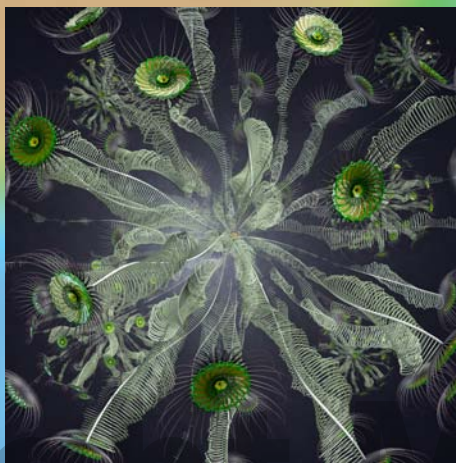




Bio Art is an emerging art practice that responds to the new and often dislocating realities revealed by the advance of the life sciences. This book presents work by more than sixty contemporary artists who blend techniques from the laboratory – such as tissue-culturing and genetic engineering – with traditional art-making. The results evoke an ominous future where human manipulation of the natural world has altered cultural norms, with results both beautiful and alarming.



Bio Art Altered Realities William Myers

Bio Art

Altered Realities



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Bio Art



Bio Art

Altered Realities

William Myers

With 300 illustrations

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To my collaborators, especially Mariam Aldhahi, Julia Buntaine, Daniel Grushkin, and Wythe Marschall.

Front cover image · Vincent Fournier · Great Grey Owl (*Strix predatoris*) with predator-resistant feathers from *Post Natural History* · 2012–ongoing (see pages 24–25)

Back cover images · clockwise from top left:

Kate MacDowell · *Daphne* (detail) · 2007 (see pages 48–49)

Neri Oxman · *Arachne* (*Self Portrait*) from *Imaginary Beings: Mythologies of the Not Yet* · 2012 (see pages 54–57)

Mark Dion · *Mandrillus Sphinx* from *The Macabre Treasury* · 2013 (see pages 106–108)

Jon McCormack · Evolved plant form based on the BP logo from *Fifty Sisters* · 2012 (see pages 184–85)

Vincent Fournier · Brown-cheeked Hornbill (*Bycanistes attractivus*) with unbreakable beak from *Post Natural History* · 2012–ongoing (see pages 24–25)

Frontispiece · Kate MacDowell · *First and Last Breath* · 2010 (see page 48)

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Foreword

Suzanne Anker

The influence of the biological sciences on the visual arts can be traced back to the furthest reaches of human history. From Paleolithic cave paintings of human–animal hybrids to periods of grotesque and Romantic art; each significant innovation in the sciences and related technologies has created a tier of attendant cultural expressions in the arts. For the Romantics, symbolists, and surrealists, paintings, sculptures, and photography were an expression of tacit anxiety amidst technological and social upheaval that altered stable ways of life. At the same time, the astonishing nature of Charles Darwin’s evolutionary theory and Sigmund Freud’s evocation of the unconscious jolted man’s conception of his own agency, compelling him to reconsider what was already known.

In the present day it is Bio Art that responds to the need for cultural expression in a time of change and unknowns, and it is gathering steam as an international art movement. It is neither media-specific nor geographically bound, and its development is flourishing in art schools, studios, and amateur and professional labs worldwide. In such a climate of experimentation and energy we can fairly say that this genre will continue to thrive, fueled by the rapid advances in biological sciences as well as the growing need for the public to engage with them. As the works profiled in this book collectively attest, the creative output of this practice demonstrates that we are, in fact, living in a “Biological Age.”

Bio Art is an umbrella term for a host of practices that draw from fields such as synthetic biology, ecology, and reproductive medicine, often combining art’s pictorial processes and nature’s living library. Simply put, Bio Art employs the tools and techniques of science to make artworks. Harnessing microbes, fluorescence, computer coding, and various types of imaging devices, it brings to the fore the ways in which nature is altered by humans. Its results are part critique, part irony, and sometimes part hard science. At other times the works resemble science fiction narratives, projecting possible, and sometimes frightening, future scenarios. Bio Art is therefore an arena that requires dedication to two mistresses: the visual arts and the biological sciences. One without the other is insufficient, as it demands both rigorous aesthetic practice and an understanding of biology and its embedded metaphors. And while its close relative biodesign may have utilitarian targets, Bio Art is more concerned with art historical connections and the ways in which ideas, long since dismissed as sterile, are reconsidered.

Bio Art may be the latest in a long line of artistic movements exploring the relationship between humans and nature, but this time our relationship to our environment has changed gear. Many argue we have entered the Anthropocene, an era where human activity has a defining impact on the natural world. Our artistic response to this might be considered as a form of neo-romanticism, perhaps with a slight surrealist accent, echoing the art made during previous times of uncertainty about man’s place in the world. While its breadth of scope, techniques, and intentions mean that Bio Art is not easily defined, we can anticipate that its practices and practitioners will continue to astound us with the possible.

Preface

William Myers

During the course of writing *BioDesign* (2012) I encountered numerous examples of artists blazing trails toward new ways of thinking about nature and the self. These artists were often using living tissues and microorganisms, or even constructing complex ecosystems. They seemed to be testing, playing with, and discovering new forms of expression and articulating positions on what I have come to regard as the most urgent issues of our time: those defining our era as the Anthropocene, the epoch of human intervention with the environment. These artworks were being loosely categorized under the term “Bio Art,” yet were defined by medium rather than in relation to the interplay between culture and the sciences; so it became clear that the topic of Bio Art warranted further study, and called for a new book of its own.

It is first important to address the question of how biodesign and Bio Art differ, which frequently arises in discussion of any creative output that draws from the life sciences. Biodesign is an approach that integrates biological processes and cycles within ecosystems into practices as wide ranging as graphic design, manufacturing, and building. It goes beyond mimicry to integration of the biological, and living material often becomes a part of the finished product or system that has utilitarian application. But biodesign can also be speculative within these parameters, or may consciously reject or critique the design brief. Design, therefore, must be directed in some way toward others, while art may not.

