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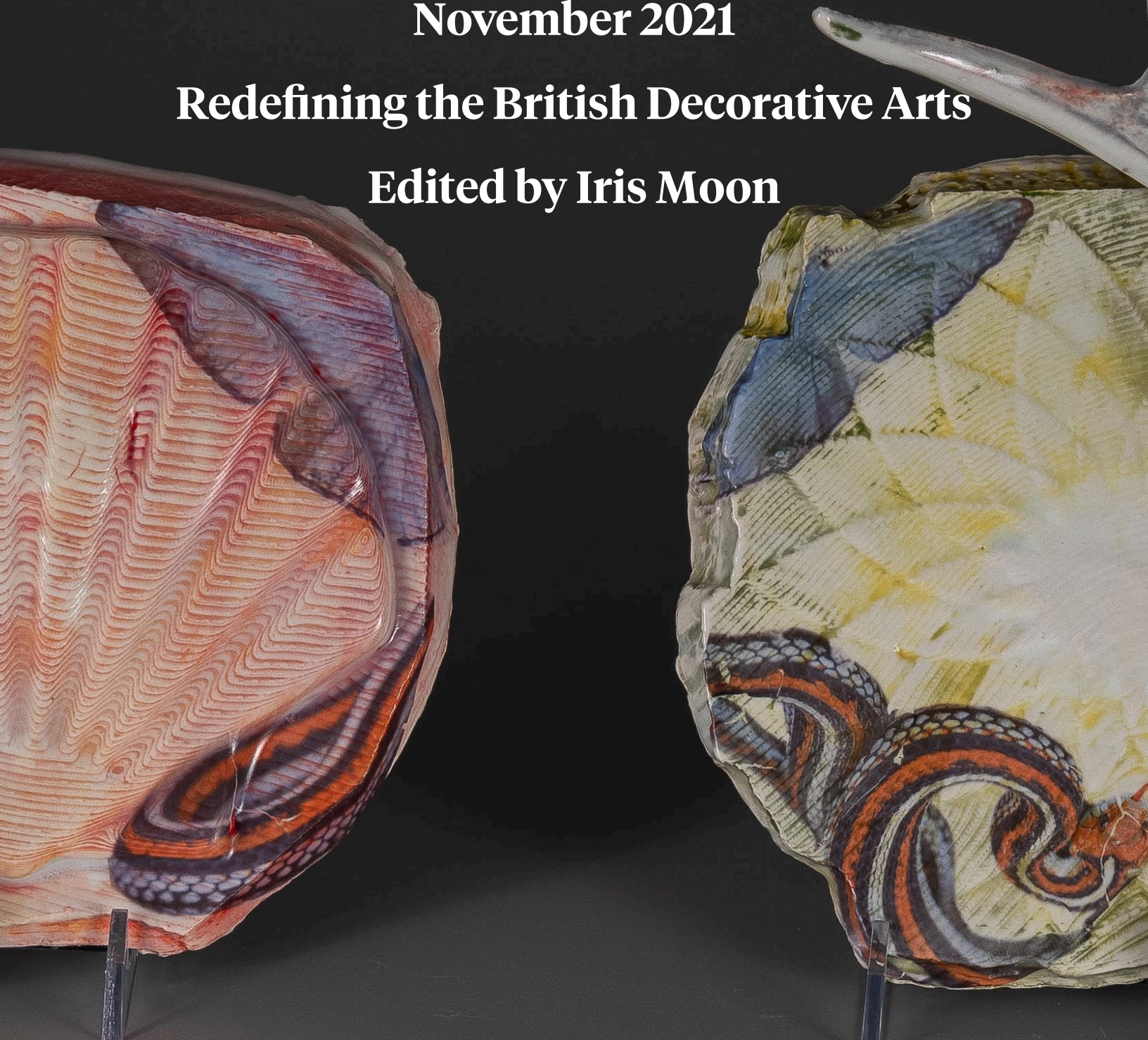
Redefining the British Decorative Arts

Edited by Iris Moon



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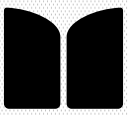

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Contents

Microorganisms, Microscopes, and Victorian Design Theories

Ariane Varela Braga

Abstract

This article looks at the interface between art, science, and design by considering the role of microscopes, the visualisation of microorganisms and British mid-nineteenth century design theories. In particular, it examines the dialogue between microscopical arranged slides that became popular in the second half of the century and the design theories of Owen Jones, diffused through the seminal *Grammar of Ornament* and the South Kensington system. Whereas the scientific observation of plants and their role in the development of guiding principles of ornament has attracted the attention of scholars, especially in relation to the Department of Science and Art, the intersections between the “microscope mania”, the material culture of microscopy, and design theories have been overlooked. Through the lenses of the microscope, a new world was revealed that potentially exposed general laws of harmony in form and colour. Coinciding with the emergence of microbial biology, the microscope was looked at as a tool for the renewal of the decorative arts. At the crossroads between art and science, the popular production of arranged slides both confirmed and performed the principles of ornament, at a time when both the visualisation of these principles and the transcription of microscopic observation shared common practices.

Authors

Acknowledgements

The idea for this article came when I was a postdoctoral fellow at the Bibliotheca Hertziana—Max Planck Institute for Art History in Rome. I thank Sietske Fransen for exchanging ideas with me on the subject of microscopic visualisation in the modern period. I am especially grateful to Howard Lynk and Piero Luporini for generously providing the photographs of diatom arrangements and the video of microorganisms, respectively. I also want to thank the anonymous referees and editors for their useful comments.

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Ariane Varela Braga, "Microorganisms, Microscopes, and Victorian Design Theories", British Art Studies, Issue 21, https://dx.doi.org/10.17658/issn.2058-5462/issue-21/avbraga

Introduction

In the second half of the nineteenth century, microscopy became a popular and social activity. In 1857, Reverend Edmund Saul Dixon, an amateur naturalist and friend of Charles Dickens, commented that “it seems probable, from many symptoms, that the microscope is about to become the idol of the day; we appear to be on the eve of a microscope mania”. [1] Technical improvements and the new relative affordability of the instruments were key factors in the popular growth of microscopy from the 1850s to the 1870s. Microscopes were no longer the privilege of scholars and scientists but became objects of common use that were displayed in Victorian parlours. At a time when the lines between amateur and professional scientists were still blurry, and when both still shared a common conceptual and descriptive language, scientific knowledge rapidly circulated to non-specialist readers through manuals and journals. [2] The use of the microscope was regulated by a series of social events, evening discussions or “conversazioni”, as well as exhibitions, demonstrations, and lectures held in clubs and scientific societies. [3] Amateurs rejoiced in the observation and collection of specimens, amassing true miniature cabinets of curiosities composed of *naturalia* and *artificilia* that also reflected contemporary attitudes towards the past and the natural sciences. [4] By the middle of the century, microscopic preparations had become the object of vivid commerce and entire “museums” could be purchased ready-made. [5] And as the introduction of balsam and other mounting media transformed the preparation of slides, in the late 1860s mounters started to produce elaborate compositions made out of several microscopic objects, known as exhibitions mounts, exhibition slides, Salon-slides, or Artistic groups—names that all point to the social practices involved in their use. [6]

Major producers were in France, Germany, and Britain, but the latter were especially known for their ornamental exhibition slides. The two images opening this article are twenty-first century microphotographs of two exhibition slides dating from the 1880s and commercialised by the firm Watson & Sons. The first, made from the scales and hair of butterflies, was probably realised by Harold Dalton and offers a bucolic floral composition carefully disposed in a wicker basket, around which float butterflies and a dragonfly (fig. 1). The second shows a rosette motif that would perfectly fit into a Gothic cathedral, and is composed of butterfly scales, spicules, which are structural elements made of silica and found in most sponges, and diatoms, the latter being microalgae that play a key role in the production of oxygen on Earth (fig. 2). These arrangements testify to the skill acquired by Victorian microscopists but also stand for two opposing visions of ornament and the decorative arts that had confronted each other at mid-century: the *mimesis* of nature versus its abstraction. Tinged with moral and social

connotations, these two divergent paths had also materialised in the well-known opposition between art critic John Ruskin and the circle of Sir Henry Cole, and the so-called design reformers of the South Kensington system. While Ruskin vehemently defended traditional craftsmanship and natural ornamental forms, the latter, which included figures like the painter and pedagogue Richard Redgrave, and the architect and decorator Owen Jones, advocated instead an alliance between art, industry, and geometric ornamentation, as illustrated in Jones's encyclopaedic *Grammar of Ornament* (1856). [7]

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Figure 1.
H. Dalton (?) for Watsons & Sons, Bouquet with Insects, c.1880s, slide imaged using combinations of darkfield and reflected lighting techniques. Digital image courtesy of Howard Lynk, www.victorianmicroscopeslides.com (all rights reserved).

