des 16. und 17. Jahrhunderts, Berlin 2015, *passim* and, for Cennini, pp. 20f.