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Shifting Spectra: Comparative Approaches to Image Making in Science and Art University of the Arts London. Central Saint Martins.

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Abstract: Shifting spectra sits upon an evolving history of image making in relation to science as it has evolved from conventional graphic means, through early photography into a complex digital domain. The paper goes on to explore a territory in which the artist and the scientist generate comparative images of complex micro-organisms. Their results converge and diverge as defined by the parameters and potential of the technology, the intended audience, and their personal aesthetic. The past twenty years have seen extensive advances in micro imaging that enable the scientist to move beyond the limitations of earlier protocols and this is a territory into which artists have increasingly been drawn. This article reflects on the history of photography and science and draws upon recent collaborations between the author and botanical scientists working in the United Kingdom, Germany and Portugal in which microscopy fulfils the dual role of scientific analysis and artistic interpretation of plant science.

Keywords: Microscopy, photography, science, art, colour.

PART I. EVOLUTION OF AN AESTHETIC

A discussion on the role of photography in relation to science and art needs some introduction into the role of hand drawn image making based on observations through a microscope. Writing about eighteenth century microscopy in her essay, *Picturing Ambiguity*, (Stafford 1996: 147) suggests, "Magnification drives to the centre of a major aesthetic problem faced by all natural history description. What do you do with things that are neither one thing nor the other?", a predicament she describes as, "a geography of betwixt and between". Stafford goes on to describe that when attempting to describe salt crystals under the microscope, the English microscopist Henry Baker (1698-1744), was to develop an aesthetics of a world invisible to the naked eye. The fractured geometries and feathery dendritic patterns were described as looking like "a Winter Scene of Trees without Leaves", (Baker 1744:138-139). It was a language of topographic aesthetics proposed by the English writer and printmaker William Gilpin (1724-1804) as "that kind of beauty which is agreeable in a picture", (Gilpin 1768). For the zoologist and artist Ernst Haeckel (1834- 1919) the aesthetics of nature was at the forefront of his belief. His illustrations of micro-organisms went beyond a mere depiction of existing ideas to reveal a new knowledge of nature, a knowledge that suggested a natural aesthetic, where "Nature which develops out of and into itself, is beautiful" (Olaf Breidbach 1998). One might argue however that Haeckel's urge to perfect the symmetry of marine protozoa undermined his notion of natural beauty. image 1

The depiction of nature for scientific purposes provokes strong opinion. In relation to botanical illustration former director of the Botanic Garden and Botanical Museum in Berlin H.Walter Lack (2001: 14) suggests, "Aesthetic considerations are wholly inappropriate, and beauty is a pleasant, but also wholly irrelevant, side effect. In an ideal world, an anonymous botanical illustration can be neither dated nor attributed to a particular artist". The flaw in this argument is that it assumes that the illustrations serve only as reference material for botanical scientists, whereas in practice they have a tendency to migrate beyond their intended audience as their artistry and beauty ensured the wider popularity and enthusiasm for all things floral. Further, it does a great disservice to the skills and sensibilities of the artists. The works of Georg Ehret (1708-1770), Franz Bauer (1758-1840) and Maria Sibylla Merian (1647-1717) stand out as masterpieces of botanical art in this context.

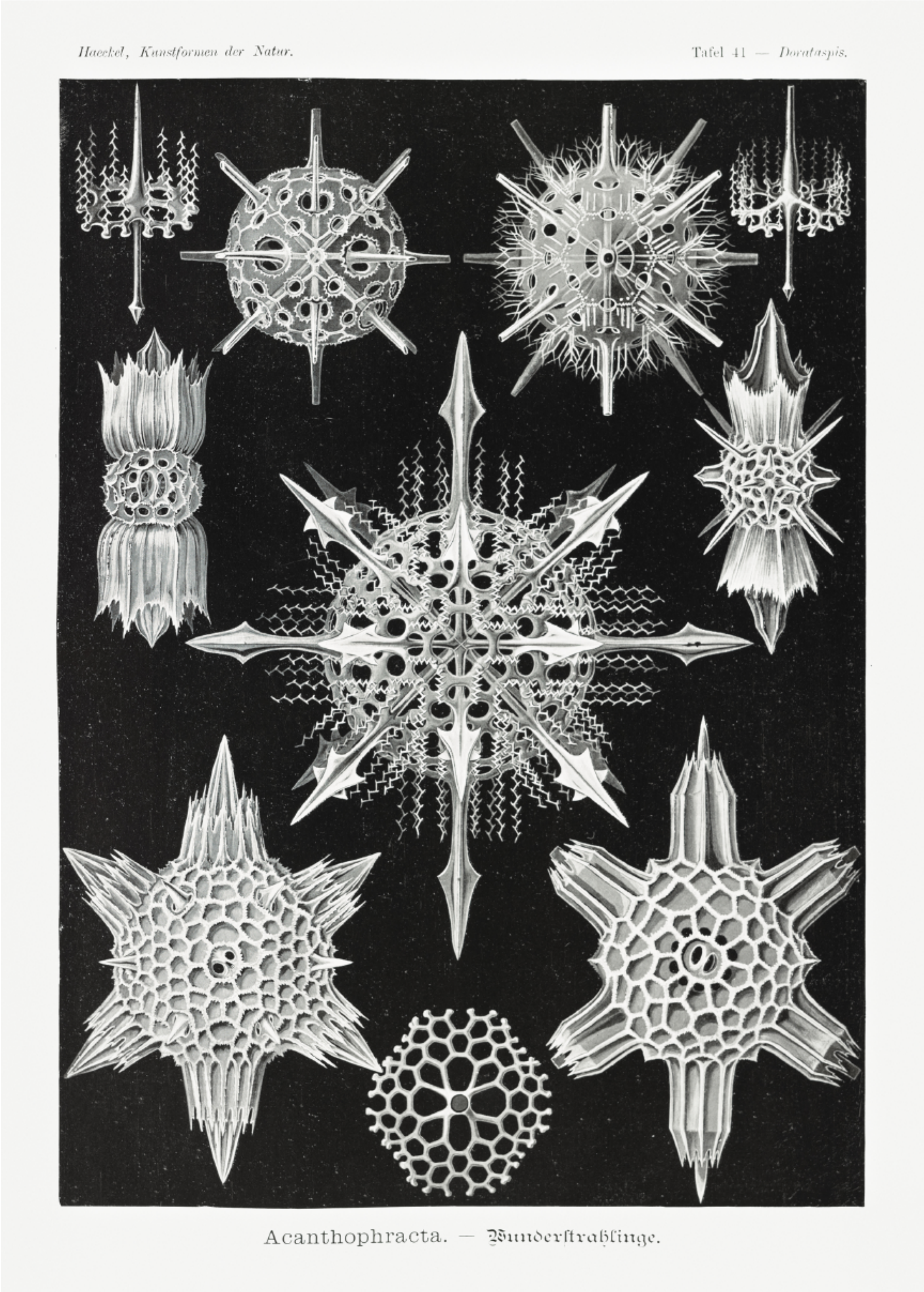


Image 1. Acanthophracta. Giltsch, A & Haeckel, E. (1904)
https://commons.wikimedia.org/wiki/File:Haeckel_Acanthophracta.jpg

As the study of plants became more popular, botany emerged as a suitable pastime for women and gained further traction with the development of the microscope in the nineteenth century. Microscopy enabled the scientist Mary Ward (1827-1869) to become one of the leading lights in the advancement of women in science, with her first publication *Microscope Teachings* (Ward 1864) selling out on publication. image 2

Image 2. Mary Ward at her microscope. https://commons.wikimedia.org/wiki/File:Mary_Ward_by_microscope.jpg

The nineteenth century coupling of photography and microscopy opened a new horizon for revealing, discussing, and communicating a world of living organisms too small to see with the naked eye. With the rapid improvement in optics for both cameras and microscopes, the quality of what could be portrayed, and the magnification of specimens observed, led to the expansion of possibilities for this new genres of image making. Whilst the skills of botanical and scientific illustrators remained valid and in demand, it became clear that when the camera was attached to the microscope, the scientific operator was responsible for the production of their images in which a new aesthetics of ambiguity was emerging.

Scientific illustrators no longer had to acquire the skill of peering down a lens with one eye whilst using the other to draw what was being observed. As early as 1840 the Austrian scientist Andreas von Ettinghausen, (1796-1878), following a meeting with photography pioneer Lois

Daguerre (1787-1851), produced an image of a section through a clematis vine using a solar microscope. image 3 Despite the distortions of focus around the edges it was seen to be an indisputable representation containing information beyond that of what an illustrator might produce. The key phrase here is indisputable representation which is line with role of image as evidence and proof, a cornerstone of scientific objectivity. Within the broader field of art photography, although the image was initially believed to be a true and accurate representation of the world, our reading of photographic images has since become better informed and our understanding of them more nuanced. Kathryn Tuma (2004: 216), explores this notion further, "Artistic representation tends openly to admit to its figurative and rhetorical aspects, with varying degrees of investment in the realism of its representation. Science, on the other hand, actively seeks to elide, conceal, or supress the figurative qualities of its descriptive or interpretive statements about the world in the service of abiding by an ideological realism necessary to support the ontological relevance of its claims".

Image 3 .Andreas Ritter von Ettinghausen. Cross-Section of a Clematis Stem, 4 March 1840. Daguerreotype, 160 x 210 mm (plate). Vienna, Albertina, inv. no. Foto2004/63.

