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ACTES COLLOQUE ASCONA
*USES, PRACTICES AND FUNCTIONS OF HISTORICAL HERBARIA*

# SEEING CRYPTOGAMS IN EARLY MODERN BOTANY

MAURA C. FLANNERY[1]

**Abstract**
Significant inquiry into mosses, fungi and lichens is thought to have begun considerably later than the early modern investigation of seed-bearing plants. While cryptogamic reproductive structures and functions were not determined until long after those of phanerogams, there was interest in the former in the 16th and 17th centuries. To focus this discussion, the emphasis here is on macrofungi, a group that is particularly difficult to preserve, but in many cases, as opposed to mosses and lichens, are eye-catching in the field. In contrast, microfungi were not appreciated until later.
As opposed to flowering plants, many fungi are difficult to preserve since they can become misshapen when dried and often unrecognisable when pressed. Because of these difficulties and the fact that the descriptive vocabulary for plants in general at this time was crude, the argument made here is that the most substantial evidence for interest in mushrooms was visual. It was in the form of drawings and specimens augmented by discussion of edible versus poisonous species. Although naturalists were puzzled by the lack of seeds in these organisms, they nonetheless made careful investigations, including dissections and examinations with hand lenses and early compound microscopes.
The 16th century saw the first books printed with good botanical images, including some printed images of fungi, but they were greatly outnumbered by flowering plants. However, there are a significant number of fungi drawings, most in watercolour, to be found in unpublished collections, a number of which display visual methods that were not seen in publications until much later. These include dissections highlighting structures, some magnified, as well as series of drawings showing the stages in development and cutaways to disclose interior anatomy.
The hundreds of drawings of fungi done by and for the Italian naturalist Federico Cesi testify to his work in this area, although he died before he had an opportunity to write his planned book on them. His manuscript is lost, but his images are preserved and speak to the depth of his study. Carolus Clusius published an illustrated text on the fungi of eastern Europe in 1601. There are also excellent 16th-century drawings of fungi, mosses and lichen in the *Libri Picturati* volumes and in Conrad Gessner's notebooks. All of this work attests to the importance of images in early modern mycology. Drawing was a way to learn about fungal morphology, and the development of engraving technology made it possible to print more detailed illustrations, as is evident in the engravings of mushrooms in the work of Pier Antonio Micheli, considered the founder of mycology.

**Keywords**: early modern botany, botanical illustration, cryptogams, macrofungi, Federico Cesi, Carolus Clusius, Conrad Gessner.

[1] A.C. Moore Herbarium, Department of Biological Sciences, 715 Sumter Street, Columbia, S.C. 29208 U.S.A.

## Résumé

On pense que les recherches sur les mousses, les champignons et les lichens ont commencé bien plus tard que les premières recherches modernes sur les plantes à graines. Alors que les structures et les fonctions reproductives des cryptogames n'ont été élaborées que longtemps après celles des phanérogames, les premières ont suscité de l'intérêt aux XVI^e^ et XVII^e^ siècles. Afin d'orienter la discussion, l'accent sera mis sur les macrochampignons, un groupe particulièrement difficile à préserver, mais qui, contrairement aux mousses et aux lichens, attirait souvent l'attention sur le terrain. Les microchampignons, en revanche, ne seront appréciés que plus tard.

Contrairement aux plantes à fleurs, de nombreux champignons sont difficiles à conserver car ils peuvent se déformer lorsqu'ils sont séchés et sont souvent méconnaissables lorsqu'ils sont pressés. En raison de ces difficultés et du fait que le vocabulaire descriptif des plantes en général était rudimentaire à cette époque, l'argument avancé ici est que la preuve la plus substantielle de l'intérêt pour les champignons était visuelle. Il s'agit de dessins et de spécimens, complétés par des discussions sur les espèces comestibles ou vénéneuses. Si les naturalistes étaient déconcertés par l'absence de graines dans ces organismes, ils n'en menaient pas moins des recherches minutieuses, y compris des dissections et des examens à l'aide de lentilles à main et des premiers microscopes composés.

