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The *ad vivum* Conundrum. Eyewitnessing and the Artful Representation of Naturalia in Sixteenth-Century Natural Science

The Shifting Meanings of *ad vivum*

It is easy to understand why *ad vivum* representation continues to attract attention and debate. It constitutes a junction where the interests and research paths of historians of late medieval and early modern culture, science, and art meet. *Ad vivum* is linked with art historical discussions of Renaissance naturalism, mimesis, the genres of portraiture and still life, prints and drawings, book illustration, and even the long-lasting debates on perspective. At the same time, *ad vivum* and its companion terms autopsy and *experientia* circumscribe a privileged area of debate for specialists in humanism, philosophy, the history of medicine and natural history, cartography, early modern communication media, and the history of collections. Among philosophers and historians of science – a term that I use here as shorthand for a wide range of expert knowledge – much attention has been paid in particular to the Renaissance re-valuation of *experientia*, personal observation and witnessing, and empirical knowledge that manifested itself, among other things, in *ad vivum* representations.[1]

Two aspects in particular are striking about *ad vivum* discussions. The Latin and Greek origins and semantic fields of *ad vivum*, *experientia* and autopsy are well known, but it is not always easy to understand whether variations in the meaning and use of *ad vivum* and its vernacular versions originate in the early modern period itself, in modern debates and interpretations, or in both.[2] Those variations were by no means minor. In the period on which I focus (c. 1500–c. 1620), *experientia* ranged in meaning from experience to experiment(ation), for instance.[3] The originally Greek term autopsy was not only used in its most literal sense – to see with one's own eyes – but also in the more specific one of direct visual observing and witnessing, for instance in cosmography, anatomy, and the study of plants and animals. In modern

usage its meaning (autopsy for the post-mortem examination of a corpse to determine manner and cause of death) is largely restricted to the domain of medicine, but still closely links up with an early-modern use in anatomical dissection, inspection, and medical demonstration that can be traced back at least to early sixteenth-century, pre-Vesalian days in Italy.[4] While autopsy refers to the act of observation, early modern sources generally tend to use *ad vivum* as a qualification of the visual representation of what has been observed. As I will argue in what follows, early modern visual and textual sources from the domain of natural history make abundantly clear that this qualification was sometimes used in a strict sense, sometimes in a loose one, and sometimes in both. But more importantly, in that same context the notion of lifelike painting – whether called in so many words *ad vivum* or not – can refer to the act of observing the living subject that is to be depicted; to the act of depicting itself; or to the resulting lifelike representation(s). *Ad vivum* may refer to any of these stages of image-making. Wherever that may lead us, it should not be to new, more precise definitions.

Secondly, in both art history and the history of science, the conglomerate of naturalism, *ad vivum* representation, autopsy, and *experientia* is – or has been – part of success stories: seductive, interlinked, grand, and teleological historiographical narratives that repeat some of the (self) images projected onto (and of) the Renaissance and seventeenth century. The art historical narrative spoke of the ›triumph‹ of naturalism, mimesis, and perspective, implying a break with and progress after the Middle Ages. The narrative of the history of science focused on an increasing turn to and positive evaluation of direct, personal eyewitnessing (and more generally of sensory experience), experimentation, and a critical attitude that encroached on a reliance on tradition, book learning, and classical authority. Sixteenth-century natural history, cosmography, and medicine (anatomy) were among the domains of knowledge where contrasts between ›new‹ expertise and insights based on autopsy, on the one hand, and ›old‹ classical book knowledge, on the other hand, were emphasized and expressed by the sixteenth-century experts themselves.[5] In the most straightforward and by now outdated version of this grand narrative, developments inexorably culminated in the Newtonian, Baconian, and Galilean scientific revolution of the seventeenth century. Both storylines – which I obviously present here in a very simplistic form, for clarity's sake – have been under fire for many decades, but they have not been replaced.

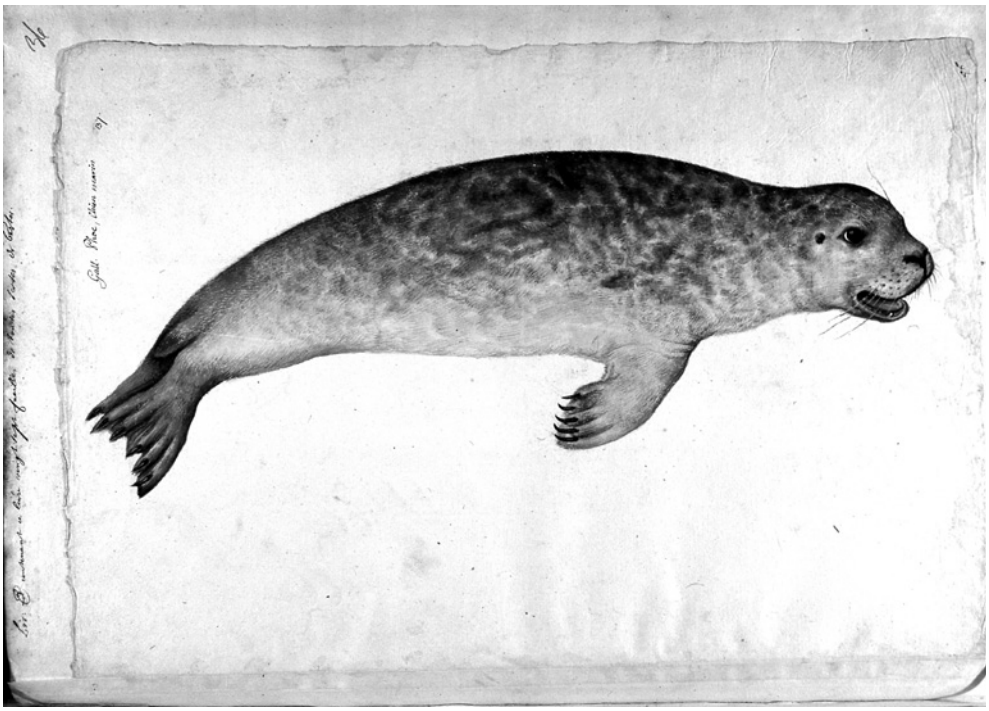
It is, indeed, questionable whether many historians would find a new grand narrative desirable, whatever its contents. Yet, by the sheer weight of historiographical discussion, efforts to analyze *ad vivum* and related notions in the context of the changes that were taking place between the fifteenth and the seventeenth centuries run the risk of reverting back to those big narratives.

Experientia and Research Practices in Early Natural History

In what follows I will focus on the specific period and cultural context of sixteenth-century visual natural history that seems to me crucially relevant to these themes and as yet insufficiently examined. Most attention has so far been paid to woodcut illustrations that interacted with printed texts in published early modern works. Those will be discussed below as well, but I would like to draw more attention to the thousands of extant, but under-investigated, naturalia drawings created in the long sixteenth century in order to document, portray, and investigate living nature (fig. 1). Of all early modern European sources, it seems to me that this visual evidence helps show and demonstrate the closest links between modes and practices of representation and the notions of life and lifelikeness which come together in *ad vivum*.

As a historical phenomenon, that visual evidence belongs to a specific period and context. A strong upsurge of interest in and research on all kinds of naturalia can be traced from at least the fifteenth century. It spread all over Europe, fanning out, it seems, from a core zone that comprised much of Italy, the Burgundian areas, and the Central European and Iberian zones ruled by the Habsburgs. It manifested itself in collections, fashion, gardens, decorative arts, herbariums with dried plants, manuscript herbals and books of health, albums with colored drawings, printed works etc. And it stimulated the gradual transformation of what is usually called natural history into a specialist field of knowledge and a scientific discipline, natural science.[6]

Practices that were predicated upon direct personal observation and *experientia* soon began to form part of the methodology of natural history. The extensive explorations of the young Pietro Andrea Mattioli (1501–1578), who became one of the most widely read European naturalists of his century, show that botanical field research was already conceived as a true research method in the 1520s–30s. Ciancio has indeed explicitly linked it with new forms of empiricism. That chronology fits in well with the creation of the first



1. Seal, by an unknown painter, probably 1560s, Southern Netherlands, Libri Picturati A16, fol. 36/37, Kraków, Jagiellon Library. © Jagiellon Library.

university botanical gardens during the early 1540s in Italy, and the many private botanical gardens from the 1530s–40s in various European countries. Those gardens functioned as both living collections and loci of experimentation with and acclimatization of plants.[7] This same period also saw the rapid spread of plant and animal representations that met the requirements of precision, lifelikeness, and reliability: naturalistic *ad vivum* representation embodied these characteristics and was intrinsically linked with these newly developing research practices.

As is well known, the upsurge of natural history in the long sixteenth century was boosted by phenomena as diverse as the European arrival in the New World and the discovery of many thus far unknown exotic species; the rapid spread of book-printing techniques from the late fifteenth century onwards; and perhaps most of all, the Renaissance rediscovery of classical authors who had written about living nature, especially Aristotle, Pliny, and on botanical-medicinal matters Dioscorides and Theophrastus. While the classi-

cal texts on plants and animals remained a foundation of knowledge about nature until well into the eighteenth century, sixteenth-century naturalists examined and critically analyzed this classical legacy, added to it, shook it up, corrected, and adapted it. In their manuscripts and printed publications, successive accretions of new and corrected information about plants, animals, and medicine almost bury that classical core, soon superseding it in terms of quantity. The supplemented commentaries on Dioscorides by Mattioli, to name but one famous example, grew enormously in size in the course of the sixteenth century.[8] Most such accretions united a critical philological analysis of the old texts, traditional knowledge, and practical sensory experience, with an emphasis on the visual inspection of ›new‹ plants and animals, live or dead, whole or in fragments, European or exotic.