Opportunities for microphotography saw an expansion of the way in which the living and physical world could be examined. Images of lightning strikes, snowflakes, image 4, pollen grains image 5, and blood cells revealed new insights in organisms and structures too small to be seen by the naked eye. The increasingly complex level of technologies also had the effect of inadvertently side-lining the role of both the scientific illustrator and perhaps more importantly the artist interpreter. Although there were occasional exceptions - Piet Mondrian (1872-1944) whose first employment after graduating was to draw bacteria under a microscope, ostensibly

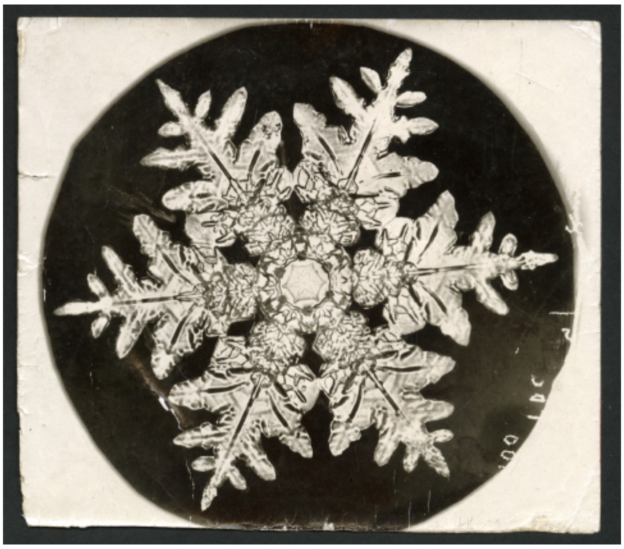


Image 4 .Wilson Bentley, Photomicrograph of Stellar Snowflake No. 990, Albumen print. Smithsonian Institution Archives Capital Gallery.

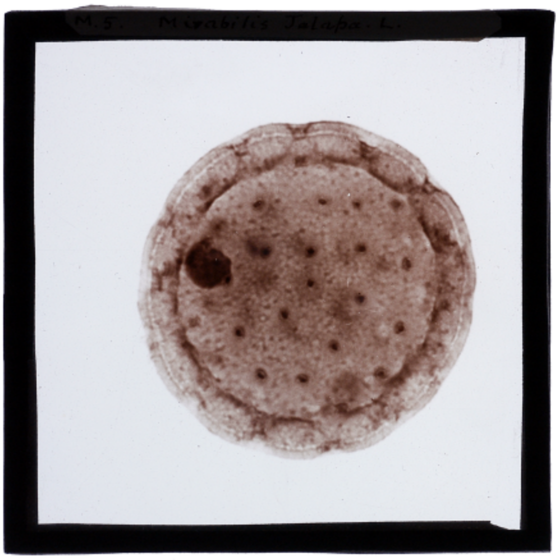


Image 5 .John Samuel Slater – pollen grain of Geranium nodosum – Knotted Cranes-bill, 1907. Plate negative magic lantern slide. [Courtesy of the Palynology Unit, Royal Botanic Gardens, Kew].

the scientist became the new conduit for scientific image making, and except for a few photographers who managed to work in the liminal space between science and art, the technology became increasingly difficult to access.

The early promise for the creative use of microphotography struggled to rise above the conventional approaches of science in which data, sequencing, evidence, and proof held sway in an environment in which visual expression had little place. The emergence of a more creative approach was slow in developing. One such who managed to bridge the gap was the French photographer Laure Albin Guillot (1879-1962). Married to a physician and scientist, she worked from slides he prepared to capture images of cellular and crystal structures on his microscope to create a portfolio of photogravures, *Micrographie Décorative* (1931). image 6. She applied a photographic aesthetic, influenced by the 'New Objectivity', an approach to art, architecture as well as photography that was emerging from the Bauhaus under the direction of Hungarian, Laszlo Maholy-Nagy, (1895-1946). He had proposed an experimental approach to photography that fused art, science, and technology, exploited by Albin-Guillot's micrographs that spoke to a new dawn of abstraction in art. The also spoke of pattern and ornament, something very present in the natural world, and our translation of it, reflecting Henry Baker's earlier descriptions of such subjects. Just as Haeckel's images proved inspirational to designers

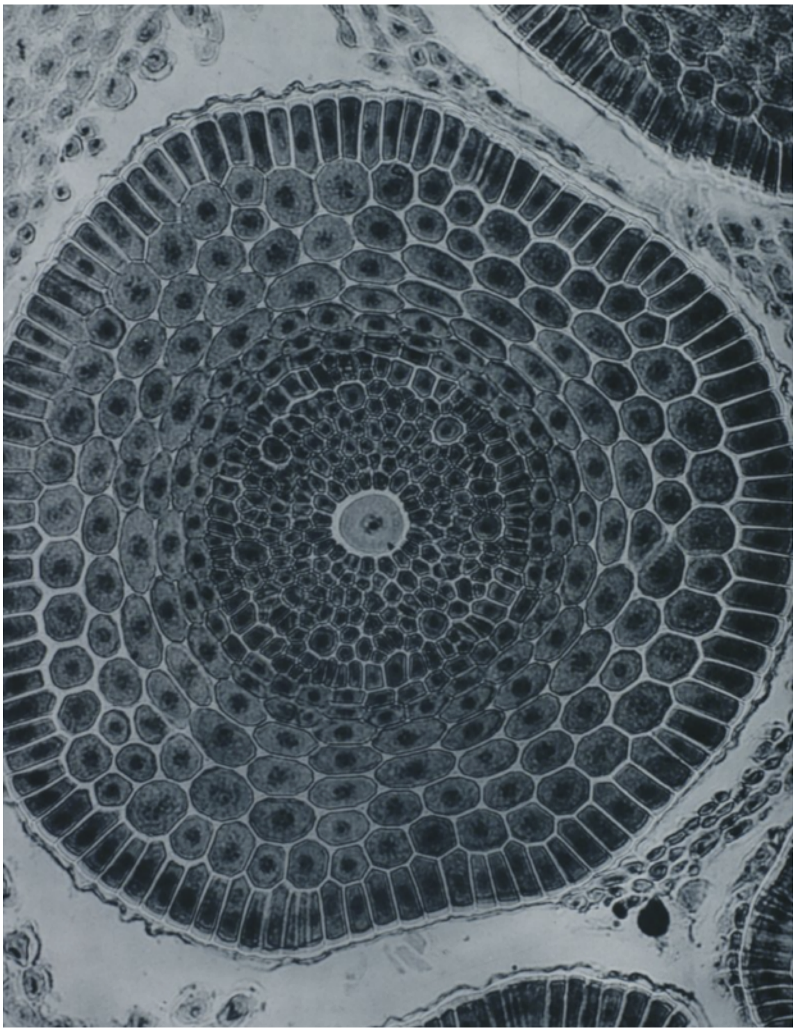


Image 6 .Laure Albin Guillot, Racine d'orge.(Barley Rooot section) from Micrographie decorative, 1931. Photogravure. Collection of Tokyo Photographic Art Museum.

around the time of the Paris World Exposition in 1990, so too did the popularity of Guillot's images spread to the production of sumptuous designs for wallpaper and interior panelling on the French liner S.S.Normandie. Her images were printed using some of the most complex advanced printing techniques of period, using multi-layering and tinted grounds to give a rich metallic effect and giving an aesthetic dimension beyond the conventions of scientific imaging of the time.

The twentieth century witnessed a to and fro of influence between the arts and sciences, each reflecting and inspiring the other. The reproductivity of the image resulted in scientific images percolating out into the public domain with the formalist presentation of scientific images finding a receptive audience in artists and ideas emerging from the Bauhaus in the 1920's. In her essay, Little Things: *Close-up in Photo and Film*, Ades (2008: 21) confirms this, "The post-First World War avant-garde now embraced the camera as the instrument of a newly objective vision whose antecedents lay more in science than in photography's attempts to ape impressionist or academic painting". The formalist close-up was perhaps best exemplified by the works of Karl Blossfeldt (1865-1932), whose plate camera photographs of plant details simply lit against a plain background were originally created to serve as visual reference for students at the Academy of the Royal Museum of Arts and Crafts in Berlin. Close up, cropped and magnified up to thirty times their powerful forms and structures resonated with and ornamental art-nouveau-esque sculptural and architectural metaphor. image 7

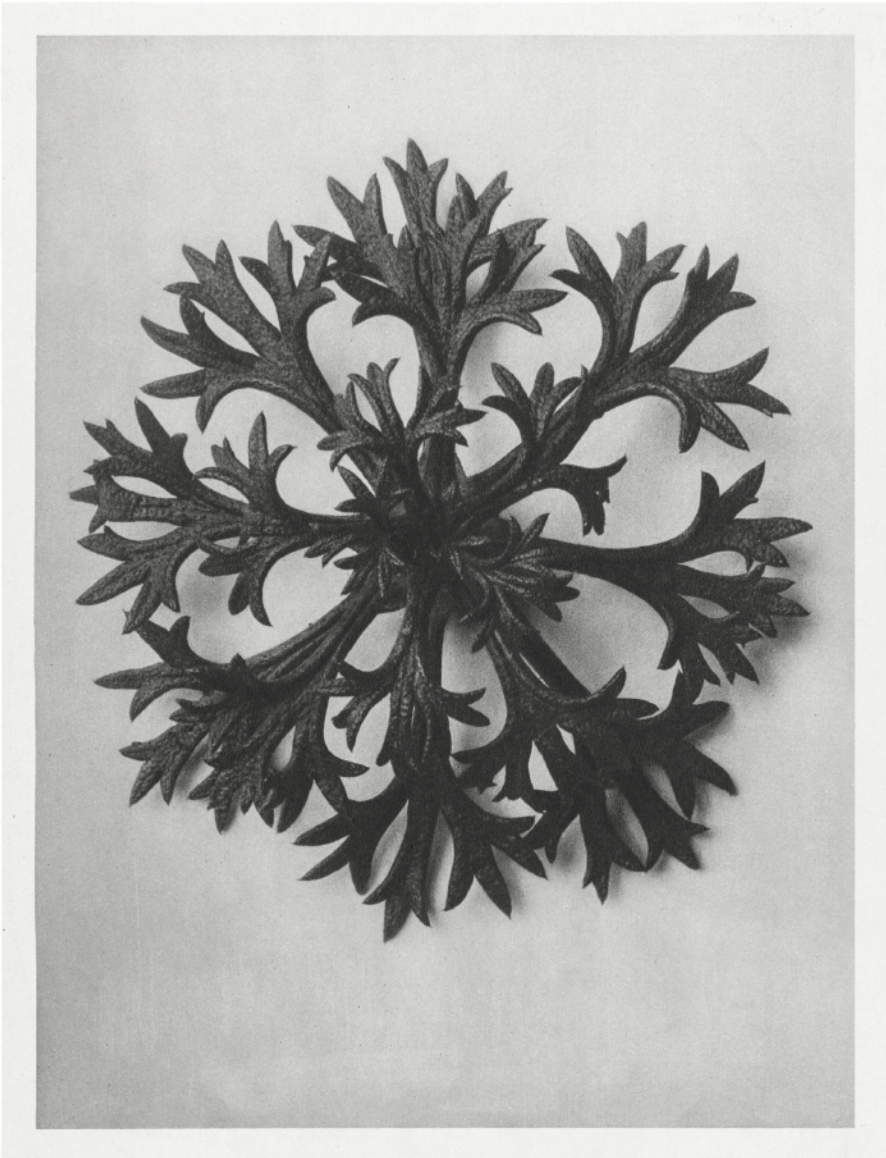


Image 7. Karl Blossfeldt, Willkomm's saxifrage, rosette of leaves, x8. 1928.The Rijksuseum.