Au XVI^e^ siècle, les premiers livres imprimés comportaient de bonnes images botaniques, y compris quelques images imprimées de champignons, mais ceux-ci étaient largement dépassés par les plantes à fleurs. Cependant, il existe un nombre important de dessins de champignons, la plupart à l'aquarelle, que l'on trouve dans des collections non publiées. Un certain nombre d'entre eux présentent des méthodes visuelles que l'on ne retrouve dans les publications que bien plus tard. Il s'agit notamment de dissections mettant en évidence les structures, parfois agrandies, ainsi que de séries de dessins montrant les étapes du développement et des coupes pour révéler l'anatomie intérieure.

Les centaines de dessins de champignons réalisés par et pour le naturaliste italien Federico Cesi témoignent de son travail dans ce domaine, bien qu'il soit mort avant d'avoir eu l'occasion d'écrire le livre qu'il prévoyait d'écrire sur les champignons. Son manuscrit est perdu, mais ses images sont conservées et témoignent de la profondeur de son étude. Carolus Clusius a publié en 1601 un texte illustré sur les champignons d'Europe orientale. On trouve également d'excellents dessins de champignons, de mousses et de lichens du XVI^e^ siècle dans les volumes *Libri Picturati* et dans les carnets de Conrad Gessner. Tous ces travaux témoignent de l'importance de l'image dans la mycologie des débuts de l'ère moderne. Le dessin était un moyen d'apprendre la morphologie des champignons, et le développement de la technologie de la gravure a permis d'imprimer des illustrations plus détaillées, comme en témoignent les gravures de champignons dans l'œuvre de Pier Antonio Micheli, considéré comme le fondateur de la mycologie.

**Mots-clés**: botanique moderne, illustration botanique, cryptogames, macrochampignons, Federico Cesi, Carolus Clusius, Conrad Gessner.

## Zusammenfassung

Die bedeutende Erforschung von Moosen, Pilzen und Flechten begann vermutlich erst wesentlich später als die frühneuzeitliche Erforschung der Samenpflanzen. Während die Fortpflanzungsstrukturen und -funktionen der Kryptogamen erst lange nach denen der Phanerogamen erforscht wurden, bestand im 16. und 17. Jahrhundert ein Interesse an ersteren. Um diese Diskussion zu fokussieren, liegt der Schwerpunkt hier auf Makropilzen, einer Gruppe, die besonders schwer zu konservieren war, aber im Gegensatz zu Moosen und Flechten in vielen Fällen im Feld ins Auge fiel. Mikropilze hingegen wurden erst später geschätzt.

Im Gegensatz zu Blütenpflanzen sind viele Pilze schwer zu konservieren, da sie beim Trocknen verformt werden können und beim Pressen oft nicht mehr erkennbar sind. Aufgrund dieser Schwierigkeiten und der Tatsache, dass das beschreibende Vokabular für Pflanzen zu dieser Zeit allgemein noch sehr rudimentär war, wird hier argumentiert, dass der wichtigste Beweis für das Interesse an Pilzen visueller Natur war. Es handelte sich um Zeichnungen und Exemplare, ergänzt durch Diskussionen über essbare und giftige Arten. Obwohl Naturforscher über das Fehlen von Samen in diesen Organismen verwundert waren, führten sie dennoch sorgfältige Untersuchungen durch, einschließlich Sezierungen und Untersuchungen mit Handlupen und frühen zusammengesetzten Mikroskopen.