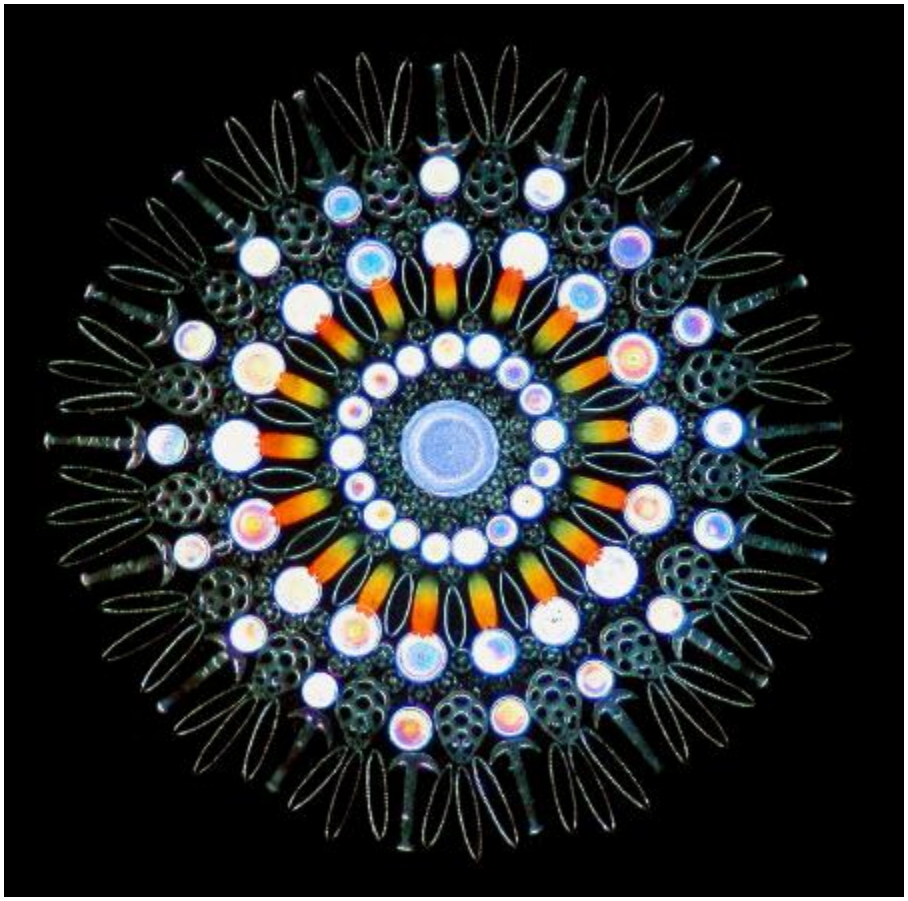

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Figure 2.
Watson & Sons, Exhibition mount of arranged diatoms, butterfly scales and spicules, c. 1885, slide imaged using combinations of darkfield and reflected lighting techniques. Digital image courtesy of Howard Lynk, www.victorianmicroscopeslides.com (all rights reserved).

In an attempt to face the cultural pluralism of the modern world and renew an aesthetic unity judged to be lost, architects and design theorists from the circle of the South Kensington system followed the example of naturalists and turned to the scientific observation of nature to establish universal foundations for the decorative arts. This search for nature's working processes as a means to break free from historicism was not new. As Barry Bergdoll has pointed out, its roots can be traced back to German philosophical thoughts, Goethe's theory of morphology, and the idea of unity in variety, which would eventually lead to the forms of art nouveau. [8] In this article, I instead explore the intersections between the visualisation of the microscopic world and theories of design in Great Britain in the 1850s–1870s. I examine how the microscope was employed as a tool for the renewal of ornament and design, by virtue of its perceived capacity to illustrate and confirm the underlying principles of nature. Art historians have studied the role played by popular science publications in mediating scientific knowledge

for artists and architects, and how these illustrations closely informed artistic practices, as demonstrated by the work of the German biologist Ernst Haeckel, author of the highly popular *Kunstformen der Natur* (1899–1904). [9] However, the material culture of microscopy has so far been overlooked. As I argue in this article, nature's order was not only visualised graphically but also staged in the production and diffusion of arranged slides, which both confirmed and performed contemporary design theories.

The Microscope in Aid of Ornamental Art

In 1844, the British painter William James Müller asked in the pages of the *Art-Journal* why students of the London School of Design, instead of copying arabesques, did not take inspiration directly from nature and make use of the microscope. [10] The Government Schools of Design had been created in 1837 as the first official initiative to support the renewal of British decorative arts in a context of intense international economic competition. Following the example of the German technical institutes, the London School's second director, William Dyce, had promoted a progressive didactic method based on linear and geometrical drawing, known as the "Dyce outlines", claiming that ornamental art had to go "side by side with practical science". [11] As a scientist, and contrary to the artist, the ornamentalist must not work according to nature, but *like* nature, that is, learn to apply the general laws of order and harmony as well as the mathematical and geometrical rules that govern natural forms. However, his vision led to few concrete results, as the Government Schools were plagued by internal quarrels and failed to meet its objectives.

Efforts to connect the arts and sciences became more prominent after the Great Exhibition of 1851. In 1852, the Schools of Design were replaced by the Department of Practical Art in charge of establishing a British national system of art education, renamed Department of Science and Art (DSA) in 1853. In an attempt to unite art and industry, and promote an aesthetics adapted to serial production, the DSA set up a rigorous didactic system based on the demonstration of primordial laws governing the application of forms and colours in art and nature. To illustrate these universal laws of order, scientists were initially invited to lecture to the art students. In 1852, the botanist John Lindley gave a lecture titled "The Symmetry of Vegetation", while zoologist, botanist, and palaeontologist Edward Forbes gave two lessons: "The Variety and Symmetry of Animal Forms" and "The Symmetry of Radiated Animals". According to the DSA, nature's laws of symmetry, repetition, and proportion were to be emulated by the designer who should at all costs avoid direct *mimesis*.

In practice, the aspired reform of design was actually more a reform of bi-dimensional ornament, for attention was mostly placed on the graphical representation of forms, resulting in ornamental patterns well fitted for the production of carpets, wallpapers and textiles. In an attempt to find common principles in the distribution of forms and colours in ornament, figures such as Owen Jones and Christopher Dresser turned to the arts of the past produced in Europe and to the arts of the present from non-Western nations, as well as to nature. Their aim was to create new ornaments fit for the present and to respond to the challenges resulting from new industrial means of production. Hence, the conventional or stylised representations of natural forms, which could easily be adapted to serial production, became their mantra and that of mid-nineteenth century design reformers and the so-called South Kensington system. [12]

Dialogue between art and science at the DSA was not only promoted through lectures but also through exchanges between scientists and artists. In 1854, the chemist Lyon Playfair, a strong advocate of the promotion of scientific education and first head of science at the DSA, showed the painter Richard Redgrave, superintendent of art at the DSA, photographs of snowflake crystals taken by meteorologist James Glaisher. Redgrave agreed they could usefully illustrate to art students “the importance of minute observation”. [13] This had not always been Redgrave’s view on the subject. But whereas five years earlier the painter had dismissed “microscopic productions which are too minute to interest the ornamentist”, things had now changed. [14] Despite this reference, little is known about the actual use of these drawings or the microscope in the art classes. But even if the DSA’s official reports do not record the use of microscopes by art students, it is nonetheless known that visualisations of plant elements drawn from a microscope were already employed by Christopher Dresser in his lectures on art and botany between 1854 and 1856.

Dresser was a figure of transition. As Stuart Durant has remarked, he had followed an unconventional path: he “approached design as a scientist”, and was both the product and agent of the South Kensington system. [15] In his youth, he had followed Playfair’s teachings at the Government School of Mines and Science Applied to the Arts, where students were familiar with the use of the microscope. [16] Initially developing a parallel career in design and botany, Dresser specialised in plant morphology and published three books on the subject: *The Rudiments of Botany* and *Unity in Variet*y (both printed in 1859 and addressed to the art student), and the more accessible *Popular Manual of Botany* (1860). He was even awarded a doctorate *in absentia* for his work on plant morphology from the University of Jena in 1859. A diagram by Dresser illustrating five seeds of pollen as seen through the microscope is one of the many still preserved in the collections of the Victoria and Albert

Museum (fig. 3). [17] Dresser emphasises the regularity and geometry of the seeds, insisting on their symmetry to demonstrate the existence of general laws. While plants and flowers had always been used as inspiration for British decorative art, their conventional treatment had been specially promoted through the work and publications of neo-Gothic architect A.W.N. Pugin, such as *Floriated Ornament* (1849). Much inspired by Pugin's ideas, the DSA systematised the scientific study of plants to extract and deduce general rules. [18] From now on, students would look at nature as a repository of geometrical patterns, drawing plants in plans, sections, and elevations, as Dresser had done on plate 98 of Owen Jones's *Grammar of Ornament* (fig. 4). In this seminal publication, which would become a privileged textbook for schools of design around the world, Jones had presented ornament as a formal language based on the laws of nature, regulated by the structuring power of geometry through rules of arrangement, symmetry, and proportion. [19] Direct imitation of natural forms was to be avoided at all costs, an idea theorised in number 13 of his accompanying propositions, which stated that "flowers or other natural objects should not be used as ornament, but conventional representations". [20] An example of "conventional" ornament inspired by natural forms may be seen in a Wedgwood vessel designed by Dresser, decorated with his "truth, beauty, power" motif. In a series of patterns that combine Greek, Mesoamerican, and organic elements, he achieves a potent and original design that conveys graphic excellence, strength, and energy, as exemplified in the fluxes of straight lines and curves radially expanding from the centre of the composition (fig. 5).