The painter, photographer, and educator György Kepes (1906-2001), a former pupil of Maholy-Nagy became influential within a post-war North American atmosphere of cultural expansion and new forms of expression. As a programme director in the School of Architecture at Massachusetts Institute of Technology, (MIT), he created what later became the Centre for Advanced Visual Studies (CAVS). The Centre declared a commitment to the arts, and a conviction that art and science are complementary and indispensable mission partners. With the curation of the pioneering exhibition and subsequent publication, *The New Landscape in Art and Science*,(1951), image 8 Kepes presented photographic images created using "high tech" devices such as X-ray machines, stroboscopic photography, electron microscopes, sonar, radar, high-powered telescopes, infrared sensors. These were shown without explanatory texts to

Gyorgy Kepes, The New Landscape in Art & Science, Paul Theobald and Co, 1967. Author's copy.
ibid, The New Landscape in Art & Science, Paul Theobald and Co, 1967. (pp.364-365) Author's copy.

enhance the abstract aesthetic qualities of the images. In the eponymous publication that followed the exhibition, these were presented as reflective morphologies alongside works by twentieth century, photographers, artists, and architects. The preface stakes a claim for the power of the visual over the written from the begging. "This book is meant to be looked at more than read. It is a picture book, arranged to bring attention to a newly emerged aspect of nature, hitherto invisible but now revealed by science and technology. The 'text' of book is not its message. Primarily, a body of material is presented, rather than scientific information or aesthetic theory" The structures of Buckminster Fuller (1895-1983) were shown alongside illustrations of Radiolaria by Ernst Haeckel, (1834-1919), photographs of the structures of soap bubbles and the stellate hairs of leaves. In creating the centre his intention was to promote an interaction between diverse disciplines to encourage a new dialogue in visual perception through the opportunities provided by scientific photography and modes of artistic expression.

Given the interest aroused by the new landscape proposed by Kepes, it is surprising that the creative potential for scientific photography did not develop more rapidly. There were occasional publications by enthusiastic scientists with a hobbyist interest in microphotography. The Swiss physician and zoologist Hans Jenny (1904-1972) developed a body of more investigate work, a photographic recording of complex sonorous vibration patterns in sand. image 9 Like Blossfeldt and Haeckel, the powerful images in Kymatik (1967), have continued to appeal to a wide community of artists, designers and engineers ensuring a long lasting influence and popularity.

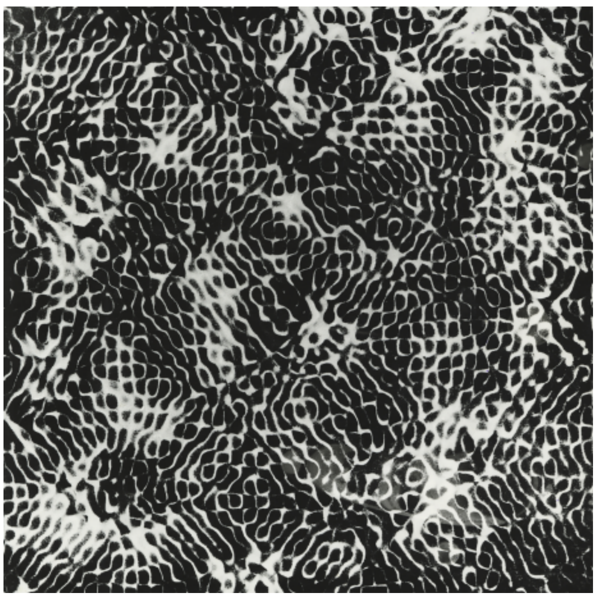


Image 9. Hans Jenny, Sonorous figure. Gelatin silver print, 1967. The Museum of Avante-garde. MoA-g SA.

Stafford (1996) reminds us that the roots of artistry and science lay in the eighteenth century predilection for experiment as popular entertainment in which object, event and image vied for equal value with the written word. Like Kepes, she argues for the value images of science having a new value beyond the conventional "habits of interpretation", where "Uncovering the lost epistemological dimension of the informed and performative gaze, and with it the complex interface of early modern nature and artifice revealed in moments of enlightening reaction, seems all the more important in our computer era".

The potential for scientists to expand the potential of their image making beyond the confines of journals and conference presentations was brought further to the fore with the publication, *Envisioning Science: The Design and Craft of the Science Image*, (Frankel 2002: 1). The book, which brought a photographic aesthetic to a range of micro subjects: mineral, botanical, physical, molecular came with a caveat, "The science pictures, although often used for presentations and submissions.... Also communicate science to a general public and thus capture the attention of those unfamiliar with the subject. They have a component that is sometimes called "artful," a word I, like you should be wary of using. They may appear as personal interpretations, but they are not. They are honest documents of scientific investigation".

The digital programs that underpin almost everything we do facilitate easier transferable languages and skills. The relentless drive for scientists to publish and communicate has turned scientists into graphic designers and video artists. Sites like the Nikon Small World are awash with spectacular images. Conversely, artists have always been keen to explore the potential of new technologies and are increasingly seeking access to the knowledge and equipment held within scientific institutions.

The rapid development of digital technology gives greater impetus for cross disciplinary experimentation and collaboration. As the American author Steven White in his essay, *Microcosmic Phytoformalism. Plant-Art, Visionary Experience and Eco Activism*, states, "Clearly, electronic technology has become the basis through which a shared interdisciplinary platform has been able to develop". White goes on to site José Reissig (1926-2021: 181) in his assertion that science operates within tightly controlled boundaries using specialized languages within academic publications, unlike art which has much softer, one might argue, ambiguous frontiers. Reissig suggests that science would benefit from importing some of the transgressive techniques and languages of the art world to foment a more considered aesthetic.

The more recent emergence of AI and its impact on photography introduces a quicksand of evolving complexity in creating and reading images. Charlotte Kent (2023) raises issues of authenticity and copyright infringement; "Many concerns around AI and photography stem from the lack of structure or accountability for image-to-text generators, which scrape the internet for billions of images with associated text—captions, tags, and so on—to feed their databases. A group of artists recently filed a class-action suit against Stability AI for copyright infringement, as has the stock photography service Getty Images. Anxiety about the death of art seems to accompany contemporary art with every new development, even as artists adopt and adapt new tools in their practice".

PART II. THE NEW NEW LANDSCAPE IN ART AND SCIENCE.

As we arrive in a post Kepes landscape the seepage between art and science, truth and trickery, substance and fancy, creates opportunities and challenges that mirror the wider concerns facing humanity. It is within this territory that I have spent the past twenty five years working as an artist, using microscopy as a creative tool to image and reflect on the living world. Initially engagement relied on the use of material provided by scientists, but it quickly became important to acquire the skills needed to develop a personal approach to micro-imaging that was informed but unfettered by the conventions of scientific convention. This relied on a deep engagement with the scientists and their laboratory equipment, to learn their languages, to engage with them on equal terms, to acquire the knowledge with which to defend and communicate an interpretive approach to image making. It is an approach that has increasingly earned the respect and recognition from the science community with an appreciation of the differences between our approaches and the ability for the work to reach different audiences. For the contemporary artworld it has proved more problematic in distinguishing the differences in approach, there is a nascent body of critical writing, but a lack of scientific knowledge compromises understanding.

An introduction to microscopy came in childhood with the gift of a Victorian brass microscope that revealed a hidden world of pattern and colour. At the end of the nineteen nineties images of contemporary science were emerging into wider circulation through organisations such as the Wellcome Trust whose enlightened approach to widening access to their collections were attracting the interest of artists. Within this climate, having worked extensively with plants as a creative source, an approach was made to the Botanic Gardens Kew with view to a collaboration which solicited a response from the palynologist Madeline Harley. She introduced me to the Scanning Electron Microscope (SEM) and her images of pollen. Her plates of different views and sections through the pollen grains had a powerful clarity and appeal, but there seemed to be more potential to move them out of the formal scientific presentation into a more personally defined interpretation. image 10