Given the weight of the classical textual tradition, it is important to emphasize that the most immediate cultural roots of at least two and perhaps all three empirical methods mentioned above – fieldwork (as a method of investigation and discovery that attributed crucial importance to autopsy); *experientia* (in the form of experimentation with plants); and *ad vivum* representation – were not primarily in the classical authors, but in historical practice as transmitted generation after generation. The fact that many sixteenth-century naturalists liked to emphasize their continuity with the classical tradition (including the fieldwork by their predecessors in antiquity) and at the same time both distanced themselves from the Middle Ages and tended to underplay the contribution of practical knowledge to their own work, should be recognized as a legitimizing rhetorical strategy.[9] There was much truth in it, as in all effective rhetoric, but it left out at least as much.

Of course, knowledge of nature was not newly invented in the early modern period after the rediscovery of the writings of Pliny, Theophrastus and Dioscorides, however important these works were. Fieldtrips to search for (medicinal) plants and garden and agricultural experimentation had existed in earlier European history. It defies common sense, therefore, to assume that the naturalists of the sixteenth century would have refused to learn from (or have remained uninfluenced by) the practices of agriculture, food culture, gardening, and medicinal plant use that surrounded them and with which they grew up. Their personal histories attest to this learning. As a very young child Conrad Gessner, for example, was taught by his great-uncle, who grew and collected medicinal herbs, to identify, name, and find medicinal plants

both in the garden and in the fields, without any particular recourse to book knowledge and using mainly local plant names. Gessner's father, incidentally, was a poor furrier.[10] Practice-based plant knowledge can, furthermore, easily be shown to have found its way into the great encyclopedic printed and illustrated herbals and works on animals of the sixteenth century: it is especially manifest in the naming of naturalia and the descriptions of their medicinal and food uses. Curiously, modern researchers have paid little systematic attention to this aspect, while decades of research have gone into an analysis of the classical sources of these early modern works.

One channel via which practice-based knowledge entered the learned tradition was via informants: virtually all naturalist-authors integrated a mass of information gathered via experts such as gardeners, plant hunters, naturalia collectors, apothecaries, farmers, fishermen, and herbalists.[11] The learned naturalist-authors themselves were a second channel. They were not merely men of books, but also men of action and of practice. Many of them were practicing physicians who themselves worked with and relied upon plant-based medicine, who professionally collaborated with apothecaries, and who personally went out into the fields in order to see plants, animals, minerals, and other naturalia with their own eyes. While in the fourteenth and part of the fifteenth centuries much nature knowledge had remained in the domain of practice, it slowly fused in the long sixteenth century with recovered classical book knowledge. The new mixture turned out to explosive. Out of it grew not merely a much vaster corpus of information enriched by local knowledge, but also the methodology of the newly developing discipline of natural science, which then gained its own momentum.[12]

The situation with respect to visual information was fundamentally different from the textual one, and the implications of this difference have perhaps not yet been explored sufficiently. The core of classical knowledge of living nature as transmitted via numerous generations of manuscripts, was almost completely without original, Greek or Roman images.[13] Nor did fifteenth- and sixteenth-century naturalists have access to many other classical representations of living naturalia. Most of the mosaics, ceramics, and Roman wall paintings (such as the famous *trompe l'oeil* frescoes of a garden in Livia's house from 30–20 BC)[14] with naturalistic representations of plants and animals that are known at present were invisible during the sixteenth century. Textual classical sources did indeed transmit an ideal of strongly naturalistic repre-

sentation – for instance in Pliny's well-known story about Zeuxis and the ideal of painting as the creation of the illusion of reality[15] – but no actual classical corpus of images of plants and animals survived that could serve early-modern naturalists in their attempts to document living nature.

Early modern naturalists were thus on the one hand confronted by the task of trying to understand, without much visual assistance, which plants and animals were discussed in the Greek and Latin texts. At the same time, they were surrounded by masses of living and dried plants that had vernacular names but could not so easily be matched with the Latin or Greek descriptions. The available visual models in late medieval bestiaria and herbals were, on the whole, rather stylized and often schematic, although they could and sometimes did serve for the identification of actual plants.[16] Early-modern naturalists tended to find these stylized images unsatisfactory, but the highly relevant question of why this was the case is yet another question that is underexplored. Visual representations of the natural world thus had to be invented almost completely anew. This concerned not merely the subject matter (what to include and what not; how to deal with exotica that could never have been seen by classical authors; how to visually order nature), but also the rules of *how* best to depict in the service of visual description, identification, and information transmission.[17] The most obvious source for such new images was living nature.

Both the need felt by early modern naturalists to create a new visual corpus adapted to their needs and their discontent with the images from the preceding centuries cannot be merely inferred from the explosion of sixteenth-century nature drawings. It was also put in so many words at the time. The German surgeon Hieronymus Brunschwig (c. 1450–c. 1512), for example, published a work on distilling medicines from plants in 1500. As Olariu has shown, Brunschwig made it clear that he was not pleased with the rather coarse woodcut illustrations chosen by his publisher and reused from the recent *Gart der Gesuntheit* (1485/86), a vernacular book of health. Brunschwig, therefore, encouraged his readers to go out into nature and look at the real plants for themselves.[18]

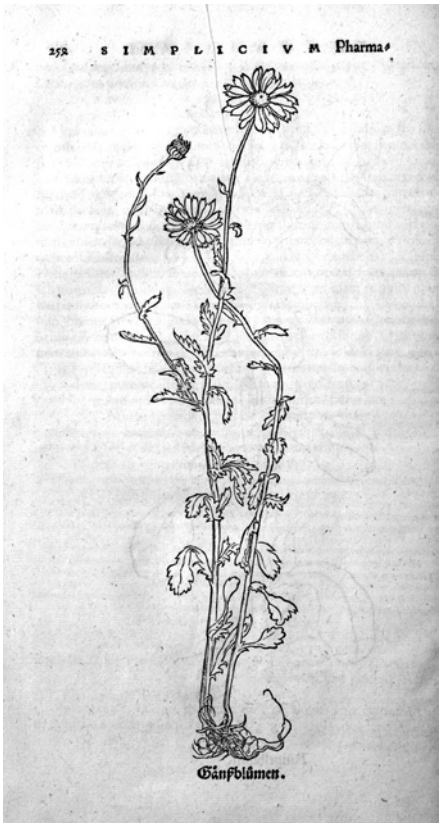
Another case of disagreement between author and publisher on illustrations of naturalia is equally informative. In 1530 the very first of the major printed and illustrated new herbals appeared: *Herbarum vivae eicones ad naturae imitationem, summa cum diligentia & artificio effigiatae*. It was written

by the German theologian and physician Otto Brunfels (1488–1534) and published by Johannes Schott in Strasbourg in 1530. The German version appeared in 1532 with the same publisher as *Contrafayt Kreüterbüch.* As both titles indicate, this work presented itself as a herbal with high-quality, naturalistic plant illustrations. Its woodcuts are indeed regarded as the very first lifelike plant illustrations of the early modern period. They are highly naturalistic portraits of individual plants – blemishes, drooping leaves, wilting stems, broken flowers, and all (fig. 2). The woodcuts are based on model drawings made specifically for this edition by the Strasbourg painter Hans Weiditz (c. 1495–c. 1536). Art historians have compared them with naturalia drawings by his close contemporary Albrecht Dürer (1471–1528).[19]

As has been pointed out by various scholars, it was not the author Brunfels' choice to use Weiditz' highly naturalistic plant images. Schott, the Strasbourg publisher, realized the selling power of new, good-quality plant illustrations, and it was most probably he who commissioned Weiditz and chose the title(s) of the Latin and German editions with their explicit references to lifelike illustrations.[20] Even the choice of which plants to illustrate may have been made by the publisher and the painter rather than by the author. It may also have depended on the painter's access to actual (fresh or half-dead) plants to portray. Less attention has been paid to the fact that Brunfels, notwithstanding his complaints about Weiditz, explicitly acknowledges the latter's fame as a painter and points to a non-commercial reason why new visual documentation was sorely needed. He states that decent plant images had been hard to come by for the last two or three hundred years and that only recently – that is, presumably, during the past decades – the rich and powerful had taken up this task from antiquity by commissioning painters to illuminate books. Brunfels adds that he had seen some of these and had heard others praised, but that the rich patrons allowed hardly anyone to see these great treasures. He also hints that the quality of many older (that is late fifteenth-century) *printed* naturalia illustrations left much to be desired. Brunfels wanted to relaunch herbal and plant medicinal knowledge and put it on the right track. He thought that the only way to do so was by means of *contrafactur* and via the corrected descriptions of the classical authors.[21] This whole episode contains more than one valuable pointer: in this case (and whatever the combination of reasons involved) the innovative visual choice of *ad vivum* painted plants was not made by the university-trained author but by a famous painter and a commercially astute

publisher. Furthermore, Brunfels' remarks not only hint at the influence of illuminated manuscripts on nature drawing in the sixteenth century. They also underline that naturalists of this period acutely felt the lack of a visual corpus and presented (correctly or not) the illustration of nature as a task that resumed and continued the enterprise of classical antiquity.