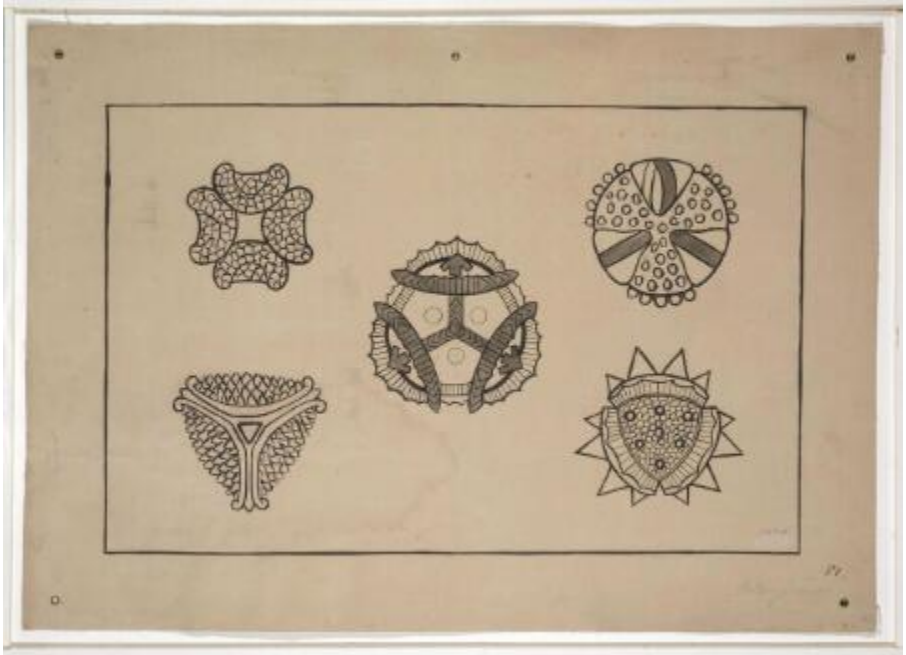

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Figure 3.
Christopher Dresser, Pollen Grains, 1854–1856, pen and ink on buff paper, 55 x 70.5 cm. Collection of the Victoria and Albert Museum, London (3974). Digital image courtesy of Victoria and Albert Museum, London (all rights reserved).

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Figure 4.
Christopher Dresser, Leaves and Flowers from Nature No.8, Original drawing for the Grammar of Ornament, Plate XCVIII (London: Day, lithographers to the Queen, 1858), 1856–1856, watercolour, bodycolour and pencil on paper with title in pen and ink, 52.8 x 36.5 cm. Collection of the Victoria and Albert Museum, London (1671). Digital image courtesy of Victoria and Albert Museum, London (all rights reserved).

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Figure 5.
Christopher Dresser (designer), Josiah Wedgwood and Sons (maker), Vessel with truth, beauty, power motif, 1867, unglazed earthenware, 25.4 cm, 2.5 kg. Collection of The Metropolitan Museum of Art, New York (L.2019.32.1). Digital image courtesy of The Metropolitan Museum of Art, New York (all rights reserved).

Several of Dresser's drawings of microscopic plant structures were included in the *Art-Journal* in his article titled "Botany, as Adapted to the Arts and Art-Manufacture", which was published in eleven parts between 1857 and 1858. [21] Readers of the *Art-Journal* were used to contributions on various artistic and scientific arguments and would probably not have been surprised by the idea of the microscope as a tool for design. Reviews of publications on microscopy featured regularly in the journal. In March 1857, two months after the first part of Dresser's article appeared, the *Art-Journal* published a paper by meteorologist James Glaisher on the microscopic structure of snow crystals and their utility for "the purpose of design", a subject with a long history that also fascinated architects Gottfried Semper and Jules Bourgoin.

[22] It was followed in January 1858 by geologist Samuel Joseph Mackie's article on "Sea-weeds as Objects of Design", which illustrated magnified sections of several specimens. [23]

Seaweed hunting was a popular Victorian pastime. Fascinated by the natural and marine worlds, amateur naturalists enjoyed observing and collecting marine creatures and shells, which, by the end of the 1850s, following the creation of saltwater aquariums, had even started to enter into the domestic sphere. [24] Through the microscope, educated observers could participate in the search for the mechanisms of life and take part in contemporary debates on its origins raised by Charles Darwin's theories of evolution. The previously invisible world revealed through the microscope suggested that there were yet other mysteries to uncover, in a transforming world where scientific knowledge was undermining religious beliefs. Cell theory had also recently been developed, postulating that all living organisms, both plants and animals, were composed of cells and considered as the most elementary units of life. [25] It is therefore no coincidence that Mackie's interest lay not so much in the decorative characteristics of the entire seaweed but in the "minute structure" of plant cells. Claiming that "the invisible is not the less beautiful that it is unseen", he appealed to the microscope to reveal the geometrical secrets of nature. He pointed to the fact that "by the mere repetition and combination of the circle, the hexagon, or the pentagon" one obtained an unfathomable number of varied and never monotonous forms. Thus, even sea hunting could become the key to the revitalisation of ornament and design, but on condition that the art student would look beyond nature's appearance to its "wonderful generative processes". [26]

The idea that the microscope might be a useful ally for the renewal of design expanded well beyond the walls of the DSA or the sphere of art journals. In 1862, the journalist and amateur microscopist Henry James Slack, author of a manual of microscopy titled *The Marvels of Pond-Life* (1860), published his article "On the Application of the Microscope to the Art of Design" in *The Intellectual Observer*, a popular science journal of which he was the editor. Slack posited the microscope as an instrument that "constantly presents us with a rich store of ideas which the decorative artist would do well to study and employ". [27] Paying great attention to colour alongside form, he discussed his observations with reference to Owen Jones's colour theory and concept of visual repose. His comments were based on the architect's Alhambra Court in the Crystal Palace at Sydenham. In this second Crystal Palace, Jones was joint Director of Decoration and designed the Egyptian, Greek, and Roman Courts alongside an Alhambra Court. In 1851, the polychrome decoration of Joseph Paxton's first Crystal Palace at the Great Exhibition had established Jones as one of the most important contemporary

colour experts. His theories formed the basis of the DSA's teaching, but the diffusion of good principles of design to the general public was also one of the architect's major concerns.

In 1852, after contributing to the establishment of the Department of Practical Art and its museum, Jones had embarked on the expanded reconstruction of the Crystal Palace in Sydenham as a museum for the people whose important didactic enterprise had been lately recognised anew. [28] In the architectural courts, and especially in the Alhambra Court, Jones had implemented for the general public the principles that would later be disseminated to students of art and architecture in his *Grammar of Ornament.* [29] Both Jones's architectural courts and Slack's article were meant to popularise knowledge for an eager public. Slack's readership would have been largely familiar with the Crystal Palace and the "laws of decorative art" displayed in Jones's courts. [30] These were the same laws that the designer was invited to apply and which the amateur microscopist would see demonstrated in the contemporary practice of microscopic, arranged slides.

Nature as Ornament or The Art of Microscopic Arrangements

The practice of mounting microscopic objects according to artistic or decorative purposes, also known as "arranging slides", seems to have appeared around 1850, a first mount being referred to by George Shadbolt (1817–1901) in the *Transactions of the Microscopical Society* of London in 1849. [31] Geometrically arranged specimens apparently developed at the same time, made first by Johann Dietrich Möller in Germany and Arthur C. Cole and Amos Topping in Great Britain. The invention around 1866 of the "mechanical finger" (a device created to ease the manipulation of microscopic objects) in different configurations significantly enhanced the ability to control individual small objects. [32] By the late 1860s, arranged slides were mentioned in the catalogues of several preparers and could be found in different countries, although British mounters were especially known for this art. Micrographer Harold Dalton, for example, who created the slide illustrated in figure 1, became internationally known in the last quarter of the century for his microscopic artistic pictures. [33] Their minute representations seem to compete less with painting than the art of micromosaics or Florentine *pietre dure*. However, the most common arranged slides featured abstract compositions, as in Arthur C. Cole's slide using sponge spicules or microscleres (fig. 6). Its composition, like Jones's beloved Moorish ornament, relied on the principle of radial symmetry, and depended not on the "multiplicity of varied forms" but on the "repetition of a few simple elements" arranged to produce a general effect (fig. 7). [34]

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Figure 6.
A.C. Cole, Arranged mount of Sponge Spicula, end 1860s–1870s, slide imaged using darkfield lighting. Digital image courtesy of Howard Lynk, www.victorianmicroscopeslides.com (all rights reserved).