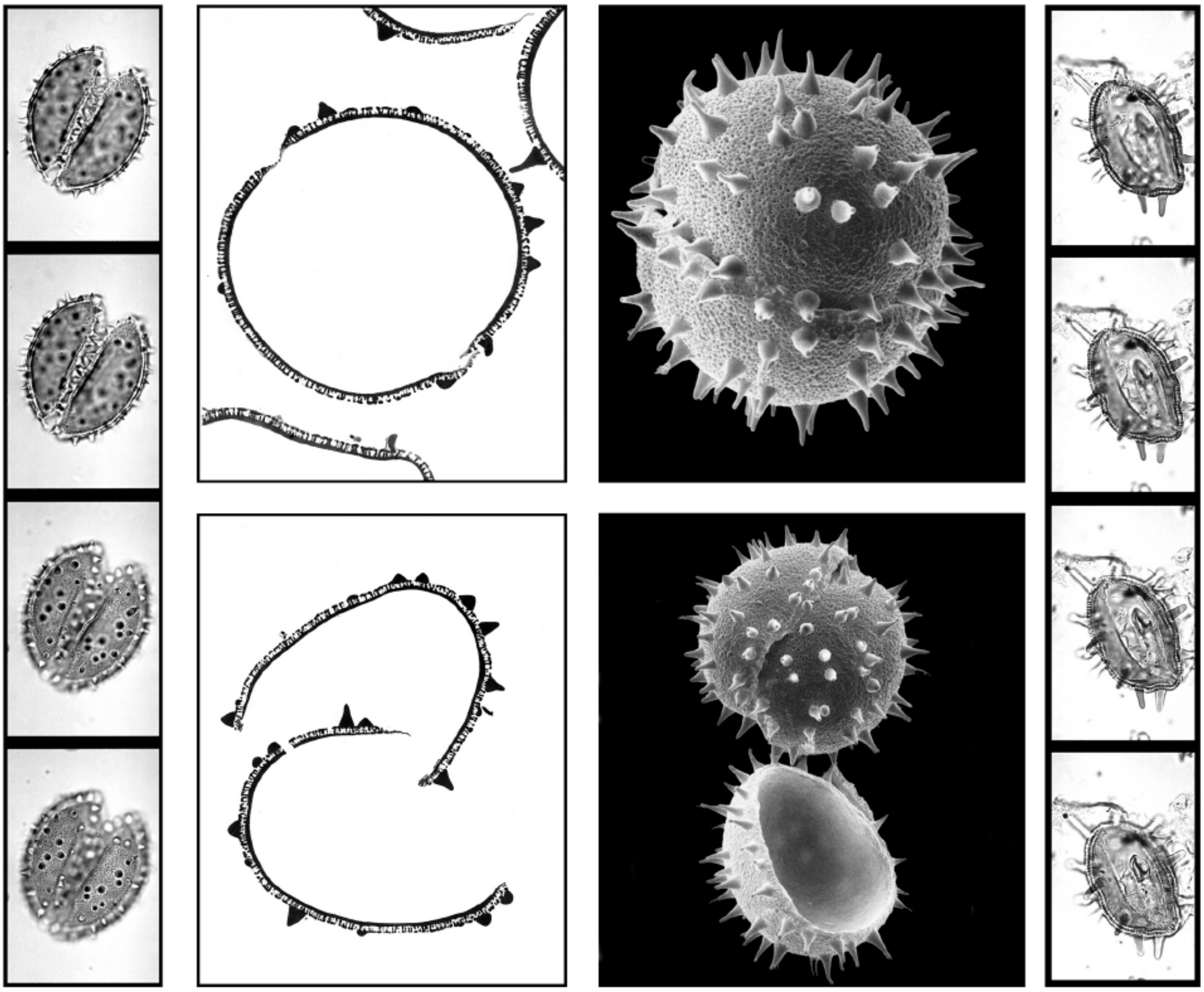


Image 10. Madeline Harley, Nypa fruticans, Mangrove Palm, pollen grains presented using Transmission, Light and Scanning Electron Microscopy.

Working with Madeline Harley it was immediately clear we employed different choices and decisions in what was selected and how we developed it. The scientific convention required a presentation of specimens in as perfect a state as possible, achieved through careful washing and drying to retain fully formed specimens. As an artist with limited time for preparation my pollen grains were often collected and imaged fresh resulting in specimens that were collapsed or deformed. There were shared common languages, the exine outer layer of the pollen grains is described as sculptured, with surface ornamentation and miscellaneous surface matter referred to as artifact. image 11 Through our conversations a clearer working practice in how to respond to each specimen was formed. Colour has always been central to my practice, and while the formalism of black and white photography produced images resonant with formalist traditions, the introduction of colour offered another dimension. Choices of colour were based on the

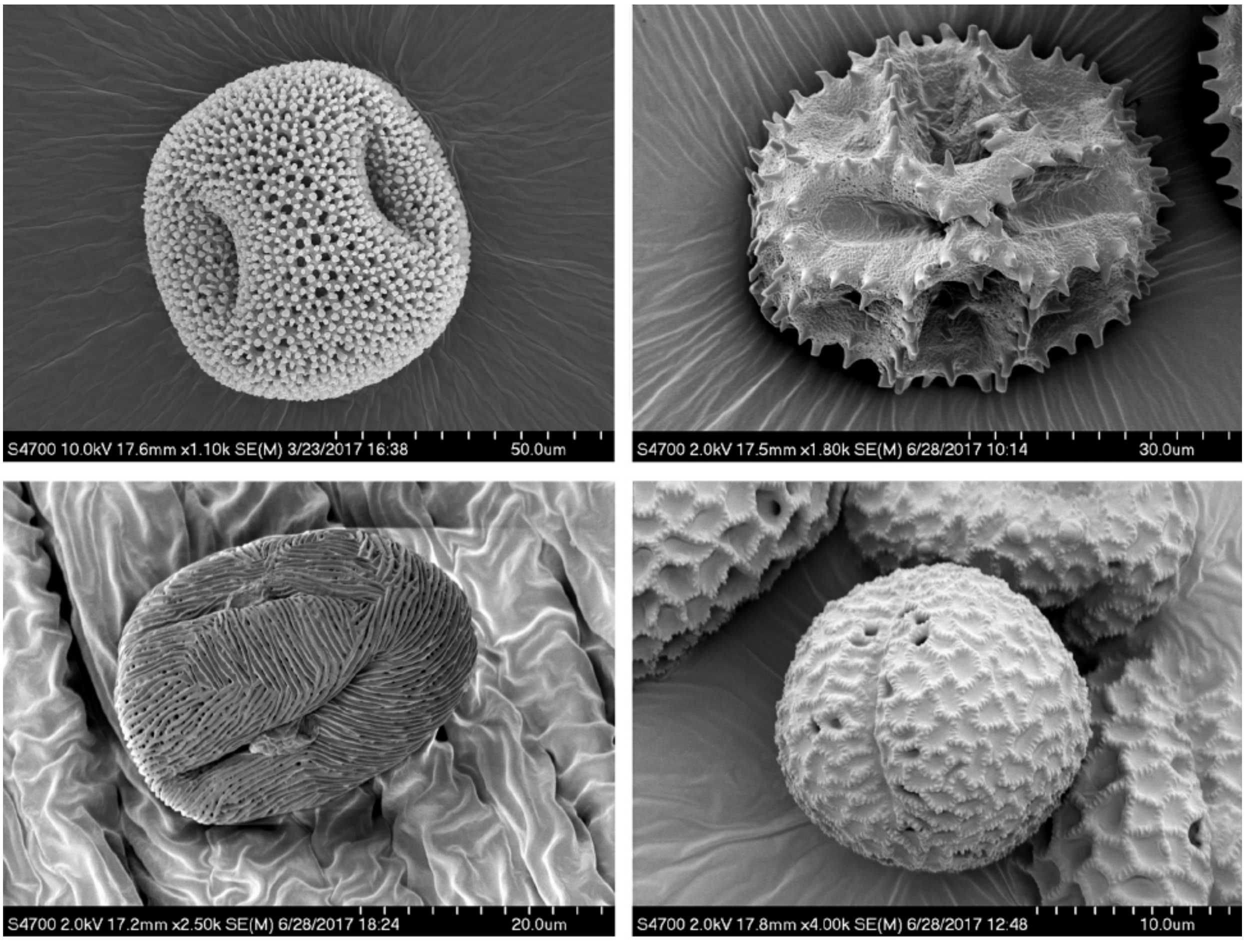


Image 11. Rob Kesseler, SEM images of various pollen grains. 2018.

original source plant, its habitat, the structural and functional characteristics of the form of the specimen and finally through an intuitive response to its character. The initial black and white SEM images cleaned up by removing all background material to give an even black ground and tonal values modulated to bring out a greater sense of three dimensionality. Colour was introduced through Photoshop by building up and working back through multiple contrasting chromatic tones to consolidate solidity and give a sense of light source to the forms. image 12 Experience over many years of working with watercolour and pastel enabled the development of increasingly sophisticated micro plant portraits. When presenting the highly finished images the question often arose, *is it the real colour*? This was not a philosophical tripwire, but more of a reference to the term, *false colour*, commonly used by scientists when applying programmes to add colour wherein any aesthetic response is limited by adherence to scientific authenticity, the limitations of any given programme and the creative skills of the user. False colour and colour enhancement are used to convey information whereas I use it to convey a bouquet of emotional responses in addition to the underlying functionality of the specimen. They are interpretive observations in which colour is employed to create powerful mandala-like image/objects. image 13

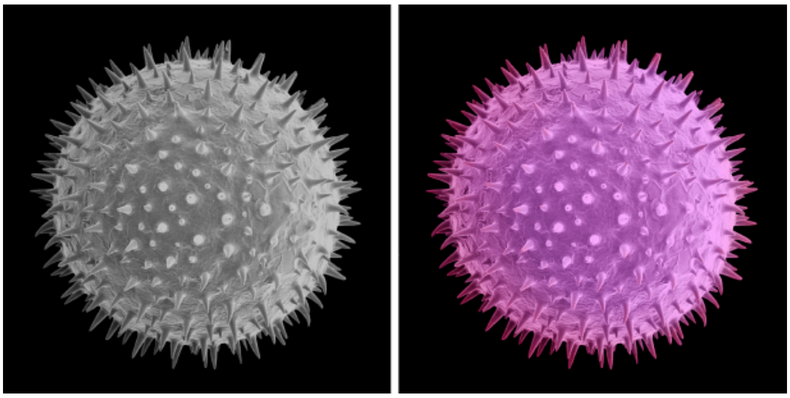


Image12. Rob Kesseler, Mallow. Greyscale and hand coloured micrographs of Mallow pollen. 2010.

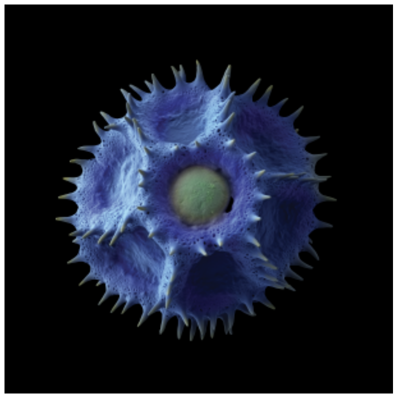


Image13. Rob Kesseler, Chicorium. Hand coloured micrograph of chicory pollen. 2022.micrographs of Mallow pollen. 2010.

Kepes reminded us that structural pattern occurs across extremes of scale, and diverse subjects, a fact that microscopy brings into sharp focus. Under the microscope allium seeds have a tough jig-saw coatings made up of interlocking plates that develop through turgor pressure, a cellular push and pull. image 14 In contrast the seeds of nigella have a tough, almost armour-plated surface, its topography also the result of organic growth within a confined space resulting in topographic ridges that segment the seed. image 15 In each case colour is employed to bring out the structural character of the seeds.