It is hard to overestimate the scale and innovative thrust of this phenomenon. Already from the late fourteenth and early fifteenth centuries – well before print, therefore – the number of manuscript herbals with hand-painted images of plants (and some animals) began to increase exponentially: Collins gives a total of 193 surviving herbals for the fifteenth century as compared to 136 for the whole of the preceding nine centuries.[22] Collections and albums of plant and animal drawings on paper and parchment followed this trend, which vastly accelerated in speed, size, and range of contents. Its better-known manifestations are the impressive illustrated and encyclopedic works on living nature of the sixteenth century: the publications by Otto Brunfels, Hieronymus Bock, Leonhart Fuchs, Pietro Andrea Mattioli, Rembert Dodoens, Carolus Clusius, and Mattias de Lobel have become landmarks in the history of plant medicine and botany, as have those by Pierre Belon, Guillaume Rondelet, and especially Conrad Gessner in that of zoology. Their thousands of generally naturalistic woodcut illustrations are, however, only part of a much vaster mass of images, of which the non-printed sixteenth-century colored naturalia drawings constitute the lesser-known segment. Many thousands of such original drawings still exist, often in albums, so-called ›paper museums‹.[23]



2. Lifelike plant illustration, woodcut in Otto Brunfels, Herbarum vivae eicones, Strasbourg, 1530, p. 258. Public domain. The model drawing by Hans Weiditz (not shown here) is in Felix Platter's herbarium, vol. X, p. 11, BBB ES 71 (11) Burgerbibliothek Bern.

The following are only a selection of the major extant albums with naturalia drawings from the sixteenth century: the painted herbal of the Venetian Pietro Antonio Michiel in five volumes with some 990 folios (c. 1545–1570); the Flemish Libri Picturati A16–30 (c. 1565, and 1590s) commissioned by Charles de Saint Omer, in fifteen volumes with some 1,400 folios of plants and some 170 of animals; the herbal of Georg Oellinger from Nuremberg (1550s) in one volume with some 660 drawings, mainly of plants; Gessner's plant drawings (c. 1545–1565) in two volumes with some 460 loose folios and approximately 1,500 plant images; the Platter-Gessner zoological albums (c. 1565–1615) in two volumes, with around 180 folios with aquatic creatures, beasts, reptiles, amphibians, and insects; the nine-volume Codex Fuchs (c. 1535/40–1564) with some 1,540 pages with large plant watercolors; the eleven volumes of the albums Anselmus de Boodt (late sixteenth–early seventeenth century) made for Emperor Rudolph II, with some 800 illustrated folios depicting animals and plants; the Aldrovandi collection (c. 1560–1610) in ten volumes with some 2,500 images of animals, plants, fruits, stones, and some human beings; and the eight volumes with botanical (c. 780) and mycological drawings made by and for Prince Federico Cesi of the Accademia dei Lincei (1620s).[24]

This huge visual corpus that was created almost completely anew in the years after about 1500 has as yet been only partly explored, especially by art historians.[25] Nearly all these colored drawings were created to visually describe naturalia and stimulate the knowledge of nature. With an explosion in numbers from about the 1520s–30s, these image collections are the very first in European post-classical history to present naturalistic, recognizable, and identifiable drawings of numerous plants and animals. And although further large bodies of naturalia images were created in the seventeenth and eighteenth centuries, many of the sixteenth-century drawings and especially the printed illustrations based on them continued to be used for centuries. They set a visual precedent.

Ad vivum and the Rhetoric of Reliability

It is impossible to quantify how many of these thousands of drawings were claimed to have been painted *ad vivum*.[26] Yet, in spite of great differences in painterly quality and style, their functions in the service of knowledge of nature indicate that virtually all of them were expected to represent an animal

or plant recognizably and truthfully. In terms of function, this corpus thus differs from mainly decorative plant or animal representations.[27] Here we enter the domain of the truth claims and epistemic value of images. Here we also find ourselves in the zone where autopsy, eyewitnessing, and personal observation meet the visual formats chosen to best convey both information and the effect of truthfulness.[28]

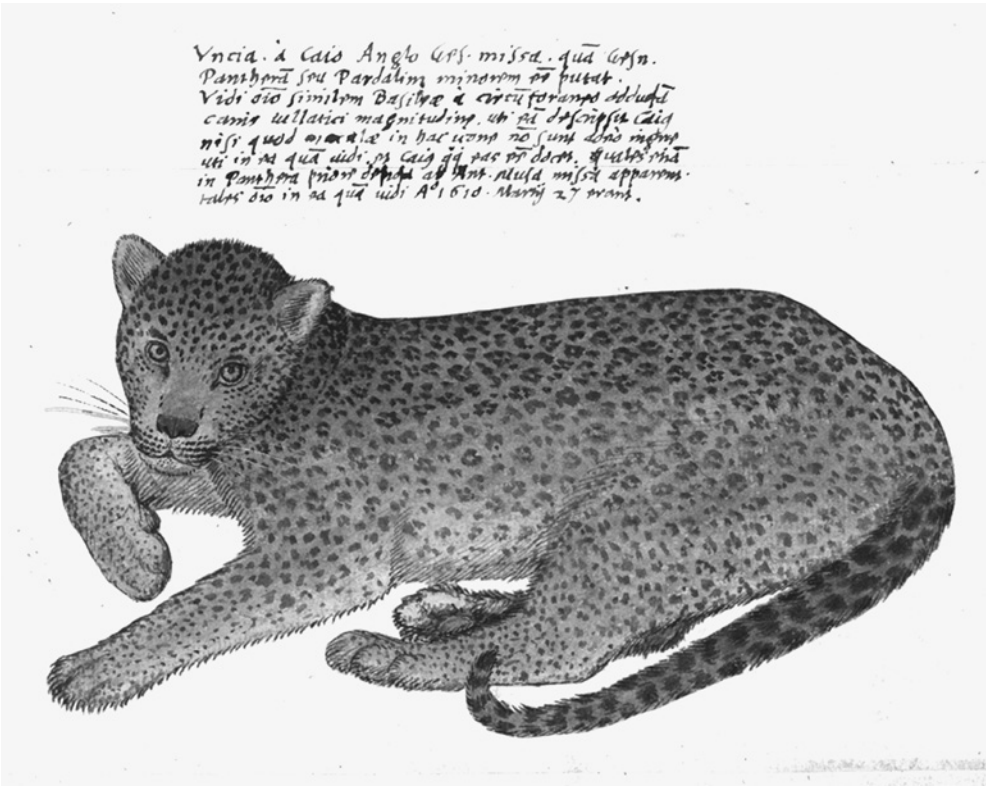
A small percentage of these thousands of drawings is directly connected with textual *ad vivum* claims. Their combined visual and textual evidence shows that *ad vivum* could have a large range of meanings – even within this period and even within this particular corpus of naturalia drawings. Sometimes *ad vivum* indicates that the painters or naturalists created an image on the basis of a real (preferably live, but otherwise dead, stuffed, or dried) plant or animal in front of their eyes. Many of Gessner's beautiful plant drawings (1550s–65) belong to this category. His handwritten notes on the sheets often indicate the dates and the locations in the Swiss mountains and gardens when and where he personally observed the plants (Tafel 1). Painters with whom he worked closely and who accompanied him on these trips drew the plants on his instructions, while Gessner himself drew many small plant details, such as seeds, leaves, flowers etc. All must have made sketches and visual notes on the spot and worked them up back at home.[29] The German naturalist Leonhart Fuchs operated in a different way, but he is known to have brought his painters fresh and well-shaped plants as models. The Medici court painter Jacopo Ligozzi (1547–1627) and various painters connected with the late sixteenth-century Habsburg courts in Prague, Vienna, and Innsbruck portrayed some rare animals, such as tropical birds, a dodo, and a South American llama, on the basis of the animals that they could see live in the court menageries or dead in museums. And Felix Platter's collection (c. 1565–c. 1610) of naturalia drawings contains various examples in which remarks in his handwritten annotation emphasize that he had seen this animal personally; that the drawing was made *ad vivum;* or that it depicted an item in his personal collection. Often such notes indicate finer details that reveal particular expertise. The text next to the drawing of a chamois says, for instance, »Another depicted *ad vivum*, as it was in the winter time when it darkens just like the bear and has lots of hair.«[30]

Now and then Platter's annotation contains comments on a divergence between his experience and the drawing, linking the latter's incorrectness

directly with the fact that the animal had not been depicted *ad vivum*: »Panther. Leopard. It seems not well depicted when compared with earlier ones nor has it been depicted *ad vivum* but after a description.«[31] His annotation to a drawing of another big cat [*uncia*] is written in the first person and mentions his personal observation of such animals, one in Basel and one in Speyer, the latter of which was used for hunting by Emperor Maximilian II (fig. 3). Platter points out differences (thinner tail, bristles, yellowish color) as well as similarities between the *uncias* that he personally saw and the drawing in his album. Those differences might have to do, he suggests, with the age of the animal or with mistakes by the painter.[32] Here, personal observation of other exemplars of the same species thus serves to correct visual details, but also to underpin the general truthfulness of the drawing and the existence of this species. All such remarks underscore the importance he attached to the reliability of the image and the link with personal observation.