Im 16. Jahrhundert wurden die ersten Bücher mit guten botanischen Abbildungen gedruckt, darunter auch einige gedruckte Bilder von Pilzen, aber es gab viel mehr Abbildungen von Blütenpflanzen. Es gibt jedoch eine beträchtliche Anzahl von Pilzzeichnungen, die meisten davon in Aquarell, die in unveröffentlichten Sammlungen zu finden sind. Einige zeigen visuelle Methoden, die erst viel später in Publikationen zu sehen sind. Dazu gehören Sezierungen, die Strukturen hervorheben, einige davon vergrößert, sowie Zeichnungsserien, die die Entwicklungsstadien zeigen, und Schnittzeichnungen, die die innere Anatomie offenlegen.
Die Hunderte von Pilzzeichnungen, die von und für den italienischen Naturforscher Federico Cesi angefertigt wurden, zeugen von seiner Arbeit auf diesem Gebiet, obwohl er starb, bevor er die Gelegenheit hatte, sein geplantes Buch darüber zu schreiben. Sein Manuskript ist verloren gegangen, aber seine Bilder sind erhalten und zeugen von der Tiefe seiner Studien. Carolus Clusius veröffentlichte 1601 einen illustrierten Text über die Pilze Osteuropas. Es gibt auch hervorragende Zeichnungen von Pilzen, Moosen und Flechten aus dem 16. Jahrhundert in den Bänden der *Libri Picturati*und in den Notizbüchern von Conrad Gessner. All diese Arbeiten zeugen von der Bedeutung von Bildern in der frühneuzeitlichen Mykologie. Zeichnungen waren eine Möglichkeit, etwas über die Morphologie von Pilzen zu lernen, und die Entwicklung der Gravurtechnik ermöglichte es, detailliertere Abbildungen zu drucken, wie die Pilzstiche in den Werken von Pier Antonio Micheli, der als Begründer der Mykologie gilt, zeigen.

**Stichwörter:** Botanik der frühen Neuzeit, botanische Illustration, Kryptogamen, Makropilze, Federico Cesi, Carolus Clusius, Conrad Gessner.

In the early modern era, botanists were realising that a variety of strategies were needed to study plants. Direct observation of living organisms was key, supplemented with herbarium specimens that could be consulted at times when the plants themselves were not available. In addition, written descriptions documented observations and transmitted ancient knowledge about plants from the likes of Theophrastus and Dioscorides. Using printing technologies, new texts were also being produced, many with naturalistic representations of plants. Botanists realised that images could transmit observations about a plant's characteristics more clearly than words, especially at a time when little descriptive botanical terminology had been developed.

Since it was difficult to send plants over long distances, except in the form of seeds, botanists developed the practice of sending pressed plants. The earliest such collections, often called a *hortus siccus* or dried garden and later herbarium, date from the 1540s, when the focus for many was still on medicinal plant uses, and there was much that needed to be determined in terms of syncing observations and specimens with descriptions found in ancient texts (Ogilvie, 2006). Additionally, there were many new and strange flowering plants coming into Europe from different parts of the world. Not only were they fascinating, but they were the species that the botanists' patrons wanted to know about, intrigued by novelties and hopes of finding new ways to increase their fortunes. Most of these were flowering plants and thus made up the preponderance of 16th- and early 17th-century specimens. There were some ferns but very few

mosses, fungi and lichens. The term cryptogam suggests their obscurity.

Flowering plants were more visible than many small, not to say tiny, cryptogams and easier to preserve. Fungi are particularly difficult in this regard because many cannot be pressed without losing their form, which is also degraded by drying. Cryptogam specimens, including mosses and lichens, are found in the collection of the German botanist Leonhard Rauwolf held at the Naturalis Center in Leiden (Stech *et al.*, 2018) as well as in the 1595 herbarium of Johannes Harder at the Oak Spring Garden Foundation in Virginia (Tomasi & Willis, 2009). Harder used a technique developed by his father, Hieronymus, also a maker of herbaria. He added watercolour backgrounds, giving an environmental context for the plants, such as with lungwort lichen on an oak tree (fig. 1). This is indicative of experimentation on how to present information about plants going on in botanical circles at the time. Some techniques similar to this soon disappeared.