Juxtaposition and cognitive association are important metaphors in photography, these extend beyond the visual into the practice. I have stated the importance of colour within the scientific image, plants also use colour to attract an audience of insect and bird pollinators, the expressive intervention of colour in microscopy attracts a different audience to evoke visual attraction and to invoke reflection on our perception of the living world. Similarly, Seeds and Fruits use a variety of dispersal mechanisms to ensure the successful continuation of the species. This dispersal metaphor was tested through the creation of a series of collaborative books on Pollen, Seeds and Fruit with Kew botanists Madeline Harley and Wolfgang Stuppy, fusing a scientific text with full page colour micrographs and photographs. Published in eight foreign language editions and continuously in print since 2004, and with the added dispersal mechanisms of exhibition and social media, a global audience has been achieved.

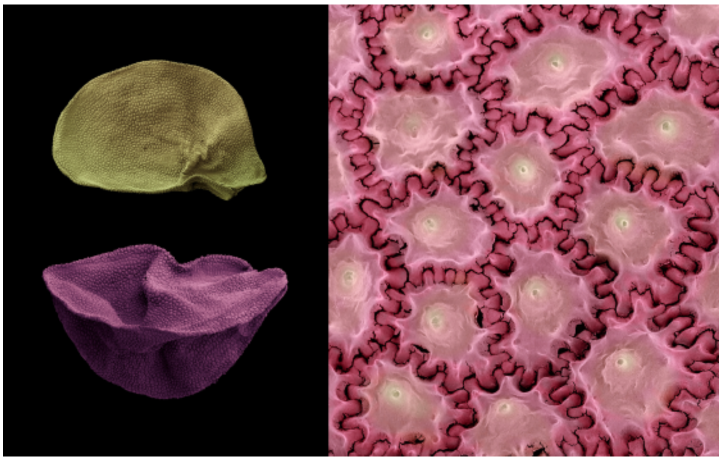


Image14. Rob Kesseler, Allium ampeloprassum, Hand coloured micrograph of seeds and seed coat. 2006.

Image15. Rob Kesseler, Nigella damascena, Hand coloured micrograph of Nigella seed. 2023.

The narrative in the books followed the dispersal metaphor. The diversity of forms and variations of plant structure is truly immense, and it is only their ubiquitous-ness that causes visual indifference. The considered use of colour in developing the micrographs of the specimens animated their many dispersal strategies. Honeycomb structures to give a bigger wind profile, simple wings to glide great distances, multiple wings to spin. Then there are hooks to catch on to passing animals, parachutes to float balletically and hairs like Venetian masks. image 16 Seeds with bulging with treats, in the form of a food source for ants. And finally rattling pods and explosive capsules.

It is rare for an artist to have such open access to microscopy labs and given this opportunity it became possible to extend the complexity of the specimens being photographed and the way

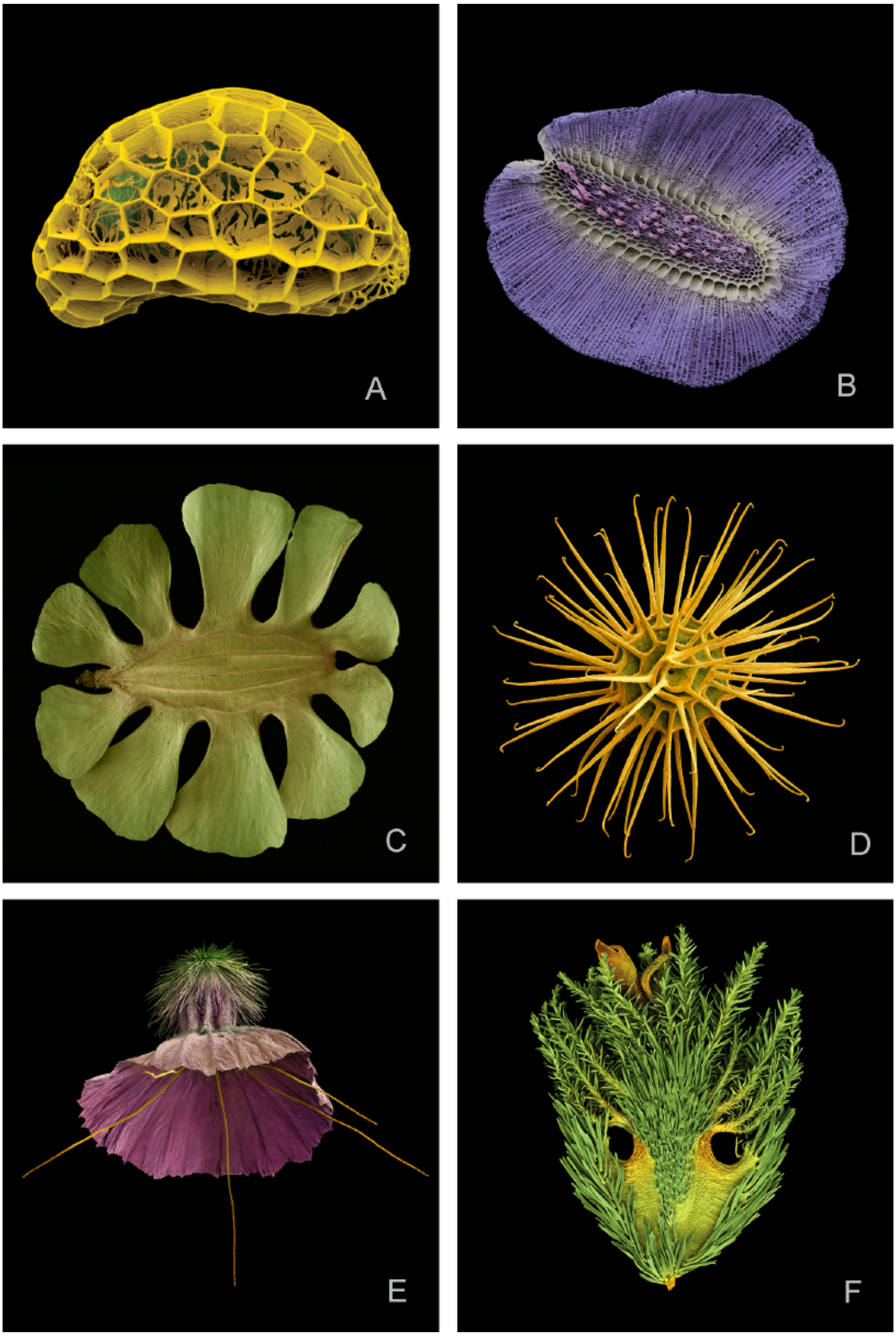


Image16. Rob Kesseler.
A. Castilleja flava. Hand coloured micrograph. 2006.
B. Nemesia versicolor. Hand coloured micrograph. 2006.
C. Artedia squamata. Hand coloured micrograph. 2006.
D. Medicago minima. Hand coloured micrograph. 2013.
E. Scabiosa_crenata. Hand coloured micrograph. 2013.
F. Calotis breviradiata. Hand coloured micrograph. 2008.

they were developed. Scanning microscopy was developed to be able to photograph extremely small specimens such as pollen where a magnification between 1,000X to 10,000X is common. The chamber on the microscope is small and it is not possible to fit larger specimens within a single frame even at low magnification and so a multi-frame process was developed. Additionally, fresh subjects such as individual flowers require freeze drying to remove all moisture and to retain the fulsomeness of the form. A single floret from an asphodel collected in Greece was taken to the UK in alcohol, freeze dried prior to coating with a microfine layer of platinum to deflect the electron beam. image 17 It required forty individual frames to capture

Image17. Rob Kesseler.
A. Asphodelus aestivus. Asphodel flower. 2018.
B. Asphodelus aestivus. Coated specimen of flower. 2018.

the whole floret that were subsequently stitched together. Maintaining exposure levels across all frames is challenging and issues of parallax further complicate the reconstructive process. Distracting backgrounds need to be cleaned and the tonal values modulated to create a strong black and white image as the starting point for the introduction of colour. First, duotones are created followed by multiple RGB layers to be erased and worked through.

The final result was a constructed, classical plant portrait in which the viewer was confronted with the architectural and structural qualities of the plant evoking a disturbing sense of familiarity beyond the conventions science photography. Simple specimens collected in this way are transformed through the process, enabling the viewer to see both through the lens of the microscope and that of the artist. Over a meter in width and printed on canvas the image was one of a series of works that acknowledged nineteenth century botanical wallcharts with their exploded diagrams of plants. image 18

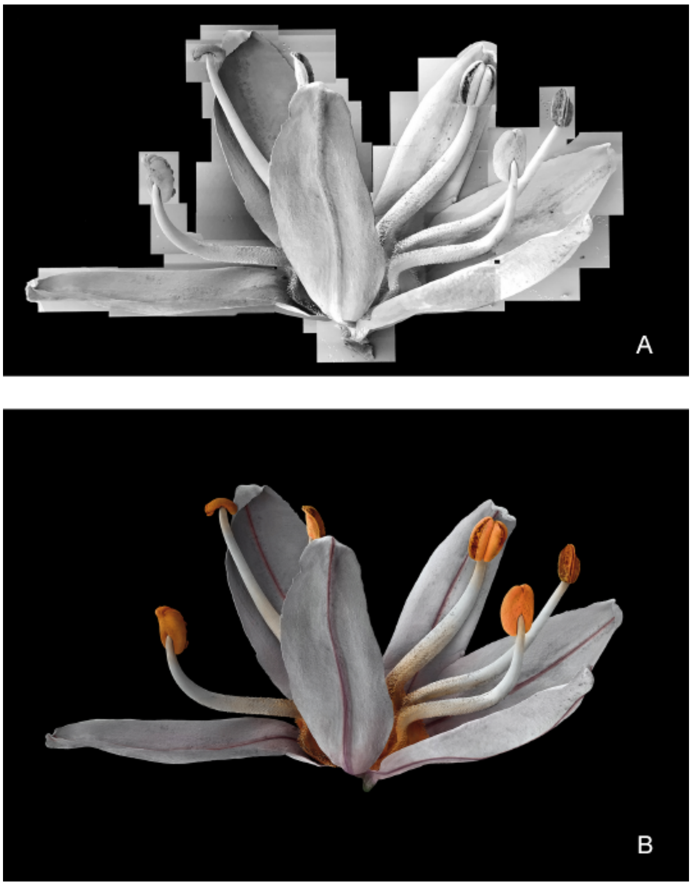
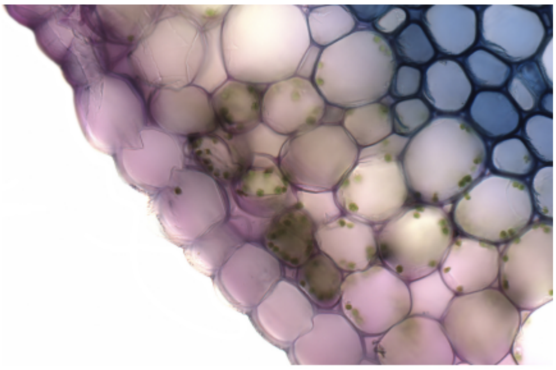


Image18. Rob Kessele
A. Asphodelus aestivus. Composite of 40 SEM greyscale images. 2018.
B. Asphodelus aestivus. Completed had coloured image. 2018.