By contrast, Bio Art is a practice that utilizes living biology as an artistic medium, or addresses the changing nature of biology’s meaning through its output. This can be achieved in a Petri dish or in a photograph; what is defining is the work’s connection with meaning in flux. At its core, Bio Art is a response to the cultural dislocations that are erupting as a result of the advance of life sciences research and its application as technology. As fields including biomedicine, ecology, and synthetic biology advance, our shared, foundational cultural concepts of identity, nature, and our relationship to the environment are shifting. An important backdrop to these changes is the era of the Anthropocene and the unfolding tragedies of habitat destruction, mass extinction, and climate change. This blend of elements precipitates the “crisis of consciousness” that many bio artists respond to.

Bio Art also engages with new understandings of the self. As artists such as Stelarc have provocatively argued, the human body is “obsolete” in light of the possibilities of technological extension, digital archiving, and networking. This argument advances further with recent developments in genetic medicine, such as the possibilities of generating both eggs and sperm from a single donor’s stem cells, or the manipulation of gut microbes to manage mental health. Life sciences research in this century will undoubtedly come to be regarded as a golden age. It is a place of accelerating breakthroughs and fundamental developments, such as the rise of epigenetics, which has revealed how we are all in meaningful genetic communication with our ancestors as well as future generations. This pace of discovery creates fertile ground for artistic expression, and calls for art as exploration and translation of what are truly jarring developments in our time.

Bio Art and the Gnawing Invisible

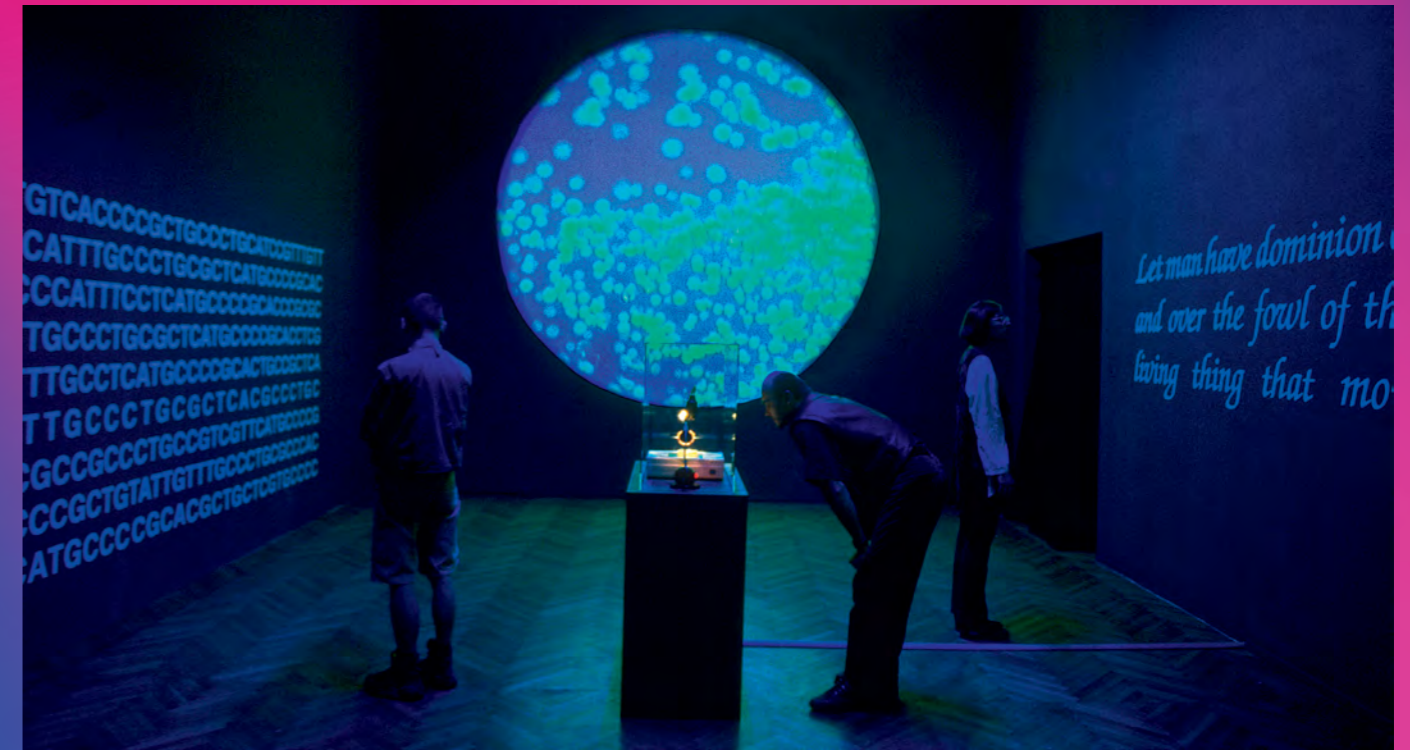
“We do not doubt that in yielding quite naturally to the vocation of pushing back appearances and upsetting the relations of ‘realities,’ it is helping, with a smile on its lips, to hasten the general crisis of consciousness due in our time.”¹
—Max Ernst, 1948

The self-proclaimed “surrealists” may be long gone, but they are not yet through with us. Their project echoes through a proliferation of artwork over the last ten years that uses biology as either medium or subject to signal significant cultural shifts caused by alterations in our ideas of identity, nature, and environment. This essay maps out the ways in which these shifts make historical alliteration with upheavals of the early 20th century, particularly those to which the surrealists responded. Bio artists working today are cast as interpreters of cultural transformations, like journalists formulating the first draft of history, but using aesthetic experiences as language to assign meaning. Like the surrealists before them, who struggled with the implications of the unconscious mind and the aftermath of war, bio artists are motivated by an imperative to engage with the crises of their time. This emerging art is not defined strictly by medium, by the use of living material, but instead by its connection with the reshaping and movement of our concepts of the self, and the definitions of life, nature, and community. Dislocation of these concepts is exactly what is happening today, as discoveries in the life sciences propel advances in biotechnology and in our understanding of both the climate crisis and the wider human impact on the biosphere.