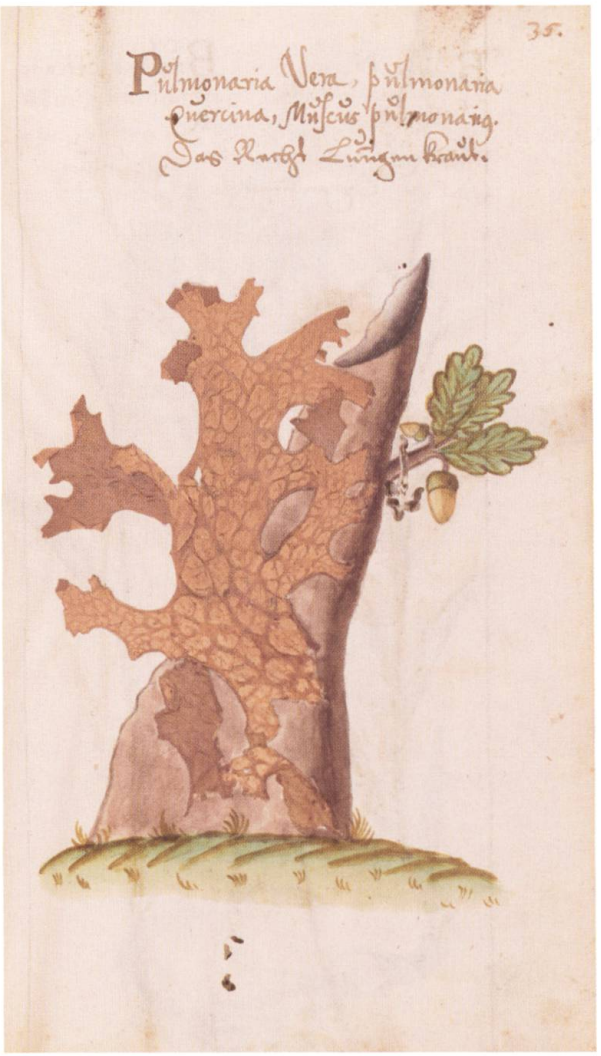


**Figure 1.** Specimen of lungwort lichen *Lobaria pulmonaria* shown growing on an oak in Johannes Harder's Herbarium (1595), p. 35. Oak Spring Garden Foundation.

Since there are so few cryptogam specimens to discuss, the concentration here is on botanical art, which was pivotal in the history of botany, particularly at this early stage and particularly for cryptogams. To maintain a manageable scope, the focus of the rest of the manuscript is on fungi, specifically mushrooms or macrofungi, organisms that look so different in life versus in death. Microfungi were not observed until later. The early modern era saw the first book printed with images of mushrooms, *Ortus sanitatis* published in 1491 in Germany (fig. 2). However, it was some time before the appearance of realistic illustrations that could be used in identification, the work of Otto Brunfels (1530) and Leonhart Fuchs (1542) most notably (Kusukawa, 2012). Neither writer included a fungus. The number of illustrations of cryptogams in general was limited, reflecting botanists' interests elsewhere.

In addition to what appeared in print, there were many drawings, often high-quality watercolours, that were created to document observations and communicate them to others. Though specimens were sent in correspondence so the recipient would know what plant the sender was writing about, illustrations were also shared. The Swiss naturalist Conrad Gessner (1516–1565) encouraged them, whether they be prints or originals, as did many others, including the Flemish botanist Carolus Clusius (1526–1609). Both aimed to have their work published, with Clusius collecting the drawings

of others. Gessner did the same but also made his own pen and ink illustrations, often with added watercolour. Gessner did not complete his manuscript before his death in 1565. The same fate was met by the Italian naturalist Federico Cesi (1585–1630), one of the founders of the Academy of Lynxes in Rome. The work of these men and several others was studied by Florike Egmond (2017) for her book on what collections of early modern natural drawings showed about how observation was done at the time and the tools and strategies used. They also provide insight into what the artists and the botanists who directed them considered important details. Egmond argued that printed illustrations lagged behind some of these early works in the use of dissections, enlargements and other visualisation strategies.