Other forms of microscopy offer different possibilities. Working at the Gulbenkian Science Institute (IGC) in Lisbon, using more conventional light microscopy to examine micro-fine plant sections, the introduction of colour shifted to the beginning of the process, with the addition of histological stains to render visible the otherwise transparent tissue. Working at the highest magnification the green chloroplast organelles are clearly visible. For the scientist this would be sufficient for publication accompanied by a low-res view of the whole section. But the aim was to be able to produce a large high-res image and this was achieved through multiple frames at different depths of field. Nearly 600 hundred individual images were hand assembled to create an image four meters in diameter. image 19 The technology has advanced since these were made and microscopes are able to automatically pan, capture and assemble the complete image. Even this is not perfect and further manual work is required to disguise the inconsistences arising from the stitching together. Working with other plants it was clear that the chemical makeup of the proteins in the tissue resulted in a kaleidoscopic array of chromatic qualities that differed between species. In this case the artist relinquishes control over colour to the plant itself. image 20



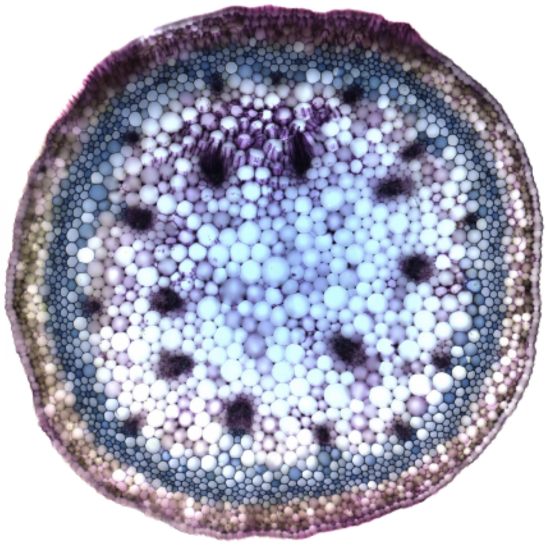


Image 19. Rob Kesseler, Gennaria, Stained stem section. 2010.

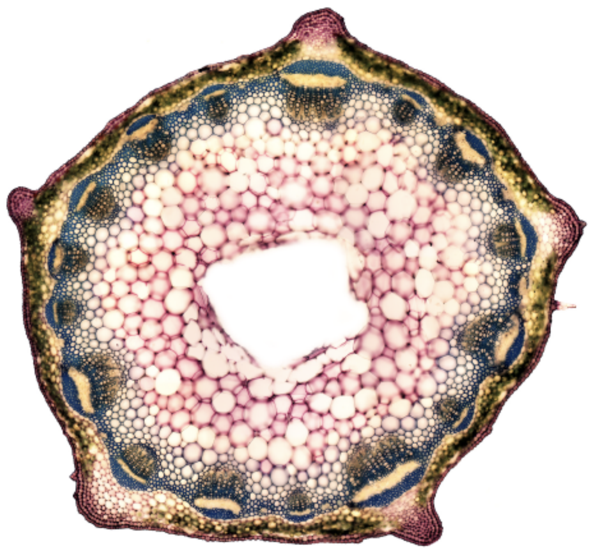


Image 20.ob Kesseler, Calendula. Stained stem section of marigold. 2010.

Transdisciplinary dialogue and collaboration are essential if we are to move beyond our specialist silos. The arts and sciences in all their diverse manifestations are enriched through interaction and dialogue. Meaningful, local engagement can achieve global impact. The access to laboratory equipment is fundamental for the artist to make new interventions that can help reach audiences beyond the conventional science channels. As an artist, it is a measure of the meaningful access enjoyed at Kew and the IGC that enabled the production of work that has attracted a significant level of respect from the scientific community.

This has extended to other institutions. Working with Ulla Neumann at the Max Planck Institute for Plant Breeding Research in Köln who specializes in pollen development, our objective was to jointly develop a body of work suitable for presentation in the form of lecture, exhibition, publication, and activities for a public event marking the anniversary of the founder of the Institute.

The Institute works extensively with control specimens of barley plants to understand the effects of mutation on the viability of barley crops. Before science, superstition and mythology played a significant part in our relationship with plants and food crops. The character of John Barleycorn was a ritualistic personification of the important cereal crop celebrated in local farming communities. There is popular misconception that mutations only occur through the intervention of science, but mutations occur naturally as the result of many complex environmental factors. Ulla's research investigates how environmental factors impact on the development of the plant. Using SEM during our collaboration a specimen presented itself under the microscope that appeared to resonate with the character of John Barleycorn resulting in the creation of an image that appeared as a scientific surrogate for a contemporary corn dolly, its rather scary screaming Wagnerian persona scattering pollen as it flies through the night sky. This reveals not only the different treatment an artist brings to an image but also in the selection of the original specimen. image 21

This is not just an artistic indulgence but has value for the scientist as was evidenced by its inclusion in an article in the journal Cell Biology about barley research at the Max Planck. Such was the power of the image that it was also used as the cover on that issue, cementing a belief that is possible to create work that exists as an autonomous artwork at the same time as adding value to scientific research.

Image 21. Rob Kesseler, Barley. Barley floret with open anthers and pollen. Hand coloured micrograph. 2022.

Artistic collaborations with scientists offer opportunities for visual hybridization that sits somewhere between the two disciplines. Neumann's Transmission Electron Microscope (TEM) images of barley pollen, recall etchings or lithographs of an abstract topography. image 22 The possibility to combine these two different approaches to add a new dimension was explored. The empathetic resonance of the swaying fields of barley that surround the Institute seem to echo the swirling patterns of the TEM images, working up one of the TEM images in colour and placing it into the landscape located subject and research together within the same frame, presented at contrasting orders of magnitude. image 23

Another pioneer of early photography, Anna Atkins (1799-1871), produced portfolios of cyanotypes of plant specimens, a process that is currently undergoing a popular revival. A solution of potassium ferricyanide and ammonium ferric citrate turns electric blue when exposed to sunlight producing a negative image of objects placed on top of the paper. For

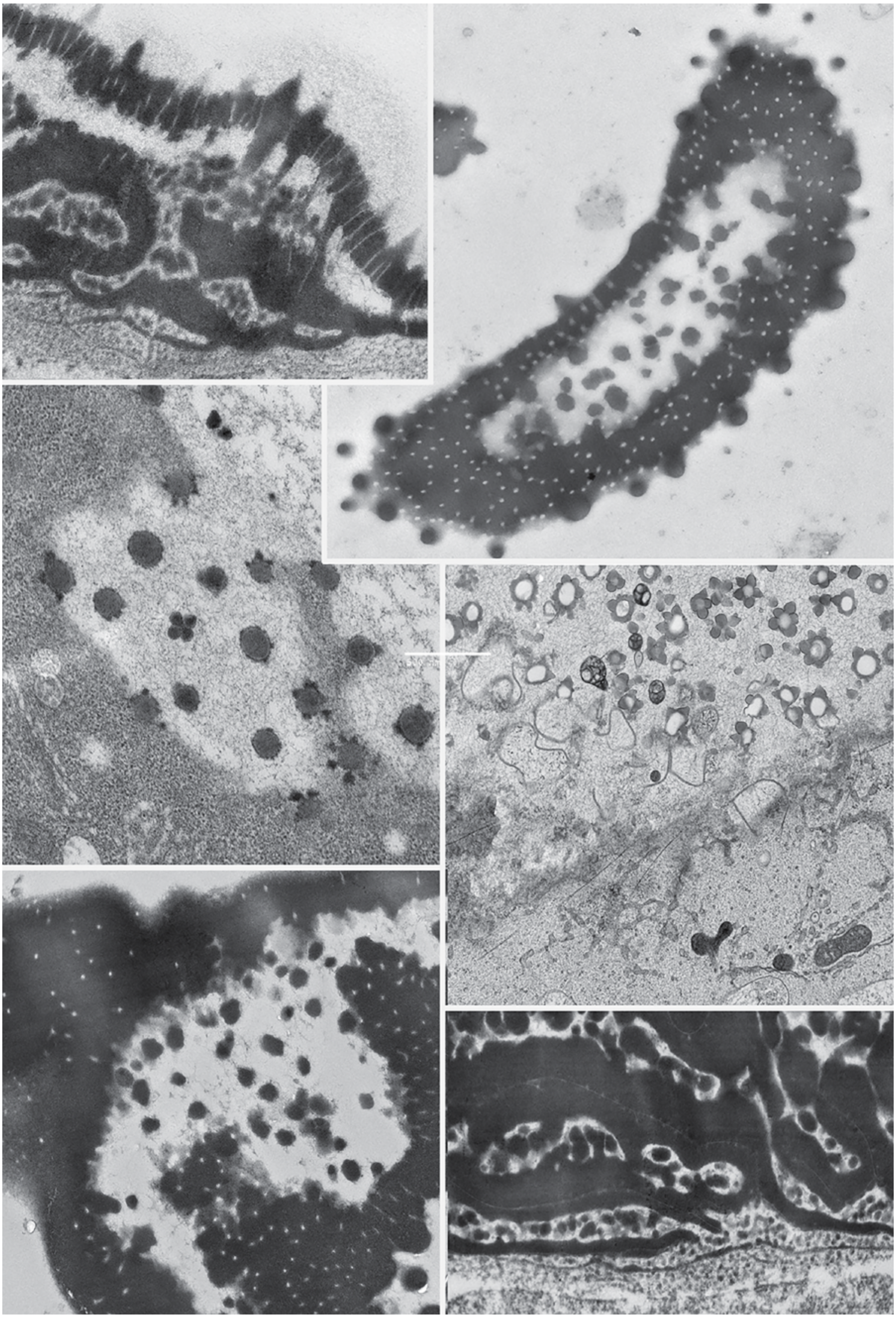


Image 22.Ulla Neumann. Barley anther sections. Transmission Electron Microscopy (TEM). 2018.