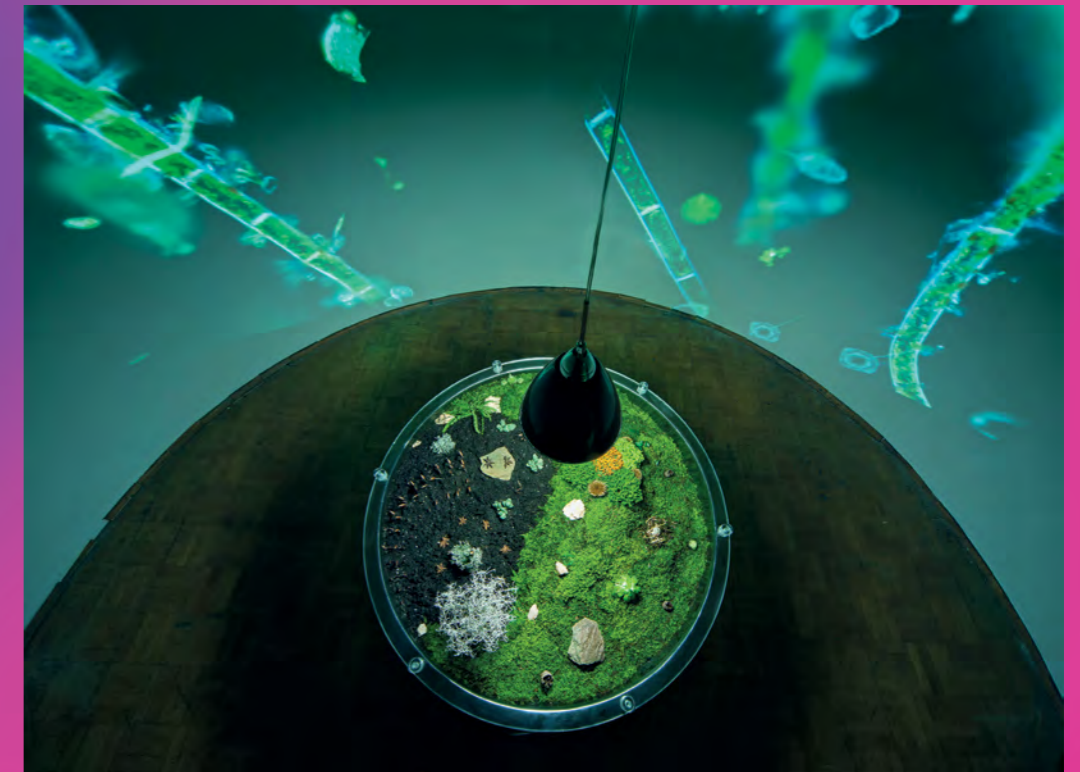
The rise of surrealism is firmly associated with the anxiety and distrust of reason bred by World War I, coupled with a deeper understanding of the unconscious mind, especially as elucidated by Sigmund Freud. The collective, psychological terrain these conditions created within culture provoked artistic responses from figures such as André Breton,

Salvador Dalí, Max Ernst, and Yves Tanguy. They developed techniques such as automatism, and wielded imagery of the uncanny and grotesque, among other strategies for their expression. In the following decades, new media and performance art emerged, each also rooted in early 20th-century experimentation, but driven by a variety of new intentions, and utilizing technologies going well beyond visual experience. The nature of this experimentation and elements of its formal output are also embodied in contemporary art which uses biology as medium or subject. The pioneering video installations of Nam June Paik and the mythological, chimerical imagery employed by Matthew Barney provide vivid examples; works of this kind have influenced bio artists such as Eduardo Kac, whose 1999 work *Genesis* included an interactive website inviting visitors to mutate a microorganism; Saša Spačal, who has staged video and sound installations that facilitate cross-species communication; and Vincent Fournier, who is creating a bestiary of futuristic chimeras adapted to a world dramatically altered by climate change.

These parallels in form and technique, as well as the similarities between particular social conditions, do not imply that contemporary art follows an established cycle or pattern. Just as it is futile to attempt to fit every story into neatly labeled boxes of “tragedy” or “comedy,” appreciating art in its time requires a suspension of grand, linear narratives. As Alfred H. Barr Jr., the founding director of the Museum of Modern Art, New York, summarized in 1946, “art is an infinitely complex focus of human experience.”² The particulars of how and why artwork is generated and what meaning it accumulates during the course of its making, display, and interpretation transcend identifiable systems or static labels. Nevertheless, there is evidence that we are entering a new age of surrealism, distinct from but making rhymes with the creative expression of the past, and hastening a “general crisis of consciousness.”



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1 Eduardo Kac • *Genesis* • 1999

2 Saša Spačal • *7K: new life form* • 2010

Liberating Thought

The surrealist movement of the early 20th century aimed to facilitate creative expression unburdened by reason or aesthetic and moral conventions; as Breton wrote in the *Surrealist Manifesto* of 1924, the surrealists would commit themselves to aiding the imagination in “recovering its rights.”³ What they sought was a deeper, unseen truth within and around us, one that might be brought to light through materializing dreams, tapping into unconscious thought, and giving voice to suppressed desires. The surrealist practice of automatic writing was an exercise to advance this goal: writing that was rapid, free-form and unedited; an attempt to tunnel a reservoir to unconscious thought and access ideas and feelings in a purer or more authentic form. Automatic writing applied a hope that the creative act itself would move the mind away from the conditioned, reflexive reliance on reason. Contemporary artist Arne Hendriks likens this to a tool for dismantling control, insisting that automatic writing and other techniques like the use of mind-altering drugs were a focused desperation of the surrealists: “Anything to break free from the unseen program”.⁴ This is even more difficult to do today, almost a century later, wherein sophisticated algorithms deliver us continual streams of tailored information.