There are three extant Gessner notebooks with hundreds of illustrations, some copied from the collections of others, such as his correspondent Johannes Kentmann in Germany (Leu, 2016). There are a few cryptogams, but flowering plants are much more numerous. A good example of Gessner's work is the stinkhorn mushroom (fig. 3). It displays his method of depiction, with different stages of development and with a cut-away to reveal the stalk's interior. These are among the innovative techniques in botanical art that Egmond writes about and that give a fuller picture of the information communicated through botanical networks.

Carolus Clusius is a key figure in 16th-century botany in part because he made so many connections throughout Europe and at different social strata including aristocrats, naturalists, gardeners, apothecaries, farmers and herb gatherers (Egmond, 2007). He was fascinated by all things plant related and made the most of his contacts and travels. From 1573 to 1587, he served the Hapsburgs in Vienna, including as director of their botanical garden. During this time, he travelled extensively in Central Europe and with the encouragement of his Hungarian friend and patron Boldizsár Batthyány he took a


**Figure 2.** Fly agaric mushroom *Amanita muscaria* in *Ortus Sanitatis,* published by Jacob Meydenbach in Mainz (1491), p. 460. Wellcome Collection.


**Figure 3.** Stinkhorn mushroom *Phallus impudicus* in Conrad Gessner's *Historia Plantarum* vol. 2, fol. 280r. University Library. Erlangen-Nürnberg.

particular interest in fungi. Clusius studied them on trips in areas of Central Europe, then called Pannonia. Batthyány supported an artist who created 87 watercolour illustrations for Clusius' planned book (Bobory, 2007). However, the drawings could not be found when Batthyány died in 1590; thus, Clusius had to rely on less detailed illustrations, including ones created for his publisher Christophe Plantin. This work was not published until 1601, when it was appended to his more well-known *Rariorum plantarum historia* (Clusius, 1601).

Some of the illustrations in Clusius's books seem derived from images in yet another impressive collection of drawings, part of the *Libri Picturati* at the Jagiellonian Library in Krakow. Although there is discussion as to their provenance, the botanical watercolours that included cryptogams may have been done for Karl de Saint-Omer, one of Clusius's early patrons (de Koning *et al.*, 2008). They were planning to produce a book together when Saint-Omer died prematurely. These watercolours are of high quality and detailed; they include mosses, fungi and lichens. Some drawings in this collection appear to be the basis for illustrations Plantin used in Clusius's publications and those of others, including the Flemish botanist Matthias de L'Obel, who was known for reusing the woodcuts prepared for one author's book in those of other authors (Chen, 2020). The figures of fungi in L'Obel's herbal *Kruydtboeck* of 1581 are an advance on those in earlier books. Some were derived from drawings in the *Libri Picturati* and were then used in the Clusius text on fungi.

The drawings originally planned for Clusius's book on fungi are now at the Leiden University Libraries as what is called the *Codex Clusius*. For a long time, they were kept in Leiden, but little attention was paid to them until they were rediscovered in the 19th century, and a facsimile was published years later (Istvánffy, 1900). However, they had been copied long before that by the Flemish botanist Franz van Sterbeeck when he was working on his *Theatrum Fungorum* (1675). Van Sterbeeck is often seen as a forerunner in the study of fungi when, in fact, he relied a great deal on Clusius's text as well as on the drawings in the *Codex* that a friend had lent him to copy. This is obvious from van Sterbeeck's plate of morel mushrooms (fig. 4), which draws heavily from the *Codex* that has two pages of illustration of these species, one shown in figure 5. Van Sterbeeck also benefited from the use of copperplate etchings in comparison with 16th-century woodcuts. One of the first to use the newer technique for botanical images was Fabio Colonna. Like Cesi, he was a member of the Academy of Lynxes; he included cryptogams in his publication.