Research of the last decades has shown, however, that many other sixteenth-century examples stretch this literal interpretation of *ad vivum*, sometimes to breaking point. Many naturalia drawings were demonstrably *not* based on personally observed plants and animals. Some were not even based on drawings made elsewhere but still underpinned by the testimony of an eyewitness. *Ad vivum* painted images could be copied from drawings that were considered correct or at least plausible. In yet other cases a painter might copy the only image available at the time. Examples from Conrad Gessner's *Historia Animalium* (4 vols. 1551–1558) show that the expression *ad vivum* and its vernacular versions was used even for images that were copies after another image that was itself of unclear provenance, while neither the author nor his friends had ever seen the animal or plant in question.[33] Terms such as *ad vivum* and *imago contrafacta* thus occur in situations where a painter and a naturalist had simply made an effort to represent a plant or animal as accurately as they could. Here it seems that we enter a zone of vagueness, good intentions regarding reliability, and statements that this was the best available at the moment. What does this imply?

To paraphrase Sachiko Kusukawa, naturalistic depiction did not necessarily guarantee direct observation by the draughtsman nor did it prove the actual existence of the object.[34] Just as there could be naturalistic representations of a dog, tiger, or American turkey, it was possible to have better or less adequate drawings of a unicorn or basilisk. It hardly needs to be argued,



3. Felix Platter's uncia with his handwritten annotation, Platter-Gessner Album, MS III C 23, fol. 10, Collection Amsterdam University Library. © Amsterdam University Library.

inversely, that proven personal observation (autopsy) offered no guarantee of pictorial reliability. A painter who drew a horse or dandelion that was in front of his eyes did not necessarily draw it in a manner that we would regard as accurate. In discussions regarding the history of natural philosophy and science, modern scholars have pointed to the phenomenon of ›virtual witnessing‹. In such cases the truth value of an image (or in other contexts the report of the outcome of an experiment) rests *not* on the autopsy of the person who writes or depicts, but on that of someone else, usually elsewhere in place and time, but deemed to be a reliable witness.[35] That situation was extremely common in natural history, as is most easily understood in cases of exotic naturalia that hardly any European could actually see alive. An extremely well documented one concerns Gessner's drawing and printed illustration of a small Brazilian sagoin monkey (fig. 4). Gessner never saw the

96 Quadrup. ferorum

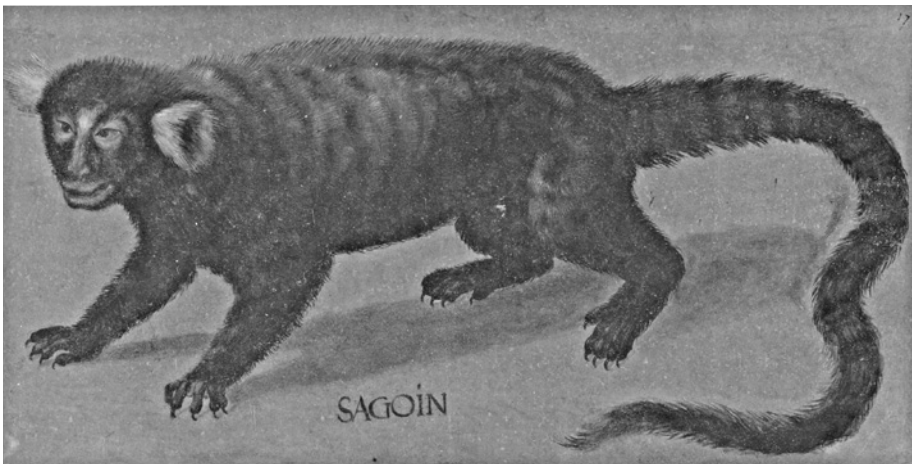
ANIMALIS quod Sagoin uul-
gò appellant (nomine forsan
Bresiliæ incolis usitato, unde
nuper aduectum est) iconem
perpulchrè & accuratè expres-
sam, Petrus Coudenbergius
doctissimus celeberrimusq;
Antuerpiæ pharmacopœus
mihi communicauit. Sagoini
animalis (inquit in epistola)
imaginem mitto ad uiuum delineatam secundū omnes dimensiones. (*Pictura quam misit magnitudo, undique tripla ferè ad nostram erat: an uerò animal ipsum quam pictura exprimitur maius non sit, ignoro.*) Viuidum admodum erat, agile ac timidum. Pilis erat mollibus admodū. Vuis passis uescebatur Sole siccatis, & pane albo modico. Coronatis hîc quinquaginta diuenditum est, aduectū ex Bresilia, forsan ex Simia parua & Mustela procreatum, miscentur enim ibi uaria animalia, propter regionis caliditatem. Nusquam de eo quicquam legi. Sicille: nos eius uerbis & specie ipsa animalis inuitati, Galeopithecum nominabimus.

GERMAN. Ein frömd thier/ kurtzlich vß dem nüwen land Bresilia gen Antorff gebracht/ anzesähen den Meerkatzen etwas gleych.

4. Gessner's printed illustration of the sagoin based on the drawing sent from Antwerp (see fig. 5), in C. Gessner, Icones Animalium, 1560, p. 96. Public domain.

animal itself. The drawing on which his printed sagoin illustration is based was painted on a specific date, in Antwerp, and *ad vivum* – after the live monkey which had survived the voyage from Brazil. The extremely reliable witness, Peeter van Coudenberghe (1517–c. 1599), naturalist, collector, and erudite apothecary, sent the sagoin drawing to Gessner (fig. 5). The latter's text furthermore provides measurements: the size of the depicted animal itself and that of its representation in relation to the real animal.[36] Here, the term *ad vivum*, the precision of date, place, and size, and the naming of the source or witness all form part of what could be called the rhetorical construction of reliability. There was nothing hollow about this rhetoric, nor was there actually anything virtual about this witnessing, which is the main reason why I would prefer to speak of ›evidence once removed‹.[37]

Early modern efforts to deal critically and intelligently with their visual sources help us to understand why none of the sixteenth-century naturalists who stress *ad vivum* representation, *contrafactur*, precision, and reliable witnesses, had any problem with using copied drawings or with reusing woodblocks



5. The original drawing of a Brazilian sagoin, painter unknown, made in Antwerp and sent by Van Coudenberghe to Gessner, Platter-Gessner Album, MS III C 23, fol. 43, Collection Amsterdam University Library. © Amsterdam University Library.

made for publications by other authors. This common practice is well documented for many sixteenth-century printed works on natural history. Original naturalia drawings too were regularly – and non-mechanically – copied, recopied, sent, and exchanged throughout Europe (often between collectors and naturalists), and used as visual evidence. Gessner, Rondelet, and a whole list of other sixteenth-century naturalists worked with and exchanged such copied colored drawings. They appear to have made no distinction between the truth-value of the first (model) drawing and the copies based on it. Clearly, the users trusted the visual evidence of the model drawing and furthermore relied on the various copyists in different countries to faithfully render a plant's or animal's important traits.[38] Finding that the meaning of a*d vivum* could stretch to situations in which a naturalist had simply done their best to depict a plant or animal accurately without ever having seen it, should therefore not lead to the conclusion that early modern naturalists lacked rigor in their treatment of evidence.

But there is another side to the question. So far, we have been interpreting *ad vivum* in a fairly literal sense as truthfully depicting a plant or animal from life. But there is evidence from the domain of natural history painting in the sixteenth-century that suggests a somewhat different reading: *ad vivum* could also refer to the *lifelike* aesthetic qualities of the resulting drawing.[39] Many of

the vernacular terms that alternate with the Latin *ad vivum* in European sources – *counterfeit*, *contrafayt* (Latin *contrafacta*), *al vivo*, etc. – can be understood in more than one way. Upon re-reading, even some of the examples quoted above from Platter's annotation to the animal drawings in the Platter-Gessner albums are open to at least a double interpretation. In the case of the panther-leopard Platter explicitly contrasts an *ad vivum* drawing with a representation based (only) on description. But in the case of the chamois »depicted *ad vivum*, as it was in the winter when it darkens just like the bear and has lots of hair«, we can interpret *ad vivum* both as reliable and as a qualification of the resulting, lifelike drawing.[40]

Furthermore, numerous verbal comments on sixteenth-century naturalia drawings emphasize their lifelikeness – and not merely their reliability – as a sign of quality. In the summer of 1565, for instance, the Florentine apothecary Stefano Rosselli wrote to the famous naturalist Ulisse Aldrovandi in Bologna, sending him portraits in color of a lion and a lioness – probably the ones living in the Medici menagerie in Florence. The portrait of the lion in particular had turned out »extremely natural; in fact, it is impossible to do it better.«[41] And as Sachiko Kusukawa has pointed out, for the precise and conscientious Gessner a crucial element of *ad vivum* was the *effect* of a representation on the beholder: the impression that what he or she saw was real. Adhering in many respects to the Plinian ideal discussed earlier, Gessner explicitly used the term *ad vivum* for images that »would capture the eyes of the beholder so strongly as to trigger the same response in the viewer as would the actual living object itself.«[42]

In this interpretation *ad vivum* is, therefore, not so much about epistemic truthfulness (the reliable representation of the depicted object) as about the persuasiveness of the representation. Phrased in slightly more art historical terms, the emphasis in naturalistic representation would shift (but never completely) from mimesis to painterly mastery in obtaining a natural effect. Seen this way, it becomes also easier to understand the early modern reliance on and continued reuse and copying of images *if* such images were regarded as satisfactory in their *effect* (and as truthful as possible). It will be clear that these are not either/or choices but gradations of meaning. The various examples discussed here show that sixteenth-century naturalists sometimes used *ad vivum* in its more epistemic sense, sometimes in the sense of a convincingly lifelike image. Preferably, an image was both, of course. The implications