Such experiments were simultaneous with the emerging dominance in art and commerce of the machine, which was establishing a position as central to aesthetic and economic life. Against the context of these events, the call for epistemological reform heard by the artist’s ear was loud: the rule of reason coupled with industrial capitalism had recently mass-produced machine guns, mustard gas, and mortars for World War I, a profound failure of Enlightenment values and the reigning political order. Breton even witnessed the outcomes of this first hand, treating patients in Nantes suffering from shell shock. The war’s worldwide orgy of brutality shoved those who witnessed it over perverse psychological thresholds, force-feeding them death at a speed and scale previously unknown, such as in the Battle of the Somme in 1916 that saw a staggering 70,000 casualties in a single day. Simultaneously, the Spanish Influenza pandemic would claim up to fifty million lives, or about 3 percent of the global population. The new reality of a world of such horror bred confusion about, and disillusionment with, modern life that ran deep and sought outlets, as might a repressed erotic desire. Free-form, spontaneous, and non-rational forms of expression were attempted through collage, frottage, and collective writing and

drawing techniques. Following in this spirit of play that relished veering into the nonsensical, Breton and Philippe Soupault wrote in their seminal 1920 surrealist work *Les Champs Magnétiques* (*The Magnetic Fields*):

“It was the end of sorrow lies. The rail stations were dead, flowing like bees stung from honeysuckle. The people hung back and watched the ocean, animals flew in and out of focus. The time had come. Yet king dogs never grow old—they stay young and fit, and someday they might come to the beach and have a few drinks, a few laughs, and get on with it. But not now. The time had come; we all knew it. But who would go first?”⁵

Freud’s theories about dreams, the uncanny, and the unconscious informed Breton’s ideas, and were a continual source of inspiration for the surrealists. Representing the uncanny became particularly important, a quality described by Freud as a recipe that must include the familiar, even primal, yet profoundly uncertain.⁶ Elaborating on this concept, Freud turned to examples such as the effect of watching epileptic seizures and manifestations of insanity, as they excited in the spectator the notion that “automatic” processes, normally concealed beneath ordinary animation, were at work. Essentially, Freud’s theories were understood at the time to have uncovered new dimensions of reality, much as Louis Pasteur and Robert Koch’s research in microbiology had revealed, much more literally, a previously unseen universe at the microscopic scale. These new terrains cried out for new acts of artistic intervention and interpretation because they offered the possibility that neither thought, behavior, nor environment were as they seemed. At the very least they had new dimensionality; they existed on spectrums of scale rather than binary divides such as sane/mad or deliberate/unconscious. This point is extended further by contemporary bio artists such as Vincent Fournier who think about “mixing living forms with synthetic biology, cybernetics or nanotechnologies.”⁷

Surrealists plumbed the implications of Freud’s newly sketched blueprints of the mind as others, including artist René Binet and architect Hendrik Petrus Berlage, drew from the discoveries of scientists like Louis Pasteur and, in particular, the German biologist Ernst Haeckel. These artists elaborated styles in the decorative arts and architecture inspired by biological forms. This effort coalesced in such movements as art nouveau in France at the end of the



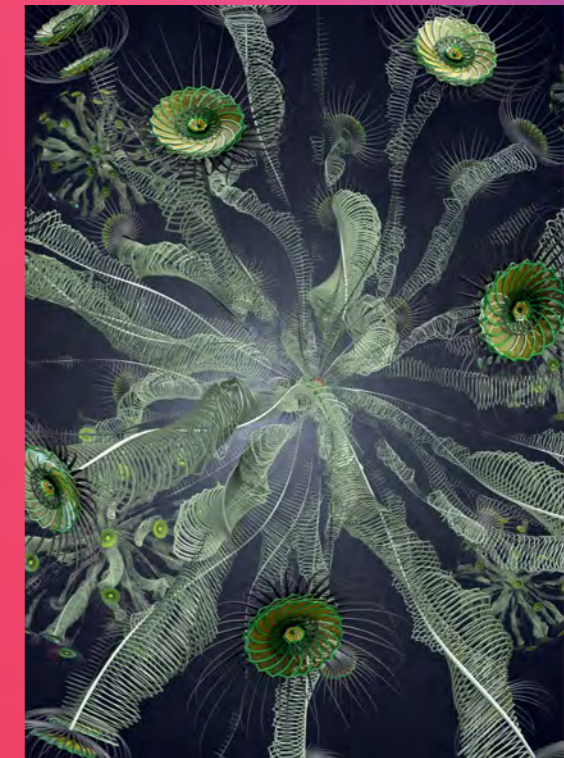
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3 Ernst Haeckel • *Tafel 88: Discomedusae* from *Art Forms of Nature* • 1904

4 Hendrik Petrus Berlage *Study: Crown For An Electric Light* • undated

5 Ernst Haeckel • *Tafel 17: Siphonophorae* from *Art Forms of Nature* • 1904

6 Jon McCormack • *Evolved plant form based on the BP logo* from *Fifty Sisters* • 2012

19th century and in similar iterations across Europe and the United States. Thus, while research on the mind and on microscopic life supported quite different forms of artistic expression, both arose from shifts in our accepted notions of the self and its environment. These developments generated irresistible artistic imperatives: any search for truth, beauty or meaning—presumably the business of artists—would have to respond to the new modern reality.

Merging Technology and Performance

“Skin has become inadequate in interfacing with reality. Technology has become the body’s new membrane of existence.”⁸
—Nam June Paik

The works of the surrealists, like those of the more anarchically playful Dadaists, anticipated various forms and strategies of artistic expression yet to come, while making visible the undercurrent of unease that characterized European life in the interwar years. One standout example of surrealist creation during this era is *Un Chien Andalou*, a silent film written and produced by Luis Buñuel and Dalí in 1929. Its non-linear narrative includes seemingly unrelated scenes, bizarre expressions of libidinal aggression, and gruesome disfiguration. The experimental character of the film’s funding, acting, and directing was much like that of present-day independent films, while the non-traditional narrative and stylized, if sometimes sloppy, editing preceded various contemporary forms, from the music video to reality television programs. In Dalí’s own time, his vision was recognized in Hollywood and would lead to collaborations with Alfred Hitchcock and Walt Disney.

The most memorable sequence from *Un Chien Andalou* depicts a woman’s eye being held open and slit with a razor, an early film special effect accomplished by a rapidly shifting camera view and the carcass of a calf. This scene still has the power to induce shudders—to shock the unsuspecting viewer with a sharp, visceral fear of pain that is generally only experienced in nightmares. This scene also channels the grotesque and erotic present in the myths of the Sandman and Oedipus, in which wounding of the eyes is central. It is such a gesture, straddling as it does the borders between sensationalism, aesthetic

experimentation, and deep emotional dread, that reoccurs in contemporary examples of fine art film and, as described below, in Bio Art. Then, as now, the horror of the nightmare depicted argues that our perceived reality is a thin, placid surface, under which darker, more consequential forces churn. This becomes especially relevant in our time when we consider the possibility of looming disasters generated by forces that remain mostly invisible, as in pollution causing climate changes or global economic shifts resulting in mass unemployment.