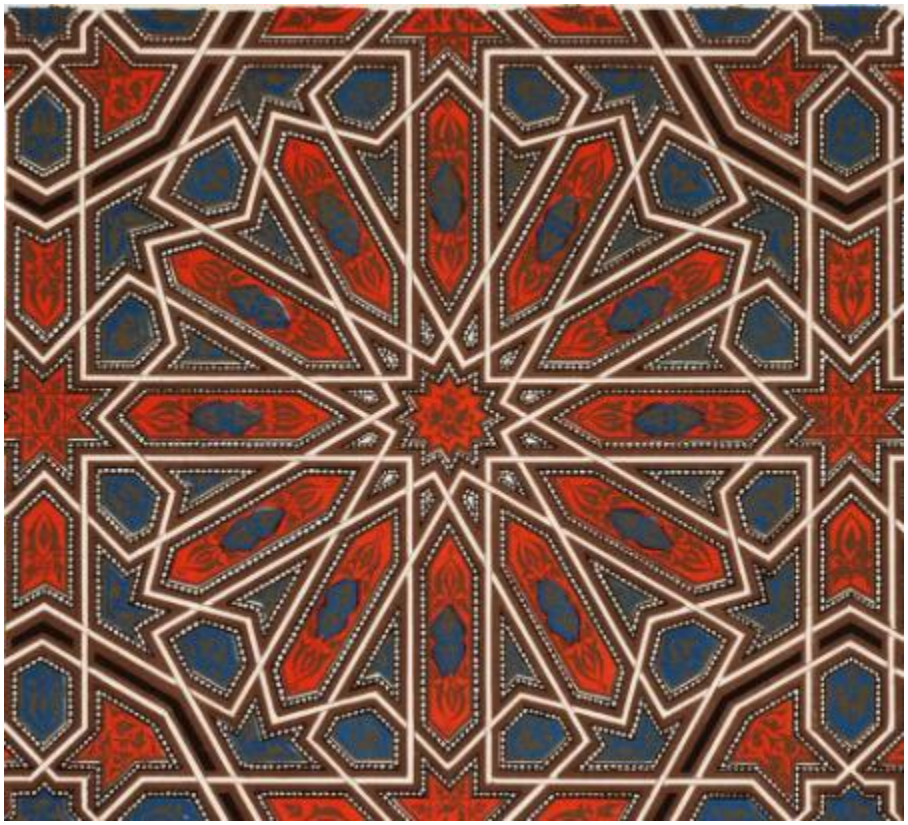

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Figure 7.
Moorish ornament from the Alhambra, (detail of plate 52), in Owen Jones, *The Grammar of Ornament* (London: Bernard Quaritch, 1910), 1856. Collection of The University of Wisconsin Library. Digital image courtesy of The University of Wisconsin Library (CC BY 4.0).

Among the favourites of Victorian mounters were diatoms, unicellular microalgae ranging from five to one thousand microns long, characterised by their hard silica shells, a great variety of geometrical shapes, and almost perfect symmetry (fig. 8). Endowed with movement, their classifications in the animal or plant kingdom had until the mid-nineteenth century divided naturalists. As classification fluctuated, so did terminology. Before the word "microbe" was coined around 1878 by Charles-Emmanuel Sédillot, microorganisms were generally referred to as *animalcules*, according to the term created in the seventeenth century by Dutch naturalist Antonie van Leeuwenhoek. Another general term was *infusoria*, from the fact that these organisms could be found in infusions of decaying animal or vegetable matter. [35] In his influential but soon controverted *Die infusionsthierchen als vollkommene organismen* (1838) German naturalist Christian Gottfried Ehrenberg had considered diatoms as animals, a view followed by British microscopist Andrew Pritchard in *The Natural History of Animalcules* (1834), but already outdated by the early 1850s. Soon thereafter, thanks to publications such as William Smith's *Synopsis of British Diatomaceæ*

(1853–1856) the study and classification of diatoms became more rigorous. At the same time, numerous articles and books provided advice for their microscopic mounting.

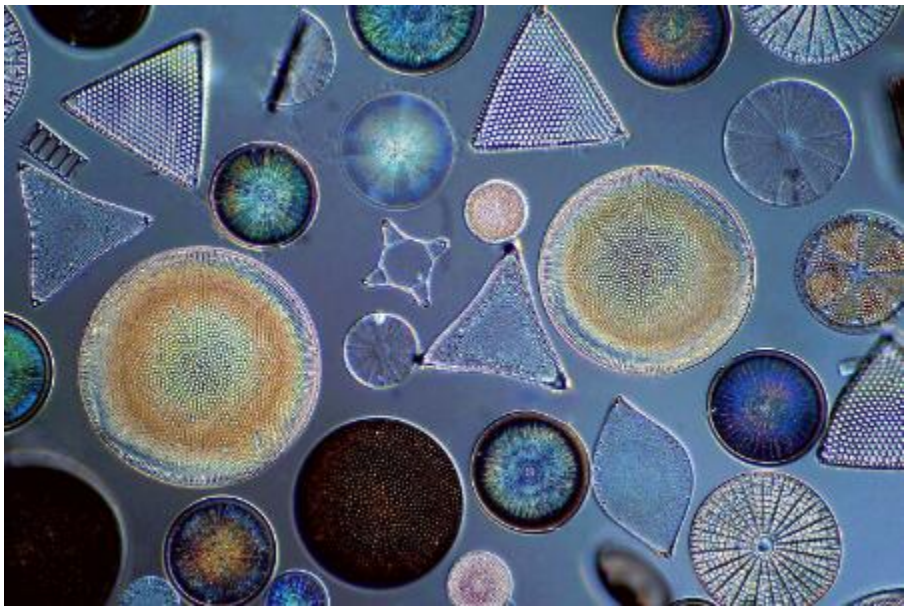

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Figure 8.
Watson & Sons, Various diatoms, c.1880s, slide imaged using differential interference contrast. Digital image courtesy of Howard Lynk, www.victorianmicroscopeslides.com (all rights reserved).

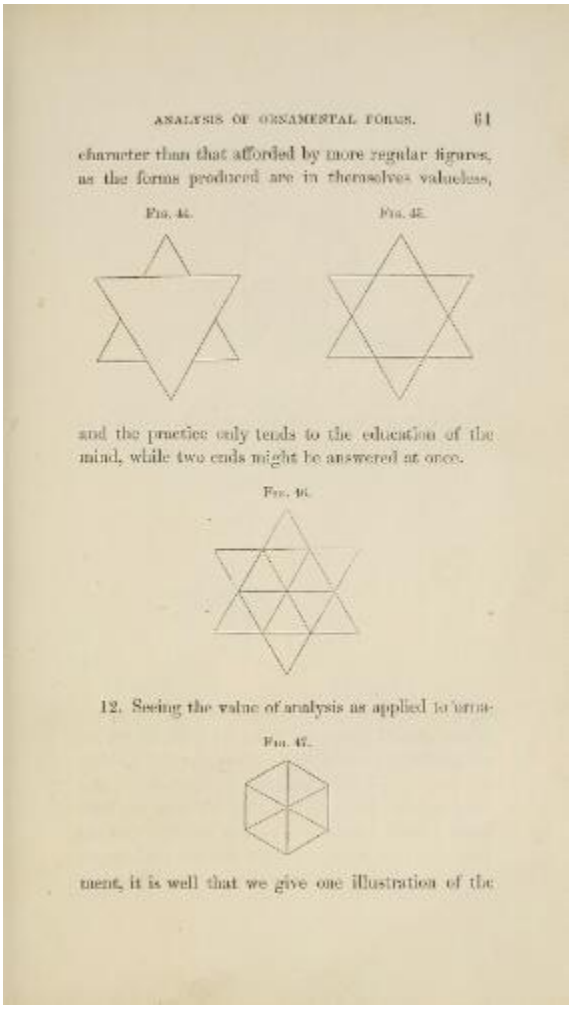
Then, as now, diatoms were easily found in freshwater or damp surfaces. Their availability and the symmetry of their patterns turned them not only into research specimens used to test the resolution of microscopes, but also ones privileged for exhibition slides. According to *Hardwicke's Science-gossip*, they were "the most suggestive of all natural objects, for purposes of artificial ornamentation". [36] A contemporary testimony on diatoms as illustrations of ornamental principles is provided by the Anglophile Italian amateur architect and microscopist, the Marquis Ferdinando Panciatichi Ximenes of Aragona. In a manuscript dated ca.1864, he commented on how the microscope had opened new paths for the architect and ornamentalist, noting:

