**GENUS**
**On the imaging of plants**

Whilst botanical art and art inspired by plants has always played a more peripheral role to the grander themes of Western Art, the richness of the source, its relationship to our health and wellbeing, and its cultural and symbolic significance has resulted in an unequalled richness of visual expression. In scientific terms genus refers to a taxonomic classification, but within the wider context of art genus may also refer to typologies and techniques used in the visualization of plants by artists and scientists throughout history. New micro-imaging technologies have expanded the range of enquiry and expression.

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The flora of Greece has been a fertile source of research for scientists and inspiration to artists since the Greek botanist and pharmacologist Piadinus Dioscorides (40-90CE) wrote about the use of plants in herbal medicine almost 2000 years ago, in his illuminated encyclopedia *Περὶ ὕλης ἰατρικῆς*, or *De Materia Medica* as it is better known. With over 400 hundred illustrations of plants and animals, the book was widely circulated from Byzantine era through to medieval times, and being translated from the Latin into Greek, Hebrew and Arabic, it's role in spreading and sharing knowledge across countries and cultures established the importance of plant research and its value to society. It could rightly be considered as the progenitor of modern pharmacopoeias.

With the evolving scientific and economic importance of plants throughout the eighteenth century, the interrelationship between botanists and artists became increasingly important, but this was to change. With the development of photography in the early nineteenth century, the possibility of attaching a camera to a microscope gave the scientists greater control over the visualization of their research and the opportunity for artistic collaboration was restricted to its more conventional role of illustration. This was further exacerbated as microscopy technologies became increasingly complex, and more importantly silo'd within research establishments. Powerful and intriguing images surfaced occasionally but were largely limited to scientific audiences and apart from a few exceptions like the portfolio *Micrographie décorative* by French photographer Laure Albin-Guillot (1879-1962), this position continued for over a century until a post war spirit of optimism heralded an era of experiment and creativity.

In 1950 the Hungarian artist, photographer and educator Gyorky Kepes (1906-2001), instigated an exhibition at Massachusetts Institute of Technology (MIT), *The New Landscape in Art and Science*, in which contemporary painting and sculpture by artists including Naum Gabo, Jean Arp, Fernand Leger, and architects Walter Gropius and Richard Neutra was shown alongside scientific photographs of cellular structures, oscillation patterns, and physical phenomena. The resulting publication encouraged other enthusiastic scientists to publish photographic collections of their images created using X-ray, stroboscopes and electron microscopes that reached a selective but growing audience (1) (2). The timely emergence of digital technologies with programmes and platforms common to both scientific and creative communities made communication and experimentation easier. Scientists were also caused to reflect on the value of their images by the influential work of Felice Frankel (3) where she pointed out…..

> The science pictures you see here have an additional purpose to thse in your notebooks. Although often used for presentations and submissions to the professional, they also communicate science to the general public and thus capture the attention of those unfamiliar with the subject.

But she also aired a view of creative caution regarding the status of the images…

> They have a component that is sometimes called “artful,” a word I, like you, should be wary of using. They might appear as personal interpretations but they are not. They are honest documents of scientific investigation.

The growth of spectacular bio-medical images and more recently videos in the popular media and competitions such as Nikon Small World (4) and Olympus BioScapes (5) revealed a new microscopic landscape rich for investigation. As technologies advanced the quality of imaging reached an unprecedented level of sophistication. The emergence of initiatives from organisations like the Wellcome Trust created collaborative openings that offered opportunities for artists to slip past the institutional gatekeepers and forge new partnerships with scientists, however these have been focused more on the physical aspects of bio-medical lab work. The new imaging technologies are complex and the levels of scientific knowledge and training needed challenging. To translate the material into a personal artistic statement requires an extensive period of engagement, something that most institutions are not able to offer or for artists to find funding.

Beyond their dazzling patterns and structures most scientific images remain abstract and divorced from a context that make them accessible to a wider public. This is not to imply that the role of the artist is to merely explain the practices and results of science. Within this vacuum there continues to be a role for the artist to extend and translate these hidden worlds into a wider artistic and critical forum. Over the past twenty years scientists have had more exposure to artists and a growing appreciation of what their creative contribution brings. Both scientist and artist are each engaged in chromatropic visions of the world. Artists stain their vision of the things around them, shifting their filters, casting a personal hue across the unseen and overlooked they cause us to readjust our perception of what we know and what we think we know or have forgotten. The challenge still remains however in gaining sufficient access to the new imaging technologies and acquiring the practical and theoretical skills needed to create meaningful work.