As video recording technologies advanced and became more widely available, they were readily appropriated by artists including early adopters Wolf Vostell and Nam June Paik. Paik, in particular, pushed the use of video in many directions and fused it with emerging artistic modes of performance and installation in the 1960s and 1970s. His was also an interdisciplinary effort: he brought to his experiments his training as a classical pianist and an intense study of Schönberg. The synthesis of these elements can be seen in *Concerto for TV Cello and Videotapes* (1971), performed by cellist Charlotte Moorman, in which television monitors were fashioned into a musical instrument and the images on the screens changed along with Moorman’s movements. In later works, Paik distorted the output of television screens using magnets or appropriated global telecommunications to coordinate live performance across the Atlantic between Paris and New York in 1984. Such works anticipated the integration of interaction design into installation and performance, as can be seen in the work of contemporary artists such as Stelarc, Eduardo Kac, Heather Barnett, and Jon McCormack, all of whom have devised installations in which the viewer participates in form-making mediated by technologies. Kac in particular has authored works channeling these elements into Bio Art: his work *Genesis* fuses information technology, code language, and genetic mutation to create a completely unique, globally designed organism.

If Paik’s works marked the beginning of fusing new media and performance to create novel aesthetic experiences, Matthew Barney’s vast project *The Cremaster Cycle* (1994–2002) may represent a creative highpoint. The series of five films is named after the cremaster muscle, which helps regulate the distance between the male testes and the body in order to maintain an optimal temperature for the production of sperm. Broadly speaking, the subject of the work is creative and destructive impulses realized in different contexts and scales, from the individual to society. The

films also repeatedly refer to both the ceremonies and symbols of Freemasonry and the stages of human fetal development in which sexual differentiation occurs, a point before which the artist regards the fetus as being in a state of “pure potentiality.” Guggenheim Museum curator Nancy Spector described the films as a “self-enclosed aesthetic system” and “metaphoric universe” in which the “creative potential of perversion pervades [its] very genetic code.”⁹

There is a dizzying array of elements and references jammed into Barney’s films: Celtic mythology, dental torture, Masonic lore, early 20th-century skyscraper architecture in New York City, and bizarre feats of athleticism featuring, among other obstacles, a salacious female kick-line and a mosh pit. A joyous jumble of aesthetic experience springs from this epic, thanks largely to its maker’s attention to detail and eye for luscious color and composition. This tremendous output includes photographs, drawings, set-pieces, and sculptures, not forgetting the films themselves, produced as limited-edition DVDs. Telling among the casting choices is that of Aimee Mullens, the double-amputee who uses advanced prostheses for lower legs and has become an accomplished athlete, fashion model, and frequent talking point in arguments concerning the use of technology to alter the body. In the films she functions as a doppelgänger of the protagonist (Barney) but also, perhaps inadvertently, introduces into the films the notion of the enhanced self, a manifestation of narcissism amplified with technology. Variations on this theme of the hybridized self are frequently explored in contemporary Bio Art, such as in the work of Jalila Essaïdi and Sonja Bäümel, in which human augmentation is attempted through cross-species production.

Mullens’s character is one that must be defeated by Barney in his journey from Apprentice to Master Mason, in which several travails are endured. At the end of the final film, *Cremaster 3* (they are presented non-sequentially), Barney completes his quest by bludgeoning her, allowing him to ascend to a higher level of being while subjugating the reflected self, his female double. There are many ways to read this film, aside from its symbolic connections to Freemasonry or its pernicious misogyny. The representation of a human-like chimera in the film in the form of Mullens as part machine and part animal and as an abomination challenging the protagonist, presaged the emerging art forms we see that address identity and the definition of nature. The disruptions in these concepts of the self and the environment have only increased in importance in the decade

since Barney’s project concluded. In fact, we have come to ambivalently regard ourselves as something new: supplemented by technologies that monitor and enhance parts of the body. A more detailed understanding of the human microbiome also forces us to consider ourselves as a superorganism controlled in part by trillions of microbes that live within us. Might we in turn feel a need to translate such technologies and organisms, or their symbols, over to a new metaphorical plane and bludgeon them?

Flourishing Infection

“Microbes Maketh Man”¹⁰
—*The Economist*, 2012

Just as new explorations of the worlds of the mind and the microbe challenged conventional thought in the late 19th and early 20th centuries, fundamental and accelerating developments in the life sciences now disrupt our accepted notions of identity, our definitions of life and nature, and our relationships to our environment. The first of these, a changing conception of identity, stems in part from rapid advances in genomics and biomedicine, including research on the human microbiome and the expanding field known as epigenetics. The human microbiome is the vast and complex ecosystem that exists on and within our bodies, consisting of trillions of bacteria and other microorganisms that interact with human cells, sometimes symbiotically. As we are rapidly discovering, this non-human life is essential to our body—to such functions as digestion, maintenance of the immune system, and even possibly our psychological health. Human DNA contains about 22,000 genes that code for proteins, the building blocks of life and all its functions, while each of our microbiomes contains a cumulative three million genes. Keeping in mind that we evolved along with microbes, it seems quite probable that we have developed to rely on this vast library of genetic resources to which we play host. The rate of discovery in this field is increasing, while its impact on our thinking about the self strains to catch up: recall that it has been not much more than a decade since the completion of the working draft of the Human Genome Project in 2003; just thirty years since the development of polymerase chain reaction (PCR), a basic tool for genetic research and experimentation;

and the very structure of DNA was only first described around sixty years ago, in 1953.

Increasingly, studies of the human microbiome demonstrate that humans are staggeringly more complex than a linear code of DNA, a string of letters, would suggest. “Code,” as in Morse code, suggests a string of information, discrete and unchanging. Popular perception has for a long time been anchored in the sludge of this powerful but inaccurate metaphor. As research is beginning to show, slight changes in the non-human life thriving inside and on our bodies may have profound effects on how we feel and think. Like the surrealists, artists and designers today are driven by an impulse to visualize these new discoveries, to comb them for cultural meaning and to uncover (micro) forces that shape yet escape our perceived (macro) reality. Edgar Lissel’s work *Myself* (2005), for example, allows elements of the artist’s skin microbiome to populate a petri dish, tracing the imprint of his hand and making visible another scale of life. Another such work is *Co-Existence* (2009) by Julia Lohmann, an artist whose practice often highlights material relationships between humans and other species. This particular work utilizes 9,000 Petri dishes to form large, pixelated portraits of two reclining nude figures. Each dish features a photograph of cultured microorganisms, with their placement in the portrait corresponding to the part of the body from which the sample originated. Anna Dumitriu also explores this new reality in the work *Hypersymbiont Dress* (2013), for which microbes known or speculated to have various effects on their hosts are stained into a dress. The garment proposes an imaginative conjecture: that it could impart to the wearer new or enhanced abilities, such as protection from pain or improved powers of creativity.