> Who would believe that the problem of the ornamentation of the most complicated geometric solids, as well as of the simplest ones, would find infinite solutions, all varied and all beautiful, in some corpuscles wandering around the seaweeds, as would be

> the diatoms and the navicules [a boat-shaped diatom], in which are found the strangest forms, and the strangest ornamentations that human mind could ever conceive? [37]

In diatoms, Panciatichi found universal laws of proportion "performed, confirmed, and applied" and considered that they put into practice "*ab initio* certain kinds of ornaments that man believed his property". [38] Diatoms illustrated the same laws that he was striving to apply in the ornamentation of his Villa of Sammezzano, an Orientalising *Gesamtkunstwerk* imbued with British architectural and design theory that he had initiated in the previous decade, whose peculiar use of forms and colours can in part be explained by his use of the microscope. He had found these same universal principles displayed in the architectural courts of the Crystal Palace at Sydenham, which he visited in 1864, and in Jones's *Grammar of Ornament*, a book he acquired shortly afterwards, whose cover pattern he had reproduced in stucco in one of the villa's rooms. [39]

As an amateur scientist and microscopist, Panciatichi had been collecting diatom slides from at least the mid-1850s, including some by the French optician Joseph Bourgogne. Bourgogne was among the most important preparers of the time, and was known to have "had the great advantage of constant communication with the most learned men of Paris, who have aided him in their several departments". [40] In the current state of research, it is unknown if microscopists in Britain and Europe had active exchange with artists and designers as well. What can be observed is that while the first arrangements were rather approximate, technical advancement and the use of mechanical devices rapidly improved the quality of mounts in the 1860s. [41] Nonetheless, and whereas practical data on the processes of collecting, separating, washing, and mounting diatoms abound in journals and manuals, we have no such information concerning choices about the design of their actual placement on the slides. Future research in designer archives might help to illuminate that question. It would certainly have been easy for mounters to find inspiration for their compositions in the pages of contemporary pattern books or art journals, or to find in them principles of axial or radial symmetry. For example, the simple star-like composition seen in an exhibition slide by Johann Dietrich Möller relies on the use of two triangles, a basic ornamental form discussed in contemporary books such as Dresser's 1862 *The Art of Decorative Design* (figs. 9 and 10).



ANALYSIS OF ORNAMENTAL FORMS. 61

character than that afforded by more regular figures, as the forms produced are in themselves valueless,

Fig. 44. Fig. 45.

and the practice only tends to the education of the mind, while two ends might be answered at once.

Fig. 46.

12. Seeing the value of analysis as applied to orna-

Fig. 47.

ment, it is well that we give one illustration of the

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Figure 9.
The basis of star-like ornament, in Christopher Dresser, *The Art of Decorative Design* (London: Day and Son, 1862): p. 61. Collection of the Glasgow School of Art Library. Digital image courtesy of Internet Archive (CC BY-SA 3.0).

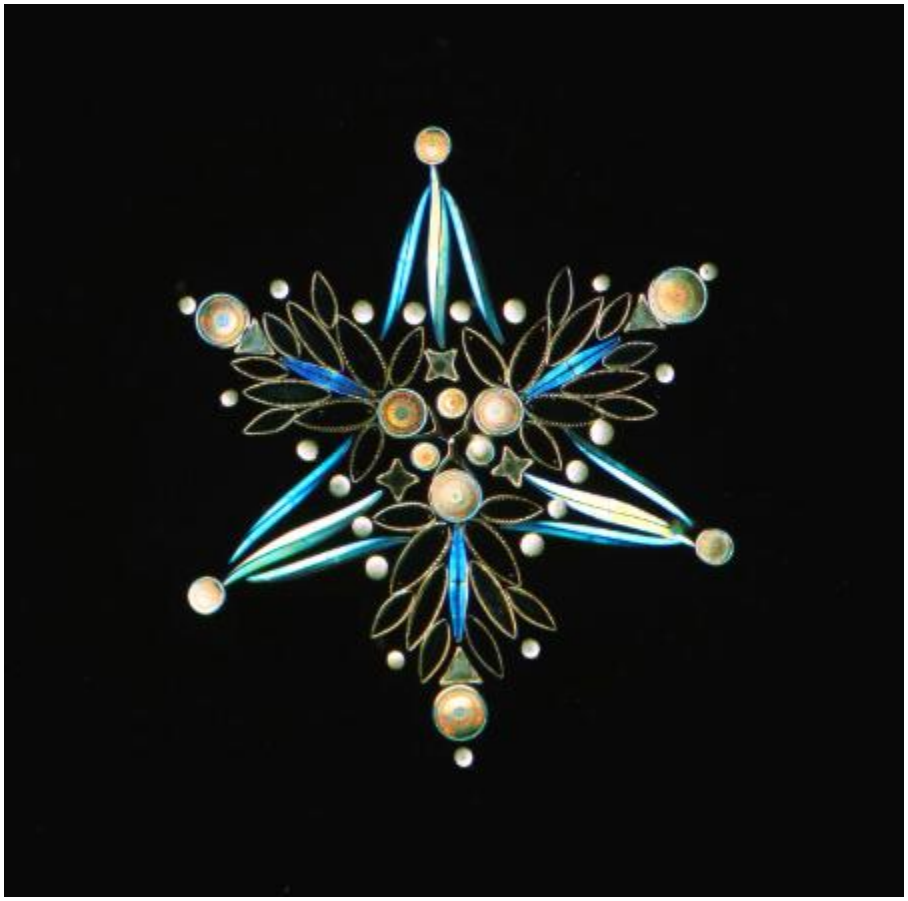

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Figure 10.
Johann Dietrich Möller, Arranged mount of diatoms, c.1880, slide imaged using darkfield lighting. Digital image courtesy of Howard Lynk, www.victorianmicroscopeslides.com (all rights reserved).

Microorganisms and Ornament: A Shared Visual Culture and Common Practices

Despite the many encouragements to find inspiration in the principles of nature by peering through the lenses of a microscope, it is still hard to evaluate the extent to which designers actually did so. That the microscope became ubiquitous is confirmed by the fact that even John Ruskin, known for his reticence towards the union of art and science, would sometimes recommend its use. [42] But did Owen Jones, for instance, avail himself of the instrument for work or leisure? After all, Jones was a close friend of the famous science populariser George Henry Lewes, and it is hard to believe that he would have been immune to the "microscope mania" of his time. Lewes was the author of *Studies in Animal Life* (1862) and *Sea-side Studies* (1867), and the companion of the writer George Eliot, who literary production scholars of English literature consider to have been impacted by the

microscopic vision of the world that Lewes described in his books. [43] In the current state of research, however, it remains difficult to assess the role of the microscope in the daily practice of most designers. As Mackie remarked in 1858, “it cannot be expected that the designer should carry on the laborious researches of the man of science [and …] that he should have one eye for the microscope, and the other for his pencil”. [44] Hence, I argue that the vision of the invisible world and microorganisms was more often mediated by images—graphic representations that were themselves the product of a shared visual culture and common practices.

Although a popular optical instrument, using a microscope demanded a trained eye. Making sense of what was seen through the lenses required a process of visual learning, which was subject to a series of procedures, conventions, and practices that could be ideologically charged. Just as science students were trained in the laboratory to domesticate nature through a series of visual, verbal, and practical “procedural conventions”, the students of the DSA were educated to reduce the natural world to a series of geometrical patterns and stylised or conventional forms. [45] Thus, in the mid-nineteenth century, the representation of the invisible world and ornament shared common visual practices and codes, which were in close dialogue.

Manuals of microscopy frequently thematised the challenges of microscopic observation, drawing parallels between science and magic, and emphasising the wonders of the invisible world that the instrument could reveal. As Laura Forsberg has shown, Victorian science literature often referred to the language of wonder and to fairies to express the bizarreness of the microscopic world. [46] In *Evenings at the Microscope* (1859), for example, Philip Henry Gosse announced that the reader was about to discover the “beauty [of the] invisible, which one who has once gazed upon it can never forget, and never cease to admire”. [47] In *Drops of Water: Their Marvellous and Beautiful Inhabitants Displayed by the Microscope* (1851) by Agnes Catlow, one among many female science educators of the time, this visual experience was transformed into a magical operation. Guided by “a spirit named Science”, she invited her reader to pass with her “through a wonderful brazen tunnel, with crystal doors at the entrance” and behold “a new world bewildered with the variety of new beings and forms”. [48] Calling into question the usual parameters of vision, the microscope thus transformed the actual process of seeing, as the observer tried to identify the images of this “new world”.