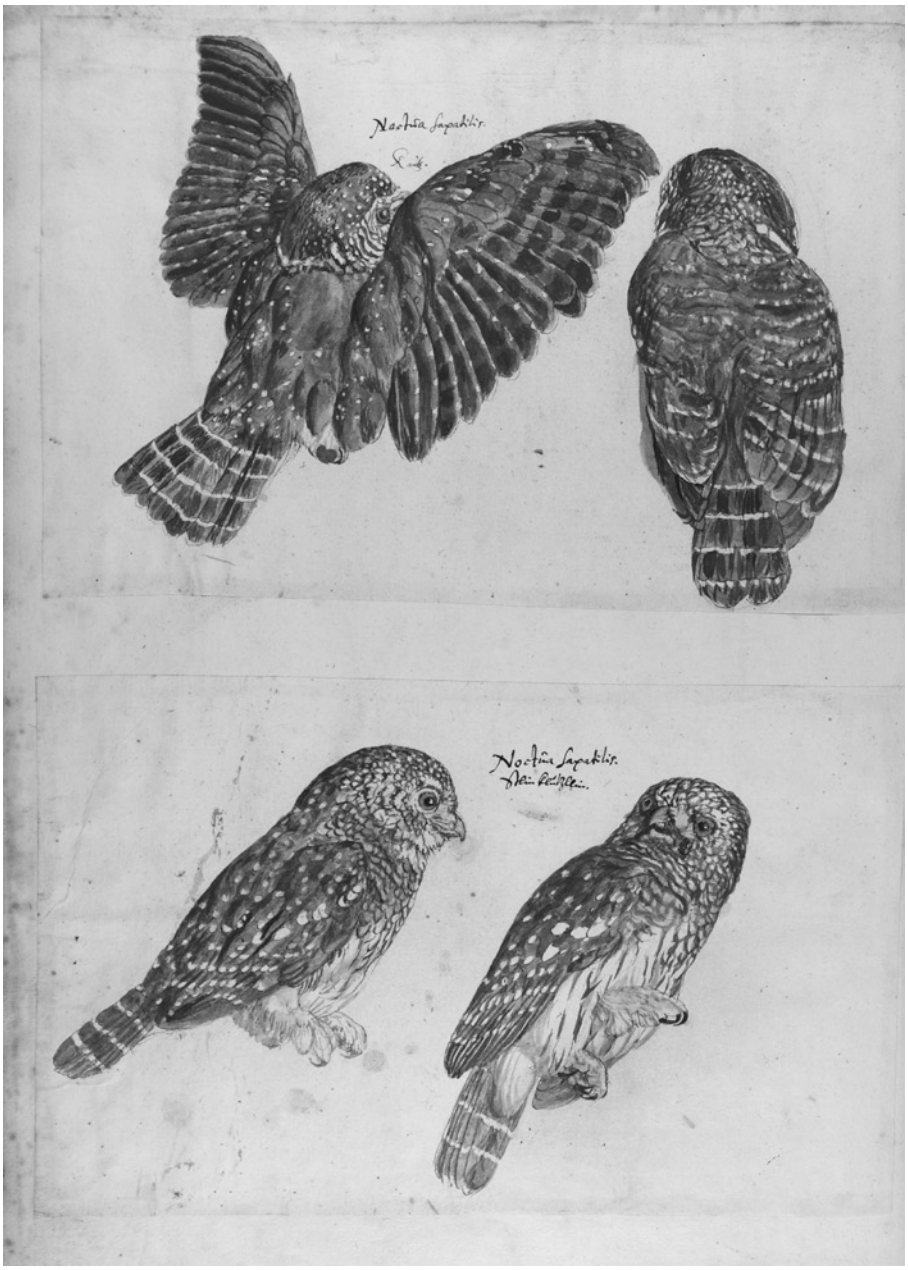
for present-day historical debate may be considerable if we take this whole range of sixteenth-century meanings seriously and do not split it into a part relevant to science and another one relevant to art. Debate among historians of science on the epistemic status of such drawings should – in such a case – become much more open to the use of aesthetic arguments. And that takes us to a closer consideration of the visual aspects of lifelike naturalia drawings and to some of the formats that were chosen in order to obtain this lifelike effect.

Naturalism and the Visual Formats of Reliability

Can more be said about the visual aspects of documentary images beyond calling them naturalistic in the sense in which Aldrovandi's correspondence spoke of the *naturalissimo* lion's portrait? Can we identify visual characteristics in naturalia drawings that help to create the effect of lifelikeness and of personal observation?

A very literal and rather idiosyncratic visual clue occurs in an album with plant drawings created by Gherardo Cibo (1512–c. 1600), an Italian aristocrat, painter and naturalist who is known for his extensive field trips and hands-on botany. Cibo includes himself (or rather the figure of the naturalist-plant collector) in his colored drawings. He depicts the plant collector and painter in the act of painting and of digging up plants in their natural setting and landscape (Tafel 2). His drawings are at the same time proof of autopsy and an inventive form of almost *trompe l'oeil*-like painting: in the background landscape the small plant is depicted in its habitat, where the naturalist is shown digging it up or holding it up to be painted or inspected, while in the same drawing the plant also appears almost as large as life in the foreground, floating in an indeterminate layer above and in front of the background landscape.[43]

A second and almost equally rare indication of the physical presence of the naturalist or painter can be found in representations of animals in movement or in highly characteristic poses. Examples are the drawing of a llama at rest by the Habsburg court physician and mineralogist Anselmus de Boodt; and drawings of playing monkeys, flying parrots, and details of open and closed claws of birds of prey in the Lazarus Röting album from Nuremberg (fig. 6).[44] They point to immediacy and the painter's opportunity to observe the habitus of an animal.



6. Drawings of typical bird poses and movements by the naturalist and painter Lazarus Röting from Nuremberg, in Michael Rötenbeck's Theatrum Naturae, Nuremberg, c. 1580–1614, ZM-B-VIII-321, fol. 068v, Museum für Naturkunde, Berlin. © Museum für Naturkunde Berlin.

Much more common in the sixteenth century are enlarged (zoomed) plant details. Gessner, for instance, not only annotated his plant drawings with dates, places, and so on that point to personal observation, but also added many enlarged details of plant seeds, and flowers. Gessner regularly drew chain-zooms (a chain of detailed drawings that zoom in on ever smaller elements of a fruit or flower) and cross-sections of small plant parts that can only have been made by extremely close and personal inspection. He often marked such drawings of details with a capital G. Such zoomed details having a double effect: they are a visual pointer to autopsy by the draughtsman and at the same time, by providing convincing detail, they enhance the lifelikeness of the representation (see Tafel 1).[45]

Intriguingly, a considerable range of representational formats – all of them naturalistic – were recognized as both reliable and lifelike in the sixteenth century. At the extremes of this range we find two, almost contradictory modes of representing plants, each of which was connected with verbal statements of *ad vivum* representation. As discussed earlier, the Weiditz plant drawings (c. 1530) made for Brunfels' herbal (see fig. 2) present highly detailed portraits of individual plants at a certain stage of their life: the blemishes and malformations that are unique to that individual plant are tell-tale signs of autopsy. Similarly, a group of anonymous drawings from the early 1550s unites highly individual plants and vegetables in a visual presentation that is at the same time still life and botanical drawing; perhaps we could call them plant ›group portraits‹.[46]

At the other end of the range we find representations of plant species in the generic plant drawings made for Fuchs, Aldrovandi, and various other naturalists. As in Weiditz' case, these drawings related to real plants, observed by Fuchs and his painters, and are in that sense truthful. Their drawings, however, fused observations of many individual exemplars into one generic representation of a plant species and often show it – in a completely *un*natural way – as having flowers and fruits at the same time or even bearing several differently colored flowers.[47] From the sixteenth century onwards such *generic* plant representations became a commonly used format in botanical field guides.[48] These generic plant representations link up closely with the epistemic aspect of *ad vivum* – that is, the correctness and truthfulness of the species representation – but far less so with *ad vivum* in the sense of a lifelike representation. Few viewers, after all, would regard a drawing of a lily as lifelike if it was depicted with flowers in five different colors.

Yet another intriguing connection between naturalism and the truthfulness of naturalia representations can be found in the stunning drawings on parchment made by Jacopo Ligozzi. He was one of the acknowledged European masters of fine naturalia painting, defined himself as a *miniator* and regarded color as essential to nature drawing. As mentioned above, we can be certain that several of Ligozzi's hyper-detailed drawings in brilliant color depict actual, individual plants and animals that he observed while in the service of the Medici.[49] The painter made a detailed study of dead fish and other animals preserved in a special liquor [*liquore*] that made them retain their color until he started to paint them. The liquor had been invented by his patron, Francesco I de' Medici himself:

> »You will be able to have various exotic fish from distant seas put into this liquor to have them painted *al vivo,* just as you do at present with a variety of plants, since you have this excellent painter who paints them with such artfulness that they seem to be born in their own natural habitat, and just as you have him depict *al vivo* fish, birds and many other animals [...]«[50]

How is it possible, then, that some of Ligozzi's hyper-realistic fish cannot be identified by modern fish experts in spite of their extreme detail and vivid colors?