The field of epigenetics further complicates ideas of the genetic self, given that it is the study of the relationship between environmental stimuli and gene expression. As recent research has found, devilishly complex environmental factors control when genes are “switched” on or off and to what degree. Some of these environmental factors are governed by life experiences, and some even by the behaviors of past generations.¹¹ Thus, trauma such as famine or extreme stress experienced by an individual’s great-grandfather could express itself as a propensity toward obesity or susceptibility to disease, for example. The mechanisms of this influence across generations are a long way from being fully understood, but the implications for how we regard our identity and our responsibilities toward, and interconnectedness with, future generations are significant. Complementing this

research is the recent confirmation that more than 90 percent of human DNA—previously little understood and even mischaracterized as vestigial “junk” because it does not code for proteins—in fact significantly affects how genes are expressed; again, the previous understanding of genes as a straightforward set of blueprints is woefully inadequate.¹² The artist Boo Chapple regards this emerging science as “both fascinating and terrifying” and goes on to say that it “speaks to tangible material relationships existing between an individual and their world over vast scales of time, space and circumstance and offers the potential for new understandings of self, for radical legal precedents as well as for Orwellian interventions into public health.”¹³

A further indication of the future direction of artistic engagement with biology—and a challenge to our definitions of life—appeared in 2010, with the creation of the first synthetic life form: “Synthia,” a cell generated entirely from artificial DNA inserted into a host. This effort, led by entrepreneurial scientist J. Craig Venter, consumed many years and millions of dollars and may be a harbinger of an entirely new and virtually limitless medium for creative output. Indeed, artists such as Kac are eager to wield these new technologies and discover their potential for creative expression. “One of my goals,” he recently said, “is to completely and thoroughly design a new life form, to conceive every aspect of it.”¹⁴ Kac has been working in this medium for some time, creating the first multicellular transgenic artwork, *GFP Bunny* (2000), and more recently *Natural History of the Enigma* (2008), in which the artist isolated a gene from his own body that codes for part of a blood antibody, and then successfully inserted it into the cells of petunia plants that were in turn cultured and grown for exhibition. This small human addition to the plant makes it unlike any other that ever existed, as in each of the red veins of the plant’s flowers, a genetically *human* protein is present.

The tension between bioethics and technology is likely to underpin the most significant cultural developments of our age, and so the language of the life sciences—broadly speaking, and including its symbols, protocols, and objects—offers a rich communication tool for artists to use in probing our shifting ideas of identity. Consequently, numerous questions arise from projects that take advantage of our new ability to design life at the scale of the molecule using techniques from the rapidly developing field of synthetic biology, an engineering approach to designing organisms with abstracted,



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7 Julia Lohmann • *Co-existence* • 2009

8 Eduardo Kac • *Natural History of the Enigma* • 2009

interchangeable blocks: are these human-made creations “natural”? What responsibilities do we have toward them, and what limitations can or should be applied to these practices?

Finally, Bio Art addresses a new and critical cultural development: the concept of the Anthropocene. This is the name given to the current geological epoch, characterized by the largely destructive impact of humans on the environment. Widespread acceptance and understanding of our global interconnectedness and shared responsibility for phenomena like human-led climate change, for example, is still relatively new and offers opportunities for artistic response. How will we and the species around us adapt to a vastly changed landscape of scarcer resources and extreme weather in the future? One vision is offered by artist Vincent Fournier in his growing encyclopedia of potential future species, *Post Natural History* (2012–ongoing). This work consists of portraits of animals that we might design a hundred years or more in the future using genetic manipulation: creatures specialized to satisfy human needs or to survive in a harsher environment. These animals appear familiar but uncannily grotesque, sometimes blending attributes of two or more life forms. They are also rendered in a photorealistic manner that, as in the surrealist paintings of Magritte, makes the animals eerily alluring while amplifying cognitive dissonance in the viewer; a discomfort reflective of all the troubling implications embedded in the images, specifically the alarming notion of designing animals dramatically different than those shaped by natural selection.

In light of our continued and increasingly sophisticated tinkering with the genetic blueprints of life, the widely understood concept of evolution will shift. If we continue to shape whole ecosystems by introducing genetically modified species as we have done with agriculture, then evolution is undermined as reproductive success as a driving force of change becomes secondary to the decisions of those humans wielding the ability to design life. It has been argued, albeit controversially, that our dawning biotechnological age might be thought of as a welcome return to a time, over three billion years ago, in which adaptive genetic changes were shared among microbial species rapidly through widespread horizontal gene transfer, which allows for the transfer of genes between organisms in a manner other than traditional reproduction. The communal workings of these early life forms, before what is known as the “Darwinian threshold” when species began to compete, has been elaborated by Carl Woese¹⁵ and others, but

the potential analogy of that pre-threshold moment with the rise of biotechnology is most convincingly described by Freeman Dyson:

“Life was then a community of cells of various kinds, sharing their genetic information so that clever chemical tricks and catalytic processes invented by one creature could be inherited by all of them....But then, one evil day, a cell resembling a primitive bacterium happened to find itself one jump ahead of its neighbors in efficiency. That cell, anticipating Bill Gates by three billion years, separated itself from the community and refused to share. Its offspring became the first species of bacteria—and the first species of any kind—reserving their intellectual property for their own private use.... The Darwinian interlude had begun.”¹⁶

In the future, the monopolistic control symbolized here by Microsoft (Bill Gates is in fact now a generous philanthropist) will succumb as ever-more accessible biotechnology will finally decentralize genetic sharing, yielding a richer and even better-adapted diversity of life. Dyson goes on to anticipate a future in which we can design miniature pet dinosaurs and program trees to grow batteries. But if such a future awaits, there are urgent ethical debates that must advance quickly, particularly around how we might define, value, and possibly protect life as it now exists. As Max Ernst foresaw, artists hasten understanding of these issues, pushing us to more fully develop positions and articulate what is at stake. Risks accompany uninformed acquiescence: the proliferation of designed life forms may accelerate and amplify the destructive aspects of large and entrenched societal structures. We must wonder: what will the biotechnological version of a billion smartphones look like? And what might they eat when they’re hungry? Designing life may simply intensify our destructive cycles of production and consumption. Arguably, the rise of digital technologies has done exactly this, helping the average human to be a more productive worker and faster consumer of goods and services. Will new biotechnology follow such a pattern?