Federico Cesi had an interest in flowering plants and owned volumes of drawings of them (Elliott *et al.*, 2015), but he was particularly focused on fungi and planning a book about them, for which he amassed hundreds of drawings. The Linceans saw documenting visual observations as a way to attain knowledge about plants. Much of Cesi's art collection and library was purchased after his death by fellow Lincean, Cassiano dal Posso, and became a significant part of what was called his « Paper Museum ». Most of the fungal drawings are now in the Institut de France library, although many of Cesi's other natural history volumes are at the Royal Library at Windsor Castle. All 2500 drawings have been published in a series of volumes over the past two decades. Most illustrations in the fungal volumes are indeed fungi, but there are also a few slime moulds and lichens (Pegler & Freedberg, 2005).

With so many images of fungi in the Paper Museum, it was difficult to choose what to include here. It is believed that some of Cesi's own drawings are in these collections, and they are most likely to be done in pen and ink. On a single page, there is a pen work that is likely by him alongside a watercolour of *Collybia fusipes*, the spindle hank mushroom. In 1624, Galileo, another Lincean, gave Cesi

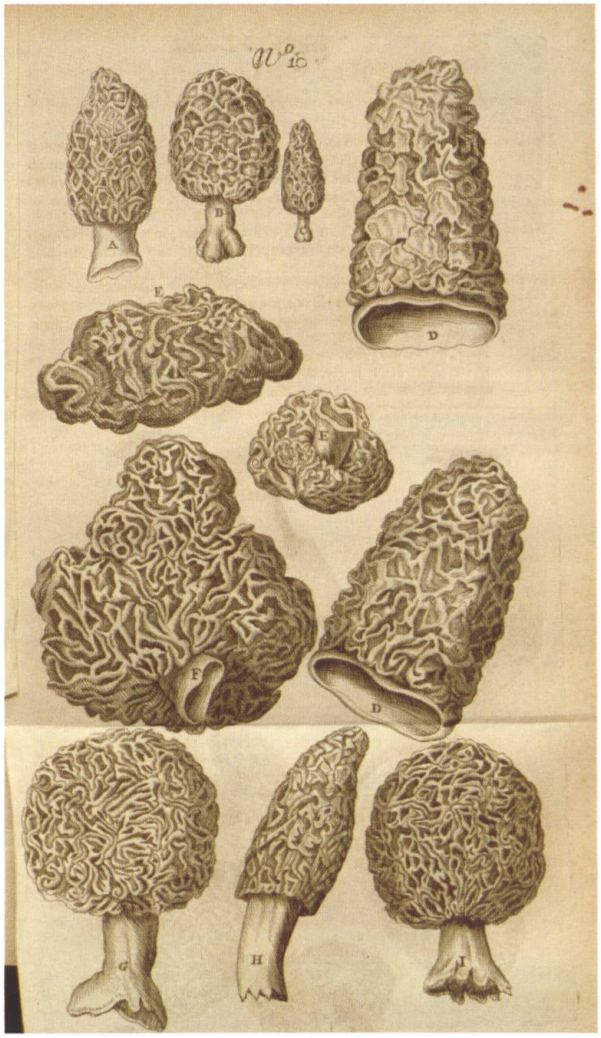

**Figure 4.** Morel mushroom *Morchella* in Franz van Sterbeeck's *Theatrum Fungorum* (1675). Illus. 10. Missouri Botanical Garden.

**Figure 5.** Morel mushroom *Morchella* in the *Codex Clusius*, p. 18. Leiden University Libraries.

a compound microscope, and it is thought that many of the drawings in these volumes date from this time or later. It is obvious that Cesi had some means of magnification at his disposal. Earlier, he had used a magnifying glass, as had Gessner. However, the microscope allowed magnifications up to 100 X. One example of this is the species now called *Coprinus stercoreus,* an inkcap mushroom. It was drawn at life size, then enlarged, perhaps using a magnifying glass, and finally, the cap's surface was drawn with the aid of a microscope (fig. 6).