Image 23. Rob Kesseler, *Landscape in transmission* #1. Photographic collage. 2019.

thescientist to render the invisible visible requires interventions such as staining of plant tissue so that its functional structures can be better understood as in Neumann's section through the anther of a barley. image 24 Cyanotypes of barley stalks from the fields were made, image 25 and the fusion of the two forms of imaging creating a compression and expansion of the pictorial space. image 26

Towards the end of his life Kyorgy Kepes believed that there were clear links between human consciousness, environmental awareness and the creative imagination. In his essay, *The Arts and the Environment*, (1972) he wrote:

> «The forces of nature that man has brought under a measure of his control have again become alien; they now approach us menacingly by avenues opened by science and technology........ What we face now are destructive forces of a completely different kind – man generated, cumulative and of a cosmic proportion.»

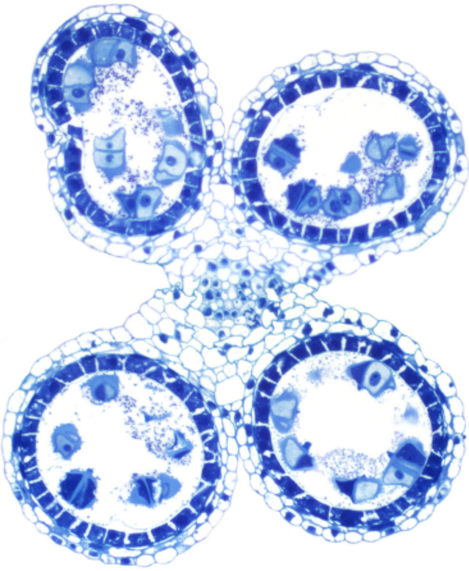
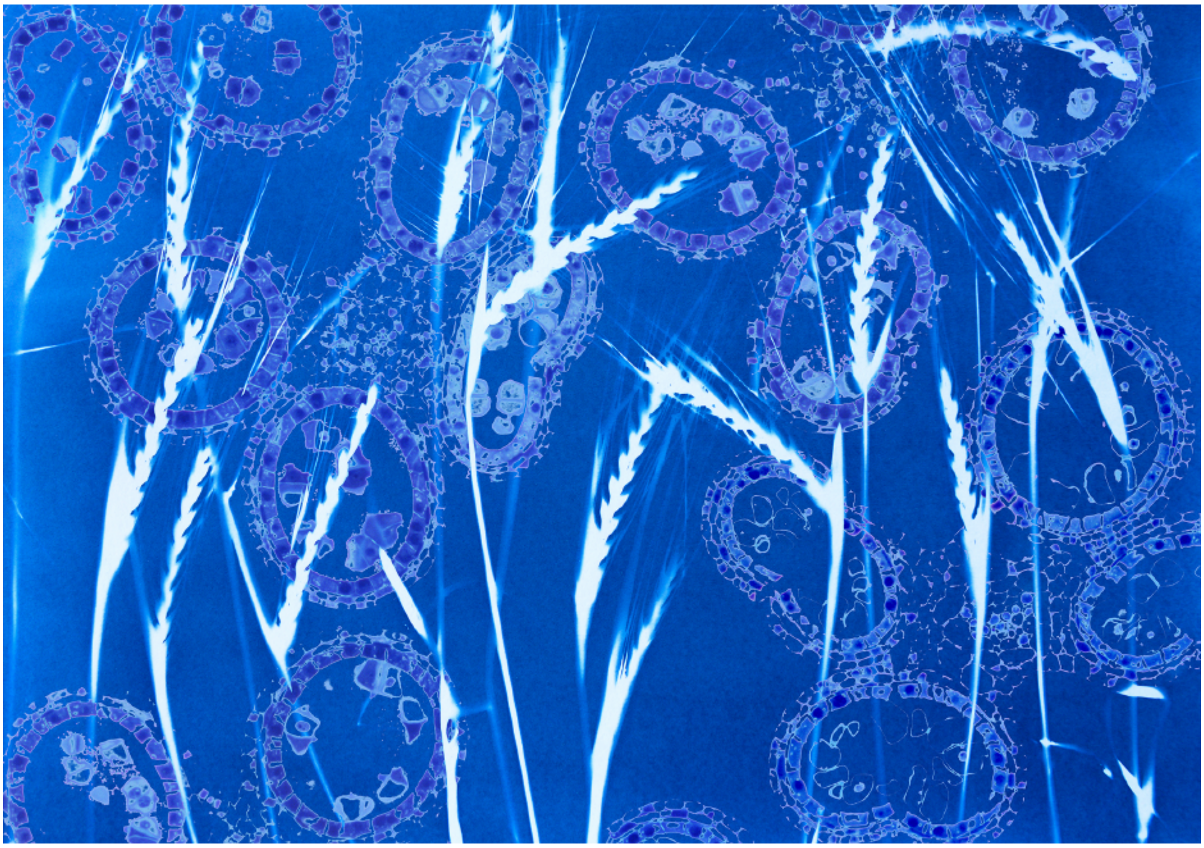


Image 24. Ulla Neumann, Stained sections of barley anthers.

Image 25. Rob Kesseler. Blue Barley, Cyanotype. 2018.

Image 26. Rob Kesseler, Barley, Barley, Cyanotype. 2018.



The climate emergency is an inescapable challenge facing us all and more recently my focus has turned to opportunities to foster a greater awareness. A commission from Mathew Tucker at the BBC to create a series of works to accompany a feature on seeds of plants suited to climate change recognised the power in which a personal approach to colour expression in micro-imaging can draw attention to this new narrative. The artist became the link between the journalist and the pant scientists. And one such example is *Medicago rotata*. In Central Asia and Northern Chile *Medicago Sativa*, Alfalfa, is a vital food crop, but as water becomes scarcer the drought resistant *Medicago rotata* will become a vital replacement. Beyond the scientific narrative the intention was to create an image of the seeds that were imbued with the same precious golden treasures that we associate with ancient South American cultures. Questions of value, wealth and need.

Image 27. Rob Kesseler, Medicago rotata, Hand coloured micrograph. 2019.

Extending the subject into environmental impact I worked with Louise Hughes at Oxford Instruments the objective shifted to a closer investigation into how data produced from a single image could generate extensive versions and colour expressions.

Using Energy Dispersive X-ray Spectrometry (EDS) and SEM in combination, it is possible to identify any individual element on a sample and additionally apply whatever colour the user decides to that element. In this case Calcium, Aluminium, Silica, Magnesium, Sodium, Potassium, Platinum, Oxygen and Carbon. Whilst scientific presentation used to be constrained by the orthodoxies of the discipline, new technologies offer the user a greater degree of creative expression than ever before. Within this framework a small project was developed to explore how individual responses to the same data might affect the outcomes. Working from leaf samples collected from sites of botanical research on a journey between London and Greece, the motivation was to look for evidence of airborne pollution.

A sample from the Garden Museum on the banks of the river Thames revealed many extraneous elements, but in using SEM on its own, one could only speculate on their mineral origins. image 28 With the addition of EDS, each individual element could be identified and assigned a colour, and in this context the scientist is enabled with far more aesthetic control than before. This provided an ideal comparative opportunity to explore how the artist and the scientist might respond to the same image. Hughes assigned a colour to a range of elements: Silicon – Magenta, Aluminum – Light Green, Calcium – Yellow, Potassium – Blue. image 29 Overlaying the selected elements on top of the SEM image she explored different levels of

Image 28. Rob Kesseler, SEM image of Ilex leaf sample. 2019.