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GENUS is a new body of work that builds on a long standing relationship with the imaging facilities in the Jodrell Laboratory at Kew and the The Gulbenkian Science Institute, Portugal. It seeks to present multiple forms of both scientific and botanical representation as a cohesive experience that can engage across the spectrum of cultural and scientific audiences. In doing so it seeks to blur the hierarchical boundaries between modes of representation from illustration to science imaging and fine art photography. Based on a personal collection of five botanical woodcuts from *Discorsi,* (1568) by the Italian physician and botanist Pietro Andrea Mattioli, (1501-1577) like its predecessor *Materia Medica* it became a highly influential work, with over 30,000 copies sold and translations from the original Italian into Latin, French, German and Czech.

Seeking to extend the shifting modes of botanical art the work explores a range of graphic and digital forms using plant material based upon the five species represented in the Mattioli prints: *Allium ampeloprasum*, *Asphodelus aestivus*, *Helleborus niger*, *Iris graminea*, *Plantago media*. An initial series of drawings were made directly from specimens on a site

visit to Greece. Using Chinese brushes and without any initial drawing, spontaneous and acutely observed silhouettes were made using solutions of Indian ink mixed with a selection of aniline dyes. These were allowed to partially dry on the paper before being washed out under running water to remove any remaining undried ink residues. The dye stained and impregnated the surface of the paper with a subtle wash of hues, bound by traces of ink that had been allowed to dry. The effect was to create a graphic botanical ghost, like a natural print as if the plant had been pressed into the paper. The same plants were subsequently used to create a collection of cyanotypes photograms, representing one of the earliest photographic processes, the solution of potassium ferricyanide and ammonium citrate, staining the paper with an intense solar blue in which the plant becomes visible by its absence.

Moving from the field to the lab, plant specimens collected from field trips to Greece were prepared for microscopic examination. Using a simple hand held razor blade, micro-fine sections were cut through the plant stems and dyed using histological stains. The word stain has accrued many meanings and connotations, many of them negative: *discolour, blemish, soil, mark, smear, blotch, sully, spoil, defile, pollute, contaminate, besmirch.* Others have a more positive familiarity to the artist: *colour, tint, dye, tinge, shade, pigment, varnish.* Perhaps lesser known is the use of stain within a laboratory context where it is a vital and transforming process. Using a range of dyes to bind to substances in the plant tissue the scientist is able to reveal and highlight otherwise transparent cellular features when viewed under the microscope, turning them into a kaleidoscopic mandala. Plants cell walls containing pectin become pink to reddish purple, those containing lignin stain various shades of blue or blue green. Vascular highly absorbant bundles, conduits for xylem and phloem through the stem become dark blue to purple, nuclei and chloroplast stain a greenish hue and various phenolic compounds appear as shades of blue. Experimenting with exotic sounding solutions of Toluidine blue O, Safranin, Gentian violet and Ponceau red resulted in a dazzling array of colour responses and bringing to mind the way artists experimented with developing new colour compounds in earlier centuries. Using a brightfield microscope at magnifications up to X400, a multi-frame sampling process was developed, capturing up to 600 frames at different depths of field to compensate for minute variations in the flatness of the sample. These were subsequently stitched together to create images several meters in diameter and well beyond the range or needs of conventional scientific presentation. The intensity of standing in front of an image that size gave the scientists and alternative perspective both on their practice and subject. It also garnered respect for the way in which an artist can bring fresh insights to familiar practices. By digitally printing parts of the sections onto lengths of Japanese Habotai silk the luminosity of the sections took on the appearance of oversized microscope slides when hung in front a light source.

Other samples, leaf fragments, florets, seeds and pollen were prepared for imaging on a Scanning Electron Microscope (SEM). This microscope is a remarkable instrument in its ability to render the smallest samples in exceptionally high definition at very high magnification, up to 30,000 times. In a slight subversion of its capabilities I often work at the limits of scale using (relatively) large samples, up to 20mm diameter that require multiple frames taken across the sample and reassembled in a form of reconstructive surgery. Specimens are first coated with a microfine layer of platinum and then placed within a vacuum chamber where they are bombarded by a beam of electron particles. Bouncing off the platinum surface the particles are detected by a sensor that translates the data into a black and white image. In conventional scientific practice, false colouration (or pseudo colour) as opposed to true colour, is a term in which pre determined colour palettes are defined by the render programme rather than the user and where it is limited by scientific conventions. Expression being a term used to describe the behaviour of genes rather than any creative intervention of the scientist. My use of colour has evolved into subtle and meticulous process of creating and working through multiple chromatic layers to model the form with an intense three dimensionality. Colour choices are derived from the original plant

and used to highlight structural and functional characteristics of a specimen. In this way I strive to create powerful plant portraits that lie somewhere between science and symbolism, harking back to Wolfgang von Goethe's concept of plant archetypes, or *Urpflanze*. Colour is also used intuitively to illuminate the individual character of each specimen. Just as the plant uses colour to attract and lure an audience of insect collaborators for pollination and seed dispersal, the use of colour in this context serves to attract both a cultural and scientific audience. The disturbing sense of hyper reality and structural complexity of something so small and delicate becomes a mesmeric metaphor for the fragility and diversity of the world in which we live.