They are painted in high definition and at least as realistically as his perfectly identifiable plants and exotic birds. Did Ligozzi paint his subjects truthfully, but were they atypical exemplars or extinct species? Did Ligozzi perhaps only claim *ad vivum* representation while actually copying someone else's inaccurately colored fish? Did the preservative liquor modify the fish's real colors after all, or have the colors changed since Ligozzi painted them? Or did Ligozzi invent those colors? Were some of his drawing perhaps not at all meant as documentary images, but as intentionally illusionistic hyper realistic trick-images to confuse the viewer? Or is Ligozzi a typical sixteenth-century example of a master-painter who portrayed sometimes truthfully and at other moments extremely convincingly but not necessarily truthfully? Six years before the letter quoted above, a Veronese apothecary wrote to Aldrovandi that a local painter tentatively identified as Ligozzi (who came from Verona) had depicted »various fish and birds better than life, and certainly miraculously.«[51] Better than life might be the key words here. Ligozzi would by

no means be the only sixteenth-century example of a painter who used the precision that serves *trompe l'œil* purposes to create an apparently perfectly natural representation that may be nothing of the kind.

Concluding Remarks

This exploration of *ad vivum* in the context of sixteenth-century natural history has in part been undertaken to discover whether and how it might be possible to move away from the constrictions imposed by the teleological grand narratives. The point is not, of course, to reject all efforts at an interpretation of the *longue durée* nor in order to dispute that empiricism, autopsy, experiment, and *ad vivum* were more strongly valued in early modern Europe than before.

One step would be to distinguish more clearly between early modern self-presentation and historical praxis. As Armer has convincingly argued, one of the big questions is shifted to a different level once we recognize that the increasing verbal emphasis on *experientia*, *ad vivum* representation, autopsy, and the critical evaluation of evidence, is at least in part a matter of a new style of self-presentation. Why did early modern naturalists (and not only they) feel the need to present themselves in this light, sharply distinguishing themselves from their late medieval predecessors and linking themselves closely with their colleagues from antiquity? And how much of it is true? At the level of knowledge formation there might be far more continuities between early modern empirically oriented naturalists and their late medieval predecessors than have been recognized so far.

So long as the *ad vivum* discussion clings to the most literal interpretation of *ad vivum* (as epistemic truthfulness) it is extremely hard to move away from the teleological development towards empiricist science. But the discussion can change from the moment that *ad vivum* can also refer to illusionistic naturalism, which has less to do with truthfulness and more with masterly painting. It is precisely here that the massive visual corpus of thousands of naturalia drawings from the long sixteenth century has a great deal to offer and urgently demands further investigation. That same corpus may also throw more light on the influence of painters – the image makers themselves – on the visual formats chosen to best convey the *ad vivum* sensation.

Finally, the evident capacity of sixteenth-century naturalists to use *ad vivum* and its vernacular versions in various meanings (sometimes perhaps even at

the same time) may look self-contradictory to us. It was probably nothing of the kind in an age characterized, as argued by Maclean, by a non-monotonic logic that can use different sets of criteria at the same time.[52] Choosing to focus on only one of its meanings (the epistemic truthfulness aspect) that fits best in a developmental pattern leading towards modernity highlights a modern preference for unequivocal definitions that are hard to reconcile with the early modern situation. Perhaps the most attractive aspect of *ad vivum* as an early modern concept is that it can trick us into believing that it describes a reality rather than creating an illusion of that reality and thus defeating exactly what it proposes to do.

Notes

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1 The literature on this cluster of concepts and the debates around them is large and growing fast. I found the following publications most inspiring or thought-provoking: Ackerman 1985; French 1985; Tongiorgi Tomasi 1987; Parshall 1993; Dear 1985 and 1991; Lestringant 1991; Maclean 1998 and 2000; Givens/Reeds/Touwaide 2006; Cunningham 2010; Smith 2006 and 2009; Kusukawa 2006, 2011 and 2012; De Angelis 2011 and 2013; Armer 2017.
2 For an older, art historically oriented discussion, see Swan 1995.
3 See Veneziani 2002.
4 As brilliantly discussed in French 1985 and Cunningham 2010; cf. De Angelis 2011.
5 For a good survey see Armer 2017.
6 See Findlen 1994; Reeds 1991; Jardine/Secord/Spary 1996; Ogilvie 2006; Ciancio 2015; Egmond 2010 and 2018; Curry 2018.
7 See Ciancio 2015; Egmond 2017b and 2018.
8 For detailed discussions of the works of Mattioli, see Bohatcová 1985; Ferri 1997 and Fausti 2004.
9 See note 11 below.
10 See Gessner's autobiography, as discussed in Leu 2016, p. 16–20.
11 Although quite a few learned sixteenth-century naturalists refer to local ›informants‹, from fishermen to herb gatherers, gardeners, and pharmacists, they only very rarely mention them by name. However, the use of their information (ranging from names,

identifications, and medicinal uses of plants to anatomical details and behavioral characteristics of animals) implicitly recognizes its value as knowledge.

12 For a fuller discussion of this argument, see Egmond 2010, and for its visual aspects Egmond 2017a.

13 On ancient natural history, see esp. French 1994; Hardy/Totelin 2016. On the transmission of old but not classical illustrated herbals (most famously the 6th-century Vienna Dioscorides), see Touwaide 2006. Lifelike images from such codices must have remained inaccessible to most European naturalists and were, to my knowledge, not copied in the sixteenth-century herbals.

14 On Livia's painted garden see Settis 2002.

15 For Pliny on painting see Pliny, *Naturalis Historia*, Book 35, Chapter 36. I have consulted (June 2018) the English edition at: http://www.perseus.tufts.edu/hopper/text?doc=Perseus:abo:phi,0978,001:35:36.

16 See Olariu 2018, p. 158, for a late fifteenth-century example in which a publicly shown herbal in a Venetian pharmacy is used for plant identification.

17 Early modern naturalists could and did engage with the late medieval bestiaria, herbals, and books of health, but the nature of this engagement and the intriguing juxtaposition (in some fifteenth-century herbals) of schematic and highly lifelike drawings need further investigation. See esp. Olariu 2012, 2015 and 2018 and Kyle 2017.

18 Olariu 2018, p. 154.

19 The Weiditz model drawings were rediscovered by the Swiss botanist Walther Rytz in 1931. The Basel physician and naturalist Felix Platter had pasted them in his late sixteenth-century herbarium volumes with dried plants. These are still kept in the Burgerbibliothek Bern. See Rytz 1933 and Zucchi 2003.

20 As has been pointed out by various authors, starting with Rytz 1933. For more information on the publishing history and the roles of Schott and Brunfels, see Kusukawa 2012, esp. p. 17–19, with references to the further literature.

21 See Capit. XXXII of the unpaginated introduction to Brunfels 1532 (German edition).

22 Collins 2000, p. 278. Following Torresella, Olariu 2018, p. 158 mentions that the number of fifteenth-century illustrated herbals was six times higher than in the fourteenth century. Cf. Blunt/Raphael 1979 and Givens/Reeds/Touwaide 2006.

23 Large numbers of these drawings were made as model drawings for planned publications, but many of these (e.g. Gessner's plants, Michiel's plants; and a large part of Fuchs' plants) were either never published or never even written. Further thousands of images were never intended for publication and mainly served research and display purposes.

24 For further details on all these codices, including locations and references to the literature, see Egmond 2017a, Appendix, p. 244–246.

25 Some important exceptions are the following art historians who analyze the genre (or large numbers) of naturalia drawings: Blunt/Raphael 1979; Tongiorgi Tomasi in a lifetime's work of publications, including 1987, 2000, 2007 and her many contributions in Molinari 1984; Olariu 2012, 2015 and 2018 and Vignau-Wilberg e.g. 2007, 2017 and her contributions to Haupt/Staudinger 1990. Many scholars focus on individual codices, painters or a specific collection.

26 Most lack annotation or have only brief references to the names of the depicted naturalia. Short descriptions, in so far as present, nearly always concern their uses, finding

places, or formal aspects rather than information about the making of the image. While in some cases we know when, for whom and for which purposes a paper collection as a whole was made, detailed information per image is often lacking.

27 Naturally, the latter could be perfectly lifelike too (e.g. the frescoed birds and plants of the 1560s in the Venetian Palazzo Grimani), but this was not necessarily the case, as is evident from many grotesque animals and plants. See on grotesques Morel 1997.

28 One of the best studies (focusing mainly on printed images in the domains of both natural history and human medicine-anatomy) is Kusukawa 2012.

29 On the painters connected with Gessner, see the still indispensable Leemann-Van Elck 1935. On Gessner, the importance of autopsy, and *ad vivum* illustrations, and his critical attitude to visual information, see Weber 1986; Kusukawa 2010 and Leu 2018, esp. p. 181–188 and 264–298.

30 Gessner-Platter album, University Library Amsterdam, IIIC23, fol. 34: »Alia, ad vivum depicta qualis erat hyemis tempore quo ursi instar nigrescit et pilos prolixos habet«.

31 Gessner-Platter album, University Library Amsterdam, IIIC23, fol. 9: »Panthera. Leppardt. Videtur non bene expressa si conferatur cum prioribus nec ad vivam sed descriptionem effectam«.

32 Gessner-Platter album, University Library Amsterdam, IIIC23, fol. 8.

33 See for a general discussion Kusukawa 2011 and 2012 and Egmond 2017a, esp. part II *Untrue to Life*; more specifically on Gessner's autopsy, see Kusukawa 2010 and Leu 2018, esp. p. 181–188 and 264–298.