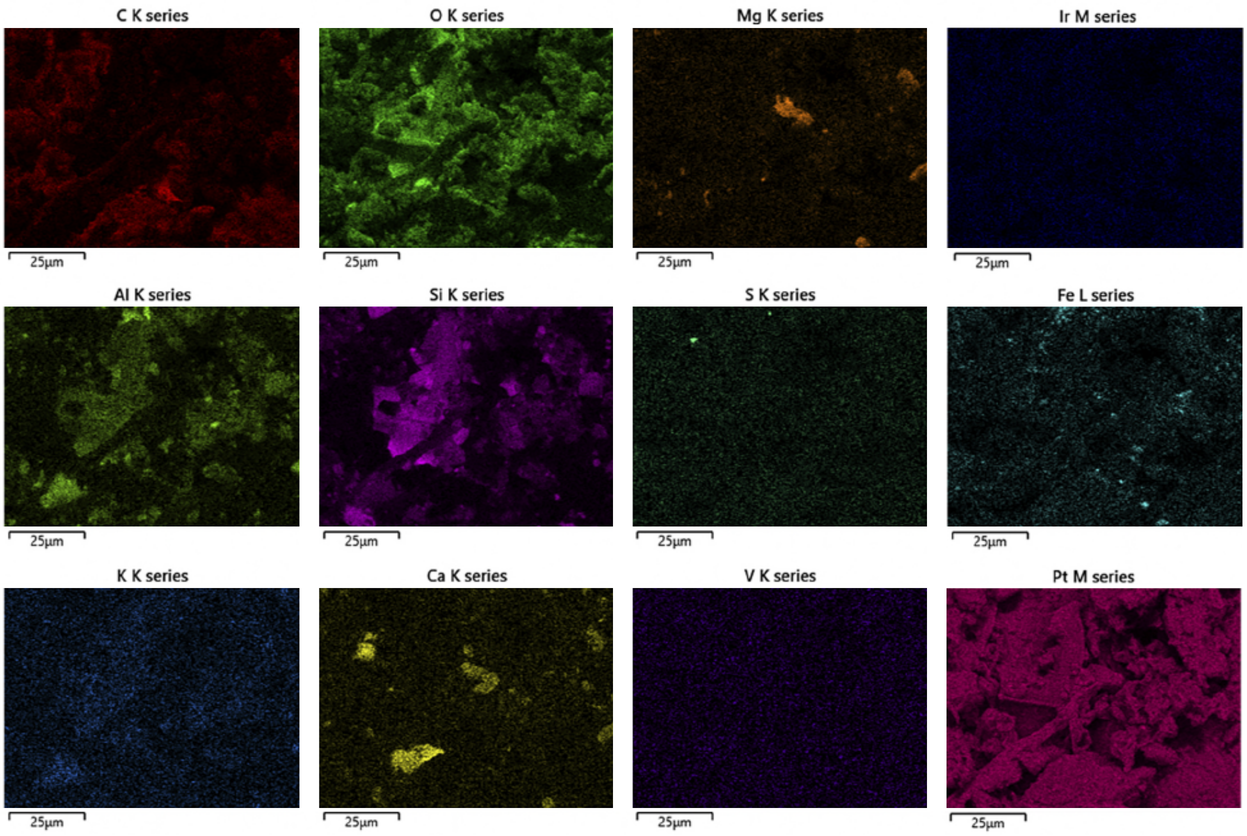


Image 29. Louise Hughes, EDS individual element maps labelled with a different colour for each element. 2019.

resolution and colour choices to create a range of images. At low-res these gave a course pixelated *pointillist* effect. image 30 Finally, her preferred version seemed to contain an interesting duality, its enticing candy-coated visual quality had a luminous appeal, whilst also seemingly at odds with nature, almost radioactive. image 31

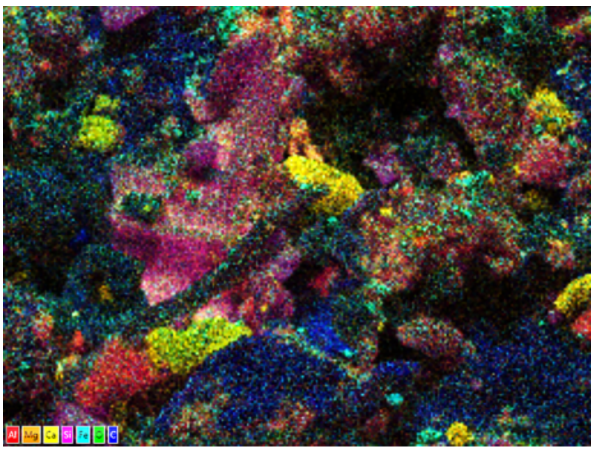


Image 30. Louise Hughes, Low resolution EDS colour version of Ilex leaf sample. 2019.

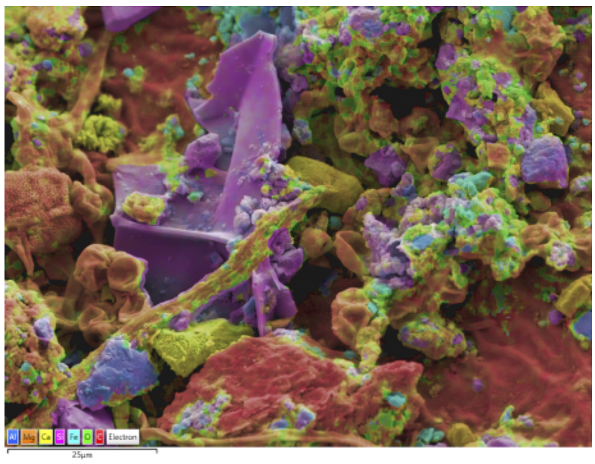


Image 31. ibid. Final colour render of Ilex colour sample. 2019.

As the artist, I sought to interpret the information in a different way, using the elemental separations as the starting point and basis for my hand colouring process. Through a fusion of spectral data and chromatic reconfiguring, the intention was to capture a quality more akin to the turmoil of a micro Brueghelian landscapes, or a complex crystaline terrain recalling the dystopian predictions of J G Ballard. Juxtaposed they present strikingly alternative visions and response to a complex subject. image 32

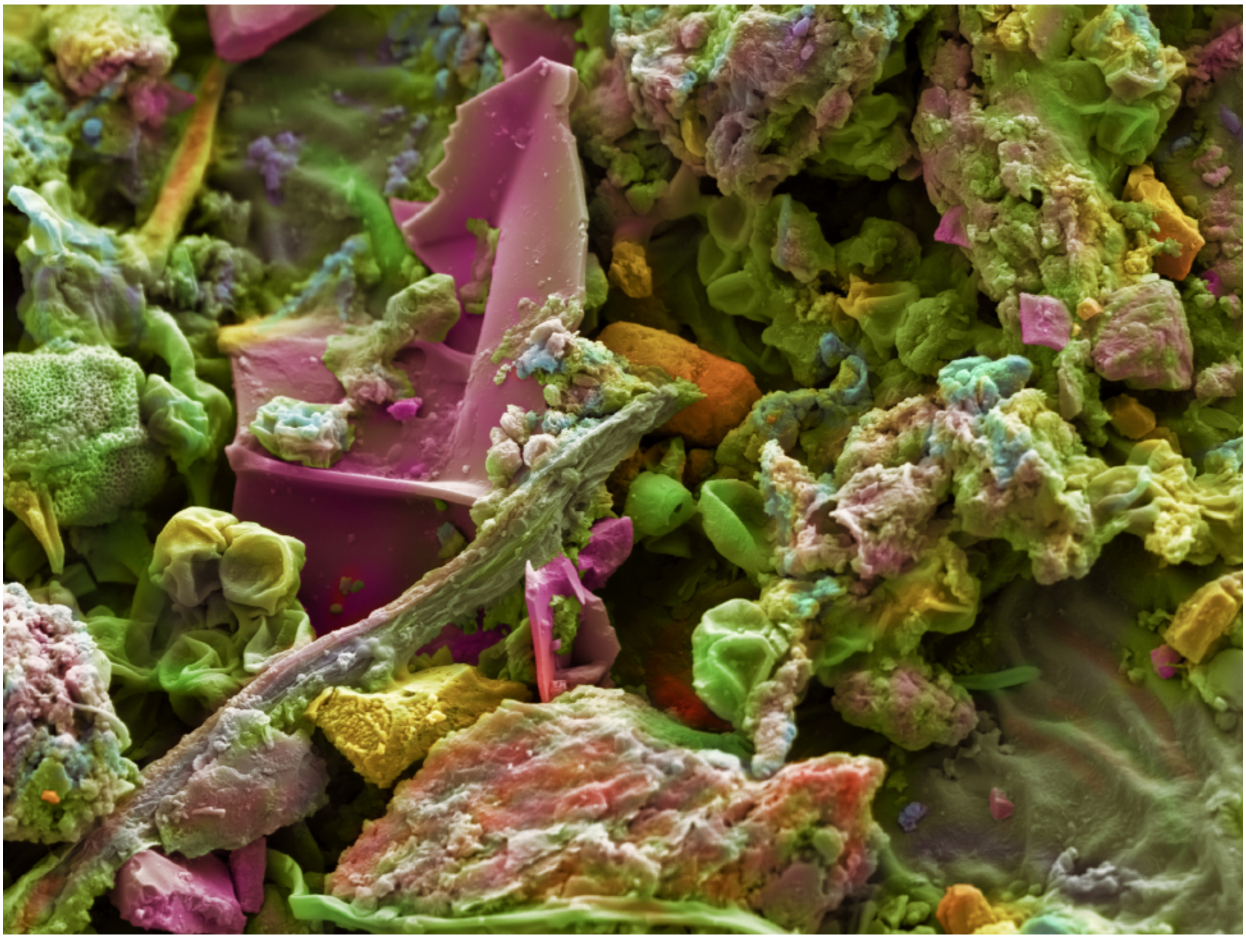


Image 32. Rob Kesseler. Final hand-coloured colour render of Ilex colour sample. 2019.

There have been mutual benefits from this approach within our respective fields. Jointly held seminar presentations for Oxford Instruments who site the work in presentations of their technologies, as well as jointly written articles for scientific journals. Within photography the image was shortlisted for the Earth Photo 23 Awards at the Royal Geographical Society, London and exhibited as part of a winning presentation at the Art & Science Synergy Foundation, *Our Bio-Tech Planet* Botanic Garden in Rome.

Both science and art thrive on the oxygen of publicity. Science being driven by a treadmill of funding applications and citations and for the arts one must navigate the oily network of critics, magazines, galleries, and museums. Based on a deep understanding of the subject, and an acknowledgment of the limitations of their own creative skills the science world is often quicker to acknowledge artistic achievement than an arts community in which the body of critical writing has been slow to emerge and understanding of science more limited. The contemporary artworld for all its claims to originality and novelty has often been slow to recognize movements outside the mainstream. The acceptance of photography as an artform is a case in point. Perhaps artistic work within the scope of science suffers a similar hard-won trajectory to its meaningful place within contemporary art.

To conclude on a positive note, in the end perhaps respect from the community in which one operates is its own reward. Enrico Coen is leading plant scientist and development biologist

Image 33. Rob Kesseler & Robert Kelly-Bellow. Science, cover image. Science AAAS, Vol 380. Issue 6651.

with whom I have collaborated over the past decade and who has explored the origins of plant form, from both a molecular scientific perspective and through reflections on cultural linkage in *Cells to Civilisations*. His recent research explores stress during early growth in plants which is evidenced through a sequence of micrograph images. Seeking acceptance for a journal publication and aware that his black and white images might not excite editorial inclusion I was invited to work on his images of *Arabadopsis* shoots injected with growth inhibitor, to give a greater impression of the dynamic forces acting on its growth. The new image contributed to the acceptance of a peer reviewed article in Science, the journal of The American Association for the Advancement for Science, widely acknowledged as a world leader in the field. Even better our image was selected for the cover. image 33

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