There is a sheet in Cesi's collection with a number of tiny fungi growing on the surface of sticks and shown at different magnifications and another with a drawing of a leaf with fungi. Lichens are given the same careful attention, although there are not too many of them in the Cesi volumes. There is even a drawing of slime mould atop leaf litter. These images suggest an interest in the substrates on which the organisms grow, and this is found a number of times in the collection. Dying in 1630, Cesi never published his planned book on fungi. There were not many notes on the illustrations beyond the organism's name; he did have notebooks and a draft manuscript, but these were lost. It was the images that caught dal Posso's eye. They were copied more than once over time. Although they were never published, they were seen and studied by others interested in fungi. It can be assumed that, similar to the *Codex Clusius*, they did influence later work,


**Figure 6.** Inkcap mushroom *Coprinus stercoreus* with increasing magnification clockwise from upper left in Federico Cesi's *Fungi,* vol. 3, p. 162r. Institut de France.

even though that influence was not obvious and these collections were not necessarily cited.

Catching the eye and holding it seems to have been the modus operandi of early modern botanical illustration. James ACKERMAN (1985) contended that the visual capacity to make fine distinctions developed in the 15th century. This relates to Pamela SMITH's (2003) view that artisans were drivers of a new form of observation. While many of the botanists discussed here made their own drawings, they also worked with artists. They collaborated with them in what DASTON & GALLISON (2007) termed four-eyed sight, each influencing the conceptions of the other. It is significant that botanists such as Cesi and Gessner made some of their own drawings, influencing the resulting art. When Gessner was looking over an artist's shoulder, as he said he did, he was looking not only as a scientist but with an eye for what it takes to make a mark. The artists involved in these projects were those who showed skill in recording fine details and small differences. Aldrovandi and others complained of the difficulty in finding artists who could create the kinds of records their patrons were demanding, could see with the mind's eye, as the historian of botanical herbals Agnes ARBER put it (1938, 1954).

The relationship between drawing and knowing has become a topic of interest among historians of art and science. The astronomer Omar NASIM (2013) described how repeated sketching of nebulae in the 19th century clarified the concept of an astronomical phenomenon that, as its name suggests, was blurry. As more observations were made and drawings were repeated night after night, these hazy structures became more familiar to the observer's eye, mind and hand. Drawings were tools in the process of discovery and knowledge stabilisation. In drawing, the hand slows down observation, allowing the mind to synthesise. Barbara WITTMANN (2013) reports on a scientific illustrator's experience drawing a new fish species that led to the discovery of a novel anatomical feature. Observers such as Gessner and Cesi drew the same organism repeatedly, often from different perspectives or with different dissections or at different magnifications, correcting their drawings and descriptions along the way as they learned more.

The emphasis here has been on art because it provides useful insights into how cryptogams were studied in the early modern era. Since many cryptogams were small, it was difficult at the time to study them adequately and to thus make sense of them. The magnifying lenses of the day were crude and using them could be frustrating. It was difficult to describe them in words that would give a sense to the reader; thus, images became essential. Additionally, there was the question of how to classify them. Pietro Andrea Mattioli made the first attempt to divide fungi into groups, simply edible and poisonous, and Clusius cited his work (MATTIOLI, 1554). Another big, stumbling block was how they reproduced. There was even a question as to whether fungi could reproduce or generate spontaneously. In 1620, Giambattista della Porta of Naples reported finding fungal spores and a few years later, his fellow Lincean Cesi recorded them in a couple of drawings.

More formal studies of cryptogams only came much later. In his study of the history of mycology, G. C. AINSWORTH (1976) dates its birth to 1729 with the publication of the Italian botanist Pier Antonio Micheli's *Nova Plantarum Genera* in which he describes how spores from a species give rise to more of the same species (MICHELI, 1729). This work also contains detailed plates of many species (fig. 7). This hardly means that earlier botanists ignored these organisms. They made remarkable observations, especially visual ones, but as David FREEDBERG (2002) argued in the case of the Linceans, the visual record could only go so far towards making the diversity of life understandable. A knowledge infrastructure had to be laid, and that took time.