34 Kusukawa 2012, p. 74f.

35 See esp. the discussion in De Angelis 2011 and cf. the works mentioned in notes 1 and 4 above.

36 Gessner 1560, p. 96. This type of precision is by no means unique to Gessner. Similar examples can be found in the works of, for instance, Clusius and Aldrovandi.

37 On witnessing, notions of proof, and comparisons with judicial evidence see esp. De Angelis 2011 and 2013, with many further references.

38 De Angelis speaks of a »doctrine of authory and testimony« and »argumentum ab auctoritate« that »characterised the epistemic situation of the scientific culture of the sixteenth and seventeenth centuries« (De Angelis 2013, esp. p. 693–696). I would like to stress that a critical use of evidence from witnesses once or much further removed is not at all limited to the early modern period, but characterizes all historical research. See on historical methodology the classic Bloch 1964.

39 Discussing late medieval French material, Turel 2011 has suggested an interpretation of au *vif* as not »brought from but to life«, an interesting point in an article that is otherwise hard to understand on account of an overdose of jargon. Regrettably, she then returns to the usual linear developmental pattern, here from »brought to life« to the epistemic »represented from life«, which latter stage had supposedly been reached by 1600.

40 See note 30 above.

41 »[…] naturalissimo, che invero non è possibile farlo meglio«; see Tosi 1989, p. 170.

42 Kusukawa 2012, p. 174, also with quotations from Gessner.

43 On Cibo see Mangani/Tongiorgi Tomasi 2013 and Egmond 2017a, p. 111–115.

44 The De Boodt albums (11 vols., some 800 illustrated folios) are privately owned and on loan to the Rijksmuseum Amsterdam. For a large selection of published drawings (but

not this llama) and an excellent discussion, see Maselis/Balis/Marijnissen 1999. The largely unpublished Lazarus Röting album is in the Museum für Naturkunde Berlin. See esp. Hackethal 2010.

45 Gessner's plant drawings (c. 1545–65) in two volumes with some 460 loose folios and approximately 1,500 plant images are in the University Library of Erlangen-Nuremberg. For more discussion of such enlarged insets, see Egmond 2017a, Chapter 6 *Zoom: Relevant Detail in the Visual Study of Nature*.

46 They occur in the Habsburg Cod. Min. 42, in the Österreichische Nationalbibliothek, Vienna.

47 On the topic of generic-specific representation, see Kusukawa 2012; Egmond 2017a and Zucchi 2003.

48 Its functionality in the service of plant identification helps to explain why the generic format was preferred in the long run.

49 See Cecchi/Conigliello/Faietti 2014; De Luca/Faietti 2014, p. 13–38, 48–49; cf. Groom 2015. Tongiorgi Tomasi 2001, p. 182f. has linked Ligozzi's work with what she sees as a move in art from generic to specific representation – the opposite tendency to what is supposed to have happened in the domain of scientific representation.

50 »Varii pesci peregrini et lontani mari potrà far portar in questo liquore per fargli dipingere al vivo, sì come hora fa tante diversità di piante havendo quel suo eccellente pittore che con tanto artificio le dipinge che paiono propriamente nate nel suo sito naturale, sì come al vivo ancora fa dipingere pesci, uccelli, et tanti altri animali […]«. Letter from Aldrovandi in Bologna to Francesco I de' Medici in Florence, dated September 27, 1577. Published in Tosi 1989, p. 231–247, quotation from p. 240.

51 »[…] ha fatto alquanti pesci, e uccelli, che passa il vivo, et è miracoloso certissimo«. Letter from Calzolari to Aldrovandi, December 16, 1571 from Verona, quoted in Conigliello 1991, p. 26.

52 Maclean 1998 and 2000.

Bibliography

Ackerman 1985: James Ackerman, Early Renaissance ›Naturalism‹ and Scientific Illustration, in: The Natural Sciences and the Arts: Aspects of Interaction from the Renaissance to the 20th Century, ed. Allan Ellenius, Uppsala 1985, p. 1–17.

Armer 2017: Stephanie Armer, Empirie als Strategie? Naturforschung zwischen Augenschein und Buchwissen, in: Luther, Kolumbus und die Folgen. Welt im Wandel 1500–1600, exh. cat. Nuremberg, eds. Thomas Eser and Stephanie Armer, Nuremberg 2017, p. 54–63.

Bloch 1964: Marc Bloch, The Historian's Craft, New York 1964 (First published as Apologie pour l'histoire ou Métier d'historien, Paris 1949).

Blunt/Raphael 1979: Wilfrid Blunt and Sandra Raphael, The Illustrated herbal, London 1979.

Bohatcová 1985: Mirjam Bohatcová, Prager Drucke der Werke Pierandrea Mattiolis aus den Jahren 1558–1602, in: Gutenberg Jahrbuch 60, 1985, p. 167–185.

Brunfels 1530: Otto Brunfels, Herbarum vivae eicones ad naturae imitationem, summa cum diligentia & artificio effigiatae, Strasbourg 1530.

Brunfels 1532: Otto Brunfels, Contrafayt Kreüterbüch, Strasbourg 1532.

Cecchi/Conigliello/Faietti 2014: Alessandro Cecchi, Lucilla Conigliello and Marzia Faietti (eds.), Jacopo Ligozzi ›pittore universalissimo‹, Livorno 2014.

Ciancio 2015: Luca Ciancio, »Per questa via s'ascende a magior seggio«. Pietro Andrea Mattioli e le scienze mediche e naturali alla corte di Bernardo Cles, in: Studi Trentini. Storia 94, 2015, p. 159–184.

Collins 2000: Minta Collins, Medieval Herbals. The Illustrative Tradition, London/Toronto 2000.

Conigliello 1991: Lucia Conigliello, Pesci, crostacei e un'iguana per l'imperatore Rodolfo II, in: Paragone. Arte 42, 1991, p. 22–29.

Cunningham 2010: Andrew Cunningham, The Bartholins, the Platters, and Laurentius Gryllus: the *peregrinatio medica* in the 16th and 17th Centuries, in: Centres of Medical Excellence? Medical Travel and Education in Europe, 1500–1789, eds. Ole Peter Grell, Andrew Cunningham and Jon Arrizabalaga, Farnham 2010, p. 3–16.

Curry 2018: Helen Anne Curry et al. (eds.), Worlds of Natural History, Cambridge 2018.

De Angelis 2011: Simone De Angelis, Sehen mit dem physischen und dem geistigen Auge. Formen des Wissens, Vertrauens und Zeigens in Texten der frühneuzeitlichen Medizin, in: Diskurse der Gelehrtenkultur in der frühen Neuzeit. Ein Handbuch, ed. Herbert Jaumann, Berlin/New York 2011, p. 211–253.

De Angelis 2013: Simone De Angelis, Experiments, Judicial Rhetoric and the *Testimonium*. Practices of Demonstration in the Hamberger-Haller Controversy on the Respiration Mechanism, in: Scholars in Action. The Practice of Knowledge and the Figure of the Savant in the 18th Century, vol. 2, eds. André Holenstein, Hubert Steinke and Martin Stuber, Leiden/Boston 2013, p. 679–701.

De Luca/Faietti 2014: Maria Elena de Luca and Marzia Faietti (eds.), Jacopo Ligozzi ›Altro Apelle‹, Florence 2014.

Dear 1985: Peter Dear, Totius in Verba: Rhetoric and Authority in the Early Royal Society, in: Isis 76, 1985, p. 144–161.

Dear 1991: Peter Dear, Narratives, Anecdotes, and Experiments. Turning Experience into Science in the Seventeenth Century, in: The Literary Structure of Scientific Argument, ed. Peter Dear, Philadelphia 1991, p. 135–163.

Egmond 2010: Florike Egmond, The World of Carolus Clusius. Natural History in the Making, 1550–1610, London 2010.

Egmond 2017a: Florike Egmond, Eye for Detail: Images of Plants and Animals in Art and Science, 1500–1630, London 2017.

Egmond 2017b: Florike Egmond, Experimenting with Living Nature: Documented Practices of 16th-Century Naturalists and Naturalia Collectors, in: Journal of Early Modern Studies 6, 2017, p. 21–45.

Egmond 2018: Florike Egmond, Into the Wild. Botanical Fieldwork in the Sixteenth Century, in: Naturalists in the Field. Collecting, Recording and Preserving the Natural World from the Fifteenth to the Twenty-first Century, ed. Arthur MacGregor, Leiden/Boston 2018, p. 166–211.

Fausti 2004: Daniela Fausti (ed.), La complessa scienza dei semplici. Atti delle celebrazioni per il V centenario della nascita di Pietro Andrea Mattioli, Siena 2004.

Ferri 1997: Sara Ferri (ed.), Pietro Andrea Mattioli, Siena 1501–Trento 1578: La vita, le opere: con l'identificazione delle piante, Perugia 1997.

Findlen 1994: Paula Findlen, Possessing Nature: Museums, Collecting and Scientific Culture in Early Modern Italy, Berkeley 1994.

French 1985: Roger K. French, Berengario da Carpi and the Use of Commentary in Anatomical Teaching, in: The Medical Renaissance of the Sixteenth Century, eds. A. Wear, R. K. French and I. M. Lonie, Cambridge 1985, p. 42–74.

French 1994: Roger K. French, Ancient Natural History. Histories of Nature, London/New York 1994.

Gessner 1551–1558: Conrad Gessner, Historiae Animalium, 4 vols., Zurich 1551–1558.