In the representation of a drop of water from Catlow’s book, we can see several microorganisms, including diatoms, harmoniously arranged (fig. 11). In contrast to the taxonomical representations of scientific atlases, the draughtsman intended to simulate the actual circular vision of the

microscope. Still, this image presents an already ordered view of nature, where each group of microorganisms, symmetrically drawn, is separated and numbered, to allow the picture to fulfil its didactic function. Therefore, this image, painted and lithographed by A. Achilles, does not provide documentary information but a fabricated and idealised vision of the invisible world. As discussed by Lorraine Daston and Peter Galison, the notion of objectivity is a historical construction that emerged in the sciences during the mid-nineteenth century. Before objectivity, “truth-to-nature” had been the common practice: that is to say, a representation based on a process of “selecting, comparing, judging, generalizing”. [49] In other words, the naturalist was not so much interested in the actual specimen itself, with its particular idiosyncrasies, but in defining its typological characteristics conveyed through an idealised depiction. This is what is at stake in this image, and it resulted from a visual tradition that was also dictated by material constraints.

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Figure 11.
A. Achilles, Drop I, in Agnes Catlow, *Drops of Water: Their Marvellous and Beautiful Inhabitants Displayed by the Microscope* (London: Reeve and Benham, 1851): plate 1, 1851, colour lithograph. Collection of the University of Toronto Library. Digital image courtesy of Internet Archive (CC BY-SA 3.0).

If we consider the microorganisms contained in the drop of water described by Catlow, we have to keep in mind that one of these constraints was movement. As she pointed out, looking at a single drop of water in the microscope means seeing a world teeming with life, where “all [is] gliding and moving about without noise and at perfect ease”. [50] This posed a further challenge to the observer and the draughtsman, as we may perceive from a short video in which microorganisms move fast and in all directions, mingling and overlapping (fig. 12). To overcome this inconvenience, Victorian amateur microscopists exchanged advice and information in the pages of scientific journals, discussing the number of anaesthetic substances needed to slow down the mobility of microorganisms without killing them. For the

draughtsmen (who were actually often women), drawing quickly was therefore a necessity. To make the process easier, they represented half of what they saw, only to recompose it later, at leisure, through symmetrical representation. Glaisher and his observation of snowflakes again offers a well-known example, in his work towards the paper “On the Severe Weather at the Beginning of the Year 1855; and on Snow and Snow-crystals”. As snowflakes melted rapidly, he sketched them roughly. They were afterwards redrawn by his wife, Cecilia, who redesigned them through the principles of symmetry. [51] Just as in Catlow’s or Glaisher’s illustrations, the ornamental motifs in Jones’s *Grammar* did not provide documentary or objective information but an idealised version of historical ornamentation. Through the regularisation of the motifs—their visual codification—Jones was able to highlight the principles of ornament and thus extract the characteristic elements of a universal grammar; a grammar that was not limited to paper but was also three-dimensionally expressed in the architectural courts of the Crystal Palace.

[mul]

As we have seen, Jones had endorsed the validity of his principles of ornament through the regulating model of nature, saying that “whenever any style of ornament commands universal admiration, it will always be found to be in accordance with the laws which regulate the distribution of form in nature”. [52] Good ornament followed the rules of nature. After the publication of his *Grammar*, these principles had acquired major authority among design reformers, and in turn could be taken as a model to explain the principles of nature itself. This paradigmatic shift is visible in Glaisher’s 1857 article in the *Art-Journal*, in which he argued for the usefulness of snow crystals for design, notably for mosaic, tilework, and cotton print (fig. 13). Glaisher referred to Jones’s design theories, even citing propositions 3, 5, 8, 9, and 10 of the *Grammar* and discussed in detail the geometrical qualities of snow crystal in relation to the Byzantine and Moorish Courts in Sydenham, reflecting that Jones’s book and his architectural decoration were given equal theoretical value.


THE ART-JOURNAL.

tals, as may be seen in parts of the pavement of the Byzantine Court. plication, far more than in the con- glass mosaic and its imitations, of have been speaking, we are compelled ffect in symmetry of design; neces- luded from imparting the idea of faces, such be- sistent with the of flooring, to present a ace to the eye we are also con- a very limited colour, in order terfere with the ns of the walls gs, and the man- f encaustic tiles itself limited to yment of but rs. Thus ex- m the rich and rmonies of co- the relievo of shade, our at- principally di- the design, regard to this n, should com- licity with uni- outline, and be rable to a purely base. And here ld, in regard to s of snow, that, n outline or in hey are equally al. In the one y are simply copies of the fect to the naked he other, they o us structural nly visible by ation of a high- s, or as seen by a microscope.

partment, and whose influence was felt more or less in every home of the kingdom, had no guide but his own ill-educated and distorted will; he threw things together without the least regard to harmony of colour, fitness of proportion, or form of any kind, and called the heterogeneous mass "a design." Of late he

be received into the higher application lain. We all know that porcelain ha joyed a monopoly of the most tastef that Art could suggest, whether flowers, medallions of figures, or ar but we are in hopes that they may few novelties of design to this the mos

medium for th of the natural tiful in Art; of itself sug question,—how the beauty and of the geomet been acknowle employed hithe designs? To a question woul an inquiry int tory of design to pottery, fro crude attempt delineation o objects to th time, when, bot land and abro attained to s perfection. As inquiry, this scarcely less i than instructiv as it would, th in design to knowledge of t is beautiful a priate, rather ventional. Th Court of the C lace, now ope ranged by Ma late of the est of Messrs. Cog Co., offers a study never thrown open t dent in Ceram and contains which will

nal range of application is likewise them in regard to floor-cloth, which attention to the conditions above l, as applying to tile-work, but in a e, inasmuch as its more household

has had better opportunities for the acquisition of knowledge, but what is of far more importance, he has had better informed critics; in some instances his task has preceded, in others it has followed, that of his customers; but

form a complete history of pottery earliest up to the present time.

For a brief period of Italian A enabled to glance cursorily at this design by means of the Soulages

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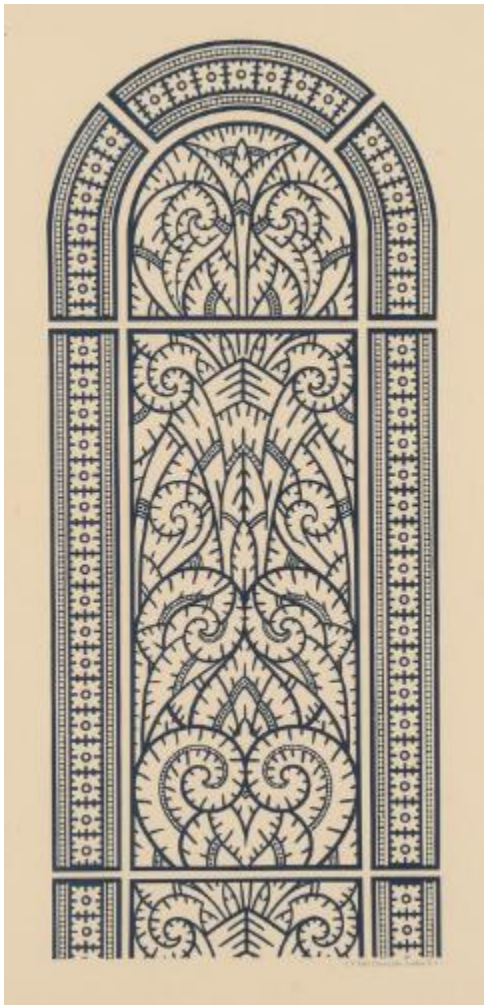
Figure 12.
James Glaisher, Pattern inspired by a crystal of snow, in *The Art-Journal*, vol. 19, April 1857 (London: Virtue and Co., 1857): p. 126. Collection of the University of Illinois at Urbana-Champion. Digital image courtesy of Internet Archive (CC BY-SA 3.0).

Glaisher's aim was not to show that these historical ornaments followed the laws of nature as exemplified in snow crystals, but just the opposite. Reversing Jones's relationship between nature and ornament, he stated that a snow crystal could "suggest new forms in the decorative design, as applied to the Industrial Arts", because crystals were "in accordance with those general principles of arrangement of form, which, in all ages and countries have constituted the truly beautiful in Art". [53] In other words, snow crystals *follow* the principles of historical ornament. In this view, the laws of ornament as illustrated in Jones's *Grammar* and at Crystal Palace had acquired an exemplary value on a par with, and even superior to, nature.

This porosity between the natural and the ornamental is well illustrated in a design for a window from the late 1860s by Christopher Dresser. The motif was later published in plate 20 of *Modern Ornamentation* (1886), with the indication that it was “in no historic style, but was derived from the frost on a window-pane in winter” (fig. 14). However, the central pattern shows striking similarities with the intricate arabesques and volutes of Islamic ornament, whereas the glass is framed by the repetition of a square pattern whose outlines are marked by small lines, comparable to that of the *bacillaria* illustrated in Catlow’s drops of water. Displaying the same laws of distribution of forms, this pattern illustrates the close boundaries between nature and ornament in the Victorian age.