Fortunately, many additional works of art that address these topics are in development. This essay offers a glimpse of the roots of Bio Art’s imperatives and practices in works of the past, coupled with examples of contemporary art that set out to address cultural shifts of recent years driven by the life sciences. In this effort, Bio Art can do much more

than visualize previously invisible forces like the unconscious, or the new realities of life and nature: it can offer us ways to ponder their meaning for our lives, help us arrive at new theoretical and practical positions, and forge new cognitive frameworks and terms to describe them. Bio Art is thus driven by the need to illuminate that which is both consequential and invisible, a gnawing need to examine change. It may also enable us to rework our conception of beauty and realign the relationship between ourselves and a world teeming with life both all around and inside us. In this way, art moves beyond the passive (if poetic) position as a signature of a civilization, to act as a lighthouse, or language-maker.

- 1 Max Ernst, “Inspiration to Order,” in *Max Ernst: Beyond Painting and Other Writings by the Artist and his Friends* (Wittenborn, Schultz, Inc., 1948), 25.
- 2 Alfred H. Barr Jr, “Research and Publication in Art Museums,” in Irving Sandler and Amy Newman (eds), *Defining Modern Art: Selected Writings of Alfred H. Barr* (Harry N. Abrams Inc., 1986), 209.
- 3 “Le Manifeste du Surréalisme” (1924), in André Breton, *Manifestoes of Surrealism*, translated by Richard Seaver and Helen R. Lane (The University of Michigan Press, 1969).
- 4 Author interview with Arne Hendriks (October 17, 2014).
- 5 André Breton and Philippe Soupault, *The Magnetic Fields* (1920), translated and introduced by David Gascoyne (Atlas Press, 1985).
- 6 Sigmund Freud, *The Uncanny* (1919), translated by Alix Strachey (reprinted in Sigmund Freud, *Sammlung Kleiner Schriften zur Neurosenlehre, Funfte Folge*, 1922).
- 7 Author interview with Vincent Fournier (May 5, 2014).
- 8 Nam June Paik, quoted in Jeanne Colleran, *Theatre and War: Theatrical Responses since 1991* (Palgrave Macmillan, 2012), 29.
- 9 Nancy Spector and Neville Wakefield, *Matthew Barney: The Cremaster Cycle* (Guggenheim Museum Publications, 2002).
- 10 *The Economist*, cover story title (August 18, 2012).
- 11 Virginia Hughes, “Epigenetics: The Sins of the Father: The Roots of Inheritance May Extend Beyond the Genome, but the Mechanisms Remain a Puzzle,” *Nature* 507 (March 6, 2014), 22–24.
- 12 National Human Genome Research Institute, “ENCODE Data Describes Function of Human Genome,” see www.genome.gov (September 5, 2012).
- 13 Author interview with Boo Chapple (October 25, 2014).
- 14 Author interview with Eduardo Kac, in *BioDesign: Nature + Science + Creativity* (Thames & Hudson, 2012).
- 15 Carl R. Woese, “On the Evolution of Cells,” *Proceedings of the National Academy of Sciences of the United States of America* 99 (13) (June 25, 2002), 8742–47.
- 16 Freeman Dyson, “Our Biotech Future,” *New York Review of Books* (July 19, 2007).



Vincent Fournier



2

Fournier's work is rooted in art history but aimed squarely at the future as anticipated by scientific and technological advances. The artist's own blend of educational background in sociology, fine arts, and photography informs his strategy of utilizing visual experience to articulate social behaviors and their potential consequences. In the case of *Post Natural History* (2012–ongoing), those behaviors do not yet exist but will be possible and perhaps even likely in the coming decades. The work centers on the redesign of species to bestow traits better suiting them for the era of the Anthropocene, a world characterized by harsher climates and severely limited natural habitats. Such redesign, Fournier suggests, would go far beyond the familiar selective breeding of animals or plants, instead creating hybrids of the familiar and exotic, with traits that would either help species to survive or satisfy new human desires.

The ideas within *Post Natural History* stretch back to antiquity, mirroring, for example, the early depictions of fantastical animals in the ancient Greek work *Physiologus* (2nd century CE). *Physiologus* used a combination of illustrations and text for a moralizing

1–4 *Post Natural History* • 2012–ongoing
Redesigned species, including: Brown-cheeked Hornbill (*Bycanistes attractivus*) with unbreakable beak (1); Rabbit (*Oryctolagus cuniculus*) with high intelligence (3); Red Poppy (*Ignis ubinanae*) with fiery plasma (4). C-prints.

purpose, assuming an inherent wisdom in nature and drawing on that to guide behavior. In contrast, Fournier's work stands between cautionary tale and playful surrealism: the photorealistic quality of his contemporary bestiary makes it both alluring and grotesque, situated in an uncanny valley wherein too much familiarity makes the fiction uncomfortable. The artist takes his cues from such figures as Freud and Darwin—whose works “destroyed” commonly held notions of the binary divisions of sane/mad or animal/human—by depicting mental state and evolution as continuums. By extension, *Post Natural History* redefines the border between natural and artificial as porous, on its way to complete disintegration, and accompanying a future characterized by both hope and dread.

Fournier's earlier works include *Brasilia* (2012) and *The Man Machine* (2010), each made up of several



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photographs of expectant and monumental energy. *Brasilia* presents what the artist calls “a true ruin of a future,” in the form of a reflection on the utopian promises offered by modernist architecture of the 1950s and 1960s: well-funded intentions that have scarcely delivered. *The Man Machine* depicts an unnerving ordinariness in moments of interaction between people and robots; despite being unsophisticated in appearance, the robots are imbued with character, even melancholy, as they are so carefully and humanly choreographed. These works can be seen as a double reflection of robots as portraiture: the successful rendering of our technological creations as both sublime in their apparent autonomy and mundane in their humanness.