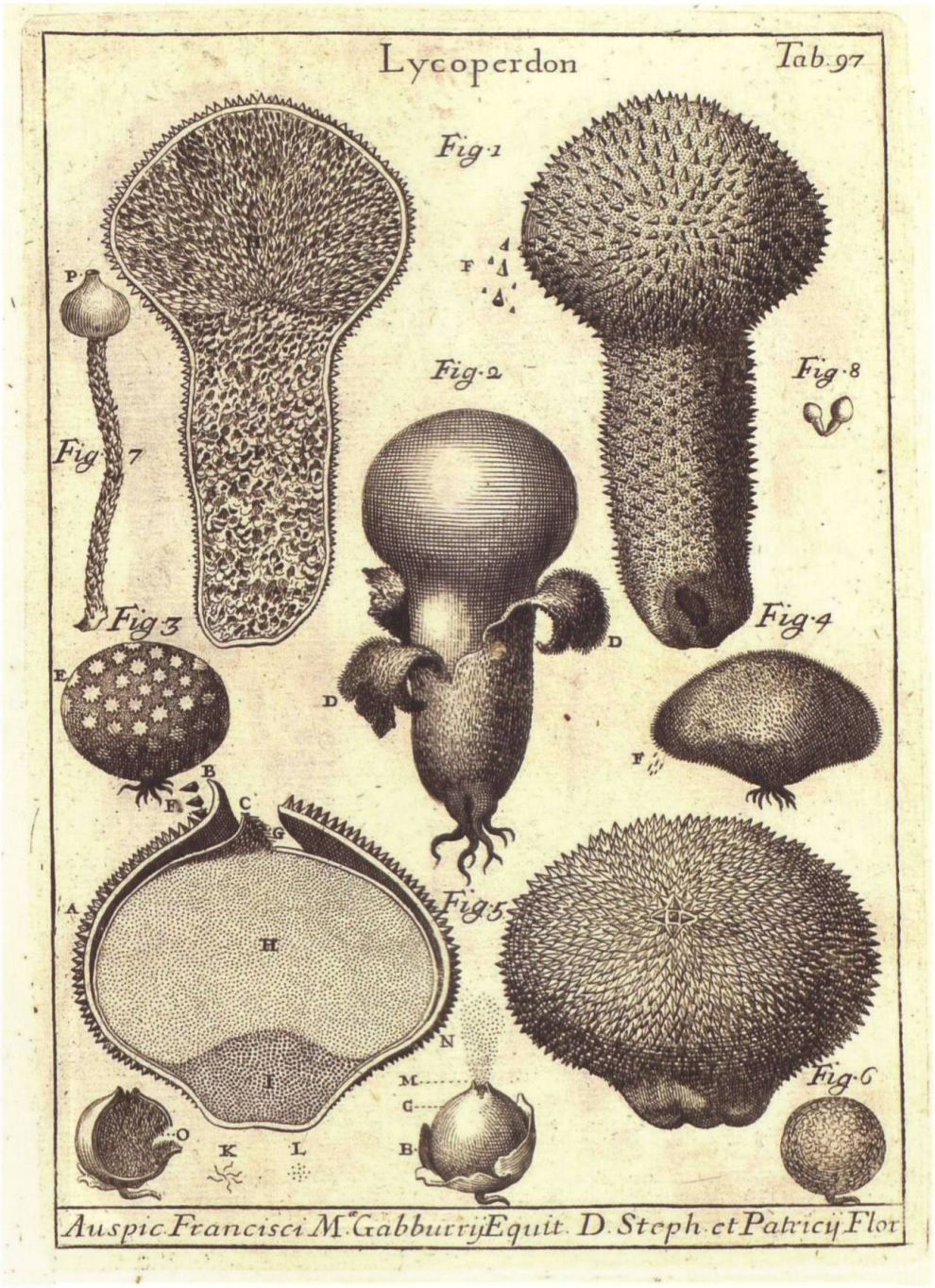


**Figure 7.** Puffball mushrooms *Lycoperdon* in Pier Antonio Micheli's *Nova Plantarum Genera* (1729). Royal Botanic Garden Madrid.

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