View this illustration online

Figure 13.
Pattern inspired by frost on a window-pane, in Christopher Dresser, *Modern Ornamentation* (London: B. T. Batsfford, 1886): plate 20. Collection of the Yale Center for British Art, Gift of Paul F. Walter. Digital image courtesy of Yale Center for British Art, Gift of Paul F. Walter (public domain).

Through the lenses of the microscope and the glass slides, microorganisms—as living beings or arranged as ornaments—were placed in the centre of a visual frame. [54] This frame dissolved when the ornament was transposed back onto three-dimensional objects. Set “free” again in the physical world, the ornament unfolded on the surface and could spread in all directions, as in Dresser’s “truth, beauty, power” vessel.

Conclusion

The mid-nineteenth century was a time of profound cultural, social, scientific, and material transformation. The advancement of historical and scientific knowledge, together with the new discoveries made in various fields and their increasing dissemination, mediatisation, and commodification through exhibitions, museums, and the popular diffusion of scientific knowledge, all contributed to redefine the perception of humanity in history and nature. New ideas and conceptions of the world were not only circulated and conditioned by text and images, but also through material culture, as witnessed by the vogue for the aquarium and the microscope, and their importance in the domestic and social sphere in Victorian times.

In an attempt to face contemporary challenges by uniting art and industry, designers turned to the study of the past and to nature. In their search for general principles, they made use of all the tools and devices available to them, including the microscope. Like the botanist or the zoologist, the designer could search for natural rules of composition in the view of the invisible world revealed by the instrument. But as this article has demonstrated, dialogue between art and science was not confined to the walls of design schools. Scientific knowledge and practices rapidly circulated between several registers, and boundaries between the amateur and the professional were hard to delineate. The production of exhibition slides testifies to these fruitful entanglements. At a time when both the visualisation of the rules of art and nature and the transcription of microscopic observation shared common practices, arranged slides both confirmed and performed the principles of ornament.

Footnotes

1 E.S. Dixon, “Microscopic Preparations”, *Household Words* (8 August 1857): 132.

2 See G. Beer, *Darwin’s Plots. Evolutionary Narrative in Darwin, George Eliot and Nineteenth-Century Fiction* (Cambridge: Cambridge University Press, 1983). On the role of science popularisers, see: B. Lightman, “Marketing Knowledge for the General Reader: Victorian Popularizers of Science”, *Endeavour*, 24, no. 3 (2000): 100–106; J.R. Dolan, “From the Popularization of Microscopy in the Victorian Age: A Lesson for Today’s ‘Outreach’”, *Protist*, 170, no. 3 (2019): 319–327. On microscopes in general: S. Bradbury, *The Evolution of the Microscope* (Oxford: Pergamon Press, 1967); G. l’E. Turner, *Essays on the History of the Microscope* (Oxford: Senecio Publishing, 1980); G. l’E. Turner, *The Great Age of the Microscope: The Collection of the Royal Microscopical Society Through 150 years* (Bristol: Adam Hilger, 1989).

3 O. Brown, R.H. Nuttall, and S. Butler, *The Social History of the Microscope* (Cambridge: Shipple Museum of the History of Science, 1986); J.A. Bennett, “The Social History of the Microscope”, *Journal of Microscopy*, 155, no. 3 (1989): 267–280; S.J.M.M. Alberti, “Conversaziones and the Experience of Science in Victorian England”, *Journal of Victorian Culture*, 8, no. 2 (2003): 208–230.

4 See for instance T. Stammers, *The Purchase of the Past: Collecting Culture in Post-revolutionary Paris c.1790–1890* (Cambridge: Cambridge University Press, 2020).

5 See for example Dixon, “Microscopic Preparations”: 133.

6 B. Davidson, “Arranged and Type Slides”, *Quekett Journal of Microscopy*, 39 (2001): 4.

7 For an introduction to these well-known questions, see: D. Schafter, *The Order of Ornament, The Structure of Style, Theoretical Foundations of Modern Art and Architecture* (Cambridge: Cambridge University Press, 2003), 17–32; A. Burton, "Ruskin and South Kensington: Contrasting Approaches to Art Education", *Journal of Art Historiography*, 20 (2020), https://arthistoriography.files.wordpress.com/2020/05/burton.pdf. Accessed 1 March 2021. See also A. Varela Braga, *Une théorie universelle au milieu du XIXe siècle. La* Grammar of Ornament *d'Owen Jones* (Rome: Campisano Editore, 2017), 201–208.

8 See B. Bergdoll, "Nature's Architecture: The Quest for the Laws of Form and the Critique of Historicism". In A. Sachs (ed.), *From Inspiration to Innovation, Nature Design* (Baden: Lars Müller, 2007), 46–47 and B. Bergdoll, "Of Crystals, Cells, and Strata: Natural History and Debates on the Form of a New Architecture in the Nineteenth Century", *Architectural History*, 25 (2007): 1–29.

9 See for instance: E. Krausse, "L'influence de Ernst Haeckel sur l'Art Nouveau". In J. Clair (ed.), *L'âme au corps: arts et sciences, 1793–1993* (Paris: Réunion des Musées Nationaux, 1993), 242–251; R. Proctor, "Architecture from the Cell-soul: René Binet and Ernst Haeckel", *Journal of Architecture*, 11, no. 4 (2006): 407–424; R.M. Brain, "Protoplasmania. Huxley, Haeckel, and the Vibratory Organism in the Late Nineteenth-Century Science and Art". In B. Larson and F. Brauer (eds.), *The Art of Evolution. Darwin, Darwinism, and Visual Culture* (Hanover: Dartmouth College Press, 2009), 92–123; M. Morton, "From Monera to Man. Ernst Haeckel, Darwinismus, and Nineteenth-Century German Art". In S. Bergmann and F. Clingerman (eds.), *Arts, Religion, and the Environment. Exploring Nature's Texture* (Leiden: Brill, 2020), 59–91.

10 W.J. Müller, "Letters from Xanthus", *Art-Journal*, 6, 1844: 356.

11 W. Dyce, *The Drawing Book of the Government Schools of Design, Published Under the Immediate Superintendence of the Council* (London: Chapman & Hall, 1842–43), I. On the Schools, see the classics studies of Q. Bell, *The Schools of Design* (London: Routledge, 1963) and S. MacDonald, *The History and Philosophy of Art Education* (New York: American Elsevier, 1970).

12 The South Kensington system has been the subject of much scholarship. For recent contributions, see: E. Chestnova, "'Ornamental Design is … a Kind of Practical Science'. Theories of Ornament at the London School of Design and Department of Science and Art", *Journal of Art Historiography*, 11 (2014), https://arthistoriography.files.wordpress.com/2014/11/chestnova.pdf and R. Dohmen, "Art, Industry and the Laws of Nature: the South Kensington Method Revisited", *Open Arts Journal*, 9 (2020). DOI:10.5456/issn.2050–3679/2020w03. Accessed 2 March 2021.

13 Letter from Playfair to Glaisher, 8 February 1854 (Playfair copybook. Science Museum Archive). Citation taken from: https://www.fitzmuseum.cam.ac.uk/gallery/ceciliaglaisher/snow/40.html

14 R. Redgrave, "Importance of the Study of Botany to the Ornamentist", *Journal of Design and Manufactures*, 1 (1849): 148.

15 S. Durant, "Christopher Dresser and the use of Contemporary Science", *The Journal of the Decorative Arts Society 1850—the Present*, 29 (2005): 24; ID, "Dresser's Education and Writings". In M. Whiteway (ed.), *Christopher Dresser, A Design Revolution* (London: V&A Publications, 2004), 47–59. On Dresser in general, see also: W. Halén, *Christopher Dresser* (Oxford: Phaidon, 1990) and M. Whiteway (ed.), *Shock of the Old: Christopher Dresser's Design Revolution* (London: V&A Publications, 2004).

16 G. Gooday, "'Nature' in the Laboratory: Domestication and Discipline with the Microscope in Victorian Life Science", *The British Journal for the History of Science*, 24 (1991): 307–341.

17 The Victoria and Albert Museum preserves seventy-two drawings that Dresser used to illustrate his lectures on botany at Marlborough House (museum numbers 3925 to 3996).

18 D. Brett, "Design Reform and the Laws of Nature", *Design Issues*, 1, no. 3 (1995): 37–49.

19 On the idea of grammar, ornament, and the decorative arts see: R. Labrusse, "Face au chaos: grammaires de l'ornement", *Perspective. La revue de l'INHA*, no. 1 (2010–2011): 97–121; ID., "Grammars of Ornament: Dematerialization and Embodiment from Owen Jones to Paul Klee". In G. Necipoglu and A. Payne (eds.), *Histories of Ornament: From Global to Local* (Princeton: Princeton University Press, 2016), 320–333; ID., *Face au chaos. Pensées de l'ornement à l'âge de l'industrie* (Paris: les presses du réel, 2018), 85–144, and Varela Braga, *Une théorie universelle*, 105–151.