Gessner 1560: Conrad Gessner, Icones animalium quadrupedum viviparorum et oviparorum, Zurich 1560.

Givens/Reeds/Touwaide 2006: Jean A. Givens, Karen Reeds and Alain Touwaide (eds.), Visualizing Medieval Medicine and Natural History, 1200–1550, Aldershot 2006.

Groom 2015: Angelica Groom, Early Modern Natural Science as an Agent for Change in Naturalist Painting: Jacopo Ligozzi's Zoological Illustrations as a Case Study, in: Knowing Nature in Early Modern Europe, ed. David Beck, London 2015, p. 139–163.

Hackethal 2010: Sabine Hackethal, Das *Theatrum Naturae* des Michael Rötenbeck: Unbekannte Naturstudien 100 Jahre nach Dürer, in: Klasse Ordnung Art:

200 Jahre Museum für Naturkunde, eds. Ferdinand Damaschun et al., Rangsdorf 2010, p. 70–75.

Hardy/Totelin 2016: Gavin Hardy and Laurence Totelin, Ancient Botany, London/New York 2016.

Haupt/Staudinger 1990: Herbert Haupt and Manfred Staudinger (eds.), Le bestiaire de Rodolphe II. Cod. Min. 129 et 130 de la Bibliothèque nationale d'Autriche, Paris 1990.

Jardine/Secord/Spary 1996: Nicholas Jardine, James A. Secord and Emma C. Spary (eds.), Cultures of Natural History, Cambridge 1996.

Kusukawa 2006: Sachiko Kusukawa, The Uses of Pictures in the Formation of Learned Knowledge: the Cases of Leonhard Fuchs and Andreas Vesalius, in: Transmitting Knowledge: Words, Images, and Instruments in Early Modern Europe, eds. Sachiko Kusukawa and Ian Maclean, Oxford 2006, p. 73–96.

Kusukawa 2010: Sachiko Kusukawa, The Sources of Gessner's Pictures for the *Historia animalium*, in: Annals of Science 67, 2010, p. 303–328.

Kusukawa 2011: Sachiko Kusukawa, The Role of Images in the Development of Renaissance Natural History, in: Archives of Natural History 38, 2011, p. 189–213.

Kusukawa 2012: Sachiko Kusukawa, Picturing the Book of Nature. Image, Text and Argument in Sixteenth-Century Human Anatomy and Medical Botany, Chicago/London 2012.

Kyle 2017: Sarah R. Kyle, Medicine and Humanism in Late Medieval Italy. The Carrara Herbal in Padua, London/New York 2017.

Leemann-Van Elck 1935: Paul Leemann-Van Elck, Der Buchschmuck in Conrad Gessners naturgeschichtlichen Werken, Bern 1935.

Lestringant 1991: Frank Lestringant, Le déclin d'un savoir. La crise de la cosmographie à la fin de la Renaissance, in: Annales E.S.C. 46, 1991, p. 239–260.

Leu 2016: Urs Leu, Conrad Gessner (1516–1565). Universalgelehrter und Naturforscher der Renaissance, Zurich 2016.

Maclean 1998: Ian Maclean, Foucault's Renaissance Episteme Reconsidered: an Aristotelian Counterblast, in: Journal of the History of Ideas 58, 1998, p. 149–166.

Maclean 2000: Ian Maclean, Evidence, Logic, the Rule and the Exception in Renaissance Law and Medicine, in: Early Science and Medicine 5, 2000, p. 227–257.

Mangani/Tongiorgi Tomasi 2013: Giorgio Mangani and Lucia Tongiorgi Tomasi (eds.), Gherardo Cibo. Dilettante di botanica e pittore di ›paesi‹. Arte, scienza e illustrazione botanica nel XVI secolo, Ancona 2013.

Maselis/Balis/Marijnissen 1999: Marie-Christiane Maselis, Arnout Balis and Roger H. Marijnissen, The Albums of Anselmus de Boodt (1550–1632): Natural History Painting at the Court of Rudolph II in Prague, Ramsen 1999.

Molinari 1984: Alberto Molinari (ed.), Immagine e natura. L'immagine naturalistica nei codici e libri a stampa delle Biblioteche Estense e universitaria. Secoli XV–XVII, exh. cat. Modena, Modena 1984.

Morel 1997: Philippe Morel, Les Grotesques. Les figures de l'imaginaire dans la peinture italienne de la fin de la Renaissance, Paris 1997.

Ogilvie 2006: Brian Ogilvie, The Science of Describing. Natural History in Renaissance Europe, Chicago 2006.

Olariu 2012: Dominic Olariu, Miniaturinsekten und bunte Vögel. Naturbeobachtung und Tierdarstellungen in Manuskripten des 13. Jahrhunderts, in: Similitudo. Konzepte der Ähnlichkeit in Mittelalter und Früher Neuzeit, eds. Martin Gaier, Jeanette Kohl and Alberto Saviello, Paderborn 2012, p. 59–76.

Olariu 2015: Dominic Olariu, The Misfortune of Philippus de Lignamine's Herbal or New Research Perspectives in Herbal Illustrations From an Iconological Point of View (Max Planck Institute for the History of Science, Preprint 469), Berlin 2015.

Olariu 2018: Dominic Olariu, Die Kunst, die Natur zu erkennen, in: Cranach natürlich. Hieronymus in der Wildnis, exh. cat. Innsbruck, ed. Wolfgang Meighörner, Innsbruck/Vienna 2018, p. 153–161.

Parshall 1993: Peter Parshall, Imago contrafacta: Images and Facts in the Northern Renaissance, in: Art History 16, 1993, p. 554–579.

Reeds 1991: Karen Reeds, Botany in Medieval and Renaissance Universities, New York 1991.

Rytz 1933: Walther Rytz, Das Herbarium Felix Platters: Ein Beitrag zur Geschichte der Botanik des 16. Jahrhunderts, Basel 1933.

Settis 2002: Salvatore Settis, Le pareti ingannevoli. La villa di Livia e la pittura di giardino, Rome 2002.

Smith 2006: Pamela H. Smith, Art, Science and Visual Culture in Early Modern Europe, in: Isis 97, 2006, p. 83–100.

Smith 2009: Pamela H. Smith, Science on the Move: Recent Trends in the History of Early Modern Science, in: Renaissance Quarterly 62, 2009, p. 345–375.

Swan 1995: Claudia Swan, *Ad vivum, naer het leven, from the life*: Defining a Mode of Representation, in: Word & Image 11, 1995, p. 353–372.

Tongiorgi Tomasi 1987: Lucia Tongiorgi Tomasi, Toward the Scientific Naturalism: Aspects of Botanical and Zoological Iconography in Manuscripts and Printed Books in the Second Half of XV Century, in: Die Kunst und das Studium der Natur vom 14. zum 16. Jahrhundert, eds. Wolfram Prinz and Andreas Beyer, Cologne 1987, p. 91–101.

Tongiorgi Tomasi 2000: Lucia Tongiorgi Tomasi, L'illustrazione naturalistica; tecnica e invenzione, in: Natura-Cultura. L'Interpretazione del Mondo Fisico nei Testi e nelle Immagini, eds. Giuseppe Olmi, Lucia Tongiorgi Tomasi and Attilio Zanca, Florence 2000, p. 133–151.

Tongiorgi Tomasi 2001: Lucia Tongiorgi Tomasi, The Study of the Natural Sciences and Botanical and Zoological Illustration in Tuscany under the Medicis from the Sixteenth to the Eighteenth Centuries, in: Archives of Natural History 28, 2001, p. 179–194.

Tongiorgi Tomasi 2007: Lucia Tongiorgi Tomasi, La conquista del visibile. Rimeditando Panofsky, rileggendeo Galilei, in: Galileana 4, 2007, p. 5–46.

Tosi 1989: Alessandro Tosi (ed.), Ulisse Aldrovandi e la Toscana. Carteggio e testimonianze documentarie, Florence 1989.

Touwaide 2006: Alain Touwaide, Latin Crusaders, Byzantine Herbals, in: Visualizing Medieval Medicine and Natural History, 1200–1550, eds. Jean A. Givens, Karen Reeds and Alain Touwaide, Aldershot 2006, p. 25–50.

Turel 2011: Noa Turel, Living Pictures: Rereading ›au vif‹ 1350–1550, in: Gesta 50, 2011, p. 163–182.

Veneziani 2002: M. Veneziani (ed.), Experientia, Florence 2002.

Vignau-Wilberg 2007: Thea Vignau-Wilberg, *In Minimis Maxime Conspicua*. Insektendarstellungen um 1600 und die Anfänge der Entomologie, in: Early Modern Zoology. The Construction of Animals in Science, Literature and the Visual Arts, eds. Karl Enenkel and Paul Smith, Leiden/Boston 2007, p. 217–243.

Vignau-Wilberg 2017: Thea Vignau-Wilberg, Joris and Jacob Hoefnagel: Art and Science around 1600, Berlin 2017.

Weber 1986: Bruno Weber, ›In absoluti hominis historia persequenda‹. Über die Richtigkeit wissenschaftlicher Illustration in einigen Basler und Zürcher Drucken des 16. Jahrhunderts, in: Gutenberg-Jahrbuch 61, 1986, p. 101–146.

Zucchi 2003: Luca Zucchi, Brunfels e Fuchs: l'illustrazione botanica quale ritratto della singola pianta o immagine della specie, in: Nuncius 18, 2003, p. 411–466.