Completing the cycle that started with the Mattioli woodcuts, SEM images of microscopic structures collected from the five plants were laser engraved into woodblocks from which a collection of prints were taken to be exhibited alongside their sixteenth century ancestors.

Having worked alongside scientists at Kew for over twenty years I am now in a position to do all my own lab work, preparing samples and operating microscopes. This privileged access has enabled me to conduct an artistic examination of plant life, exploiting the full potential of the microscope to create an extensive body of work. The powerful attraction of the images has found a broad audience through exhibition, digital media, scientific journals and the popular press. More importantly, through the publication of an award winning series of books on pollen and seeds co-authored with scientists from Kew the images have attracted a global audience, (6). With increased interest in bio-design they have become an inspirational reference for architects, designers and craftsmen as well as plant lovers. Perhaps of equal relevance is the respect it has gained from the scientific institutions and communities with whom I collaborate. Kew has recognized their value in promoting their vital research and concerns for sustaining bio-diversity and plant conservation and the images have been used across their website to highlight the work of the Millennium Seed Bank (7), on the cover of their five year science strategy and recently as part of BBC feature on climate change (8).

Opportunities for collaboration between artists and scientists started opening up during the 1990's when artists like Suzanne Anker and Steve Miller presented work that investigated the nature of representation within the context of science practice. Their interventions opened up an immense culture of ideas and technologies that became an enticing prospect for artists. The nature of representation however brought with it its own complexities, as Kepes [ 9] had much earlier alluded to:

> In the thought of the seventeenth century are the seeds of the widely held belief that art and science are polar opposites, mutually exclusive in aims, methods and results. The view that quantitative, measurable attributes of things are real and that direct sensory experience is unreal and untrustworthy leads quite logically to a value judgment favorable to science and unfavorable to art.

Writing fifty years later Ingeborg Reichle [9] reveals a growing sophistication in our understanding of the evolving landscape:

> Visualizations from the field of natural sciences are never simply illustrations, but instead represent complex phenomena, which in their formulation are always bound by conventions of representation and the reigning vocabulary style of their respective period or time. They touch upon arrangements as to the ways in which respective scientific context captures knowledge in an image and ascribes to it an epistemological meaning.

In early collaborations the question was often posed, what value do the artists add? However, artists were quite clear that their role was not merely to explain the science, but to create independent work that brought new perspectives arising from a serious investigation

into scientific themes and practices. The further challenge was to go to the next level, to go beyond investigating themes to one that engages directly with the science, a challenge that is increasingly being met despite obstacles that persist. The complexities of both scientific and artistic research need an informed level of engagement for a meaningful exchange of ideas. It also requires time, something more problematic for scientists locked into institutional research frameworks driven by the need to produce peer-reviewed publications in response to funding opportunities. Artists have more temporal flexibility in the pursuit of personal rather than institutional goals but are severely limited in available funding opportunities. The further challenge for artists is to gain sufficient access to scientific establishments to be able to acquire the level of knowledge and skills in order to produce work that is both valued and respected within the scientific community. The proof driven conditions within science dominated by peer review and funding applications does not always leave room for side projects with artists for which there would be very little opportunity for peer recognition. The system is not set up to value such collaboration.

Things are not necessarily any better in an art world that is theory and opinion driven and in which value is ascribed by critics, curators, dealers and market forces. Considerable progress has been made over the past twenty years with a growing number of institutions, galleries and academies supporting and promoting work in the field. It must be noted however that the mainstream contemporary art world seems fairly impervious to these developments.

The works illustrated here formed part of an extensive collection originally exhibited at the Municipal Art Gallery in the Peristilio of the Old Palace Corfu , in collaboration with the Ionian University in 2018 as part of the 12th Audio Visual Arts Festival. The five interconnected rooms introduced the visitor to the processes of the science and the practices of artistic mediation in a personal mission to gain respect and equal status for a diverse range of art forms in a form that can appeal and engage a wide audience, cultural, scientific and popular.

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[1] Postma, C. Plant Marvels in Miniature, New York, John Day Company, 1961
[2] Jenny, H. Kymatik, Cymatics, Basel, Basilius Presse AG, 1967
[3] Frankel,F. Envisioning Science, Cambridge Massachusets, MIT Press, 2002, p1
[4] https://www.nikonsmallworld.com/
[5] https://www.olympusbioscapes.com/
[6] http://papadakis.net/books/pollen-original-size/
[7] https://www.youtube.com/watch?v=2XpXyHIanQc&list=PLF805CBB5B5186579
[8] BBC
[9] Reichle, I. The Art of DNA, in: Leach,D. Kacunko,S, Image-Problem, Berlin, Verlag, 2007, p.159