20 Proposition no. 13 in O. Jones, *The Grammar of Ornament, Illustrated by Examples from Various Styles of Ornament* (London: Day & Son, 1856), 4.

21 According to David Brett, these are the first instance of the application of "microscopic drawing to design" in Brett, "Design Reform": 37.

22 J. Glaisher, "On the Crystal of Snow, as Applied to the Purposes of Design", *Art-Journal*, 19 (1857): 73–76, 125–128; see J. Boucard and C. Eckes, "Les sources scientifiques de Jules Bourgoin: cristaux, polygones et polyèdres". In M. Bideault, E. Thibault, and M. Volait (eds.), *De l'Orient à la mathématique de l'ornement. Jules Bourgoin (1838–1908)* (Paris: Picard, 2005), 299–313 and Labrusse, *Face au chaos*, 72–76.

23 S.J. Mackie, "Sea-weeds as Objects of Design", *Art-Journal*, 20 (1858): 5–8.

24 S. Granata, "'At Once Pet, Ornament, and "Subject for Dissection"': The Unstable Status of Marine Animals in Victorian Aquaria", *Cahiers victoriens et édouardiens*, 88 (2018), DOI:10.4000/cve.4272. Accessed 26 February 2021. In his book *Unity in Variety* (1859), Dresser had also introduced, on page 20, images of fossilised marine organisms, to defend the idea of the universality of Nature's principles.

25 L. Wolpert, "Evolution of the Cell Theory", *Philosophical Transactions: Biological Sciences*, 349, no. 1329 (1995): 229–230.

26 Mackie, “Sea-weeds as Objects of Design”: 97, 100, 104.

27 H.J. Slack, “On the Application of the Microscope to the Art of Design”, *The Intellectual Observer: Review of Natural History, Microscopic Research and Recreative Science*, 1 (1862): 111.

28 See J.R. Piggott, *Palace of the People, The Crystal Palace at Sydenham 1854–1936* (London: C. Hurst & Co. Publishers, 2004); S. Moser, *Designing Antiquity: Owen Jones, Ancient Egypt and the Crystal Palac*e (New Haven, CT: Yale University Press, 2012); K. Nichols and S.V. Turner (eds.), *After 1851: The Material and Visual Cultures of the Crystal Palace at Sydenham* (Manchester: Manchester University Press, 2017).

29 On the Fine Art Courts and the *Grammar of Ornament*, see Varela Braga, *Une théorie universelle*, 33–49.

30 Slack, “On the Application of the Microscope to the Art of Design”: 114.

31 B. Bracegirdle, *Microscopical Mounts and Mounters* (London: Quekett Microscopical Club, 1998), 4.

32 H.L. Smith, “On a Mechanical Finger for Use with the Microscope”, *American Journal and Science and Art*, 41 (1866): 331–337.

33 See the entry by B. Stevenson, “Henry ‘Harold’ Dalton, 1836–1912”, http://microscopist.net/DaltonH.html. Accessed 1 February 2021.

34 Jones, *The Grammar of Ornament*, 15.

35 R. Mazzolini, “Infusoria”. In *The Oxford Companion to the History of Modern Science* (Oxford: Oxford University Press, 2003). https://www.oxfordreference.com/view/10.1093/acref/9780195112290.001.0001/acref-9780195112290-e-0360. Accessed 24 February 2021. J. Cresswell, “Microbe”. In *The Oxford Dictionary of Word Origins* (Oxford: Oxford University Press, 2009). https://www.oxfordreference.com/view/10.1093/acref/9780199547920.001.0001/acref-9780199547920-e-3200. Accessed 24 February 2021.

36 An., “New Books”, *Hardwicke’s Science-gossip. An Illustrated Medium of Interchange and Gossip for Students and Lovers of Nature*, 10, no. 109 (1874): 27.

37 “Chi crederebbe che il problema dell’ornamentazione de’ più complicati solidi geometrici, come de’ più semplici, trovasse infinite soluzioni tutte varie e tutte belle in alcuni corpuscoli vaganti intorno all’alghe marine, come sarebbero le diatomee e i navicoli, ove si trovano le più strane forme, e le più strane ornamentazioni, che mente umana potesse mai concepire?” F. Panciantichi Ximenes d’Aragona, “Pensieri sull’architettura”, *Architettura & arte*, 11/12 [1864] (2000): 85.

38 “eseguite confermate ed applicate […] in questo mondo novello si trovano praticate *ab initio* certi generi di ornamenti che l’uomo credeva sua proprietà ”. Panciantichi Ximenes d’Aragona, “Pensieri sull’architettura”: 85.

39 A. Varela Braga, “Building a Dream: the Alhambra in the Villa of Sammezzano”. In F. Giese and A. Varela Braga (eds.), *The Power of Symbols. The Alhambra in a Global Perspective* (Bern: Peter Lang, 2018), 300–303. I develop this topic further in an upcoming publication.

40 Letter from G.B. Amici to J. Bourgogne, 3 December 1855 (Modena: Biblioteca Estense Universitaria, Archivio Giovanni Battista Amici, folder 1126, letter 8617). Dixon, “Microscopic Preparations”, 137. On Bourgogne, see B. Stevenson, “Joseph Bourgogne, ca.1805–ca.1885”. http://microscopist.net/BourgogneJoseph.html. Accessed 20 February 2021.

41 Davidson, “Arranged and Type Slides”, 3. By 1868, the German Johann Diedrich Möller had developed taxonomic type slides with hundreds of different species.

42 J. Ruskin, *The Laws of Fésole. A Familiar Treatise on the Elementary Principles and Practice of Drawing and Painting as Determined by the Tuscan Masters* [1877–79]. In E.T. Cook and A. Wedderburn (eds.), *The Complete Works of John Ruskin* (London: George Allen, 1904), 405.

43 See for instance Beer, *Darwin’s Plots*, 139–168 and Y. Xiao, “Lost in Magnification: Nineteenth-Century Microscopy and the Lifted Veil”, *George Eliot—George Henry Lewes Studies*, 69, no. 1 (2017): 68–88.

44 Mackie, “Sea-weeds as Objects of Design”: 107.

45 Gooday, “‘Nature’ in the Laboratory” and Xiao, “Lost in Magnification”: 72–76. For an ideological interpretation of the DSA see: J.G. Rhodes, “Ornament and Ideology: a Study in Mid-Nineteenth-Century British Design Theory” (PhD dissertation, Harvard University, 1983).

46 L. Forsberg, “Nature’s Invisibilia: The Victorian Microscope and the Miniature Fairy”, *Victorian Studies*, 57, no. 4 (2015): 638–666.

47 P.H. Gosse, *Evenings at the Microscope; Or Researchers Among the Minuter Organs and Forms of Animal Life* (London: Society for Promoting Christian Knowledge, 1859), iii.

48 A. Catlow, *Drops of Water: Their Marvellous and Beautiful Inhabitants Displayed by the Microscope* (London: Leave and Benham, 1851), x–xi.

49 L. Daston and P. Galison, *Objectivity* (New York: Zone Books, 2007), 55–113, here 59.

50 Catlow, *Drops of Water*, xi.

51 Daston and Galison, *Objectivity*, 150. J. Glaisher, “On the Severe Weather at the Beginning of the Year 1855; and on Snow and Snow-crystals”, *British Meteorological Society 5th Annual Report* (London: British Meteorological Society, 1855), 17. See the online exhibition about the work of Cecilia Glaisher, *Snow Leaves Ferns*, by the Fitzwilliam Museum, put online in March 2016 https://web.archive.org/web/20161117063419/https://www.fitzmuseum.cam.ac.uk/gallery/ceciliaglaisher/.[/fn] But these practices were not limited to the observation of the natural world—they were common to designers and architects as well, whose sketchbooks are filled with ornamental patterns only half sketched to save time during their travels. This process was also employed in making plates for ornamental publications, as shown in the preparatory drawings for the *Grammar of Ornament* preserved in the Victoria and Albert Museum, where several motifs are left half-drawn to be completed by the lithographer.[fn]Varela Braga, *Une théorie universelle*, 158–163.

52 Jones, *The Grammar of Ornament*, 2.

53 Glaisher, “On the Crystal of Snow”: 75.

54 Historically and culturally constructed, this ordered vision of the world which privileged centralised and symmetrical dispositions was challenged when Dresser was confronted with the asymmetry of Japanese art. See: K.T. Oshima, “The Evolution of Christopher Dresser’s ‘Art Botanical’ Depiction of Nature”, *The Journal of the Decorative Arts Society 1850—the Present*, 29 (2005): 53–65.

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Boucard, J. and C. Eckes. “Les sources scientifiques de Jules Bourgoin: cristaux, polygones et polyèdres”. In M. Bideault, E. Thibault and M. Volait (eds.), *De l’Orient à la mathématique de l’ornement. Jules Bourgoin (1838–1908)*, 299–313. Paris: Picard, 2005.

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