The recent work *Synthetic Flesh Flowers* (2014) expands on *Post Natural History* and depicts the imagined results of tissue engineering experiments to make artificially fleshly plants. In the words of the artist, these are “precious vanities” and emblematic of the human desire to transform the living.

5 *Asterae (Paulisper desiderare)* from
Synthetic Flesh Flowers • 2014
Computer renderings, 3D printing



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4



Copyright Material

Azuma Makoto

In 1962 Hans Haacke, a pioneer of systems-based art, created his *Condensation Cube*, the first enclosed natural system displayed in a gallery. Azuma has taken up and developed this practice much further, achieving original forms, immense complexity, and layered meaning. As a self-described “flower artist” updating the traditions of Japanese ikebana and bonsai, Azuma works with plants to create artworks that straddle traditions of sculpture, installation, institutional critique, and Earth art. Inspired by the life force that generates the shape plants take over time as they grow, Azuma creates environments for flora and fauna to flourish into beautiful forms endowed by evolution, yet clearly framed by his hand.

In his *Shiki 1* (2011), for example, Azuma suspends a pine tree in the center of a perfect cube framed in metal. In effect he transplants the living organism into an alien but habitable environment, held firmly in place by wiring, almost as if it were leashed. In decontextualizing the bonsai plant from the soil, its root systems are exposed and its true form, free of any other visual distraction, is revealed. Its presence in a gallery is akin to an ancient relic or religious totem meant for worship appearing in a museum: an object completely removed from its intended context.

Extending the idea of controlled or closed systems for plants further, Azuma has also created entire contained ecosystems, including *Water and Bonsai* (2012). In this work he submerges the plant into a water environment constructed to simulate natural light and air. The bonsai thrive in the water, growing as might free-floating seaweed. In this display, Azuma presents us with an elaborate machine composed of engineering and evolution; a novel, aesthetic bridge between the natural and unnatural.

In describing another of his closed ecosystem works, *Paludarium SUGURU* (2012), Azuma writes, “... we can appreciate a plant that is not capable of migrating on its own regardless of climate, environment, countries or regions.” In response, Azuma creates homes to protect the plants in his works, a reflection of how we humans construct our own specialized places to live comfortably in extreme environments. In these plant homes Azuma simulates wind, water, and air to



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6-7 *Water and Bonsai* • 2012
Sabina chinensis, java moss, water tank

create what he calls an “encapsulated environmental experiment system.”

The elaborate features of this system include light to mimic the sun's cycles, rain, and a small population of rice fish that swim among the underwater grasses. The work is self-contained, constituting a separate, tiny world within our own, for our contemplation. As such, it can spark empathy for the plants, for the fragility of their environments and the systems they create. The artist thus raises the question: how far can we push the limits of a species to survive? This becomes an especially interesting question when we consider the likelihood of mass migration of humans as a consequence of climate change.

Text by Julia Buntaine



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8 Paludarium SUGURU • 2012
Juniperus sargentii, rock, water, glass, stainless steel, small pebbles
9 Shiki 1 • 2011
Sabina chinensis, stainless steel frame, wire

9



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Patricia Piccinini



52

“And if she could be engineered, would she actually be something people might choose to create?”

So said Piccinini of her recent work *The Skywhale* (2013), a balloon in the form of a terrifically fecund aquatic mammal. This question resonates through much of her work, from drawing and sculpture to film. The artist thrusts into our consciousness an uncomfortable combination of the plausible and grotesque: life forms we might one day breed, engineer, or simply imagine, which cross meaningful psychological thresholds. Our uneasiness with exposed flesh, outward sexuality, the endangerment of children, or large insects, for example, creates distinct vulnerabilities that Piccinini readily exploits with cinematic finesse. But in these works she constructs more than friezes from horror films in her mind’s eye; she confronts us with a combination of what we fear and want and do not yet have a vocabulary to describe to create a vision of dystopia laden with hope and humanism.

Although she is keen to downplay it, Piccinini’s study of economics prior to her shift to fine art may inform many of her creative decisions and critical reflexes. She has described the subject as more akin to an ideology, and it seems that it is the (albeit unintended) consequences of such an ideology’s manifestations that interest her most: the messy reality

- 52 *The Listener* • 2013
Silicone, fiberglass, human hair, speaker cabinet
- 53 *Doubting Thomas* • 2008
Silicone, fiberglass, human hair, clothing, chair

beyond abstracted models. In *The Listener* (2013) we see a friendly monstrosity mounted on a speaker, a unified sculpture and plinth with warm, welcoming eyes. Its diminutive size works to amplify its non-threatening nature—like a tiny dog—and it somehow balances revulsion and comfort within its gaze. It appears both profound in its strangeness and akin to a cute consumer product tailored to some tasteless preference. Still more confounding to the senses is *Doubting Thomas* (2008), referencing the biblical story and its depiction by Caravaggio in c. 1601–2, about the skeptical apostle who needed to touch Christ’s wounds to believe the Resurrection. The allusions to the original story accumulate quickly: the stand-in for Christ appears to be a mutated or engineered blob of tissue—a product of technology, a contemporary god. And one cannot help but be fearful for the boy, Thomas, who is more curious than skeptical and seemingly in danger, threatened by something he may have inadvertently created.

Eulogy (2011) presents a sad portrait of a species victimized by human industry and a clear indication

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of the mindless exploitation that characterizes part of the nature/culture relationship for the artist. The work stands out for how literally it can be read: it is about the unfortunate blobfish (*Psychrolutes marcidus*) brought to near extinction by the crabbing industry. Its outlook is especially bleak given its lack of aesthetic appeal. The fish is unlike, say, an adorable panda and few would miss it. *Eulogy* spotlights the invisibility of many of the consequences of human activity. Likewise, *Aloft* (2010) presents an infestation of sorts, one that feels repellent and brazenly unnatural, but can be seen as a critical mirror. Humans routinely trammel the habitats of other species; why should we expect anything different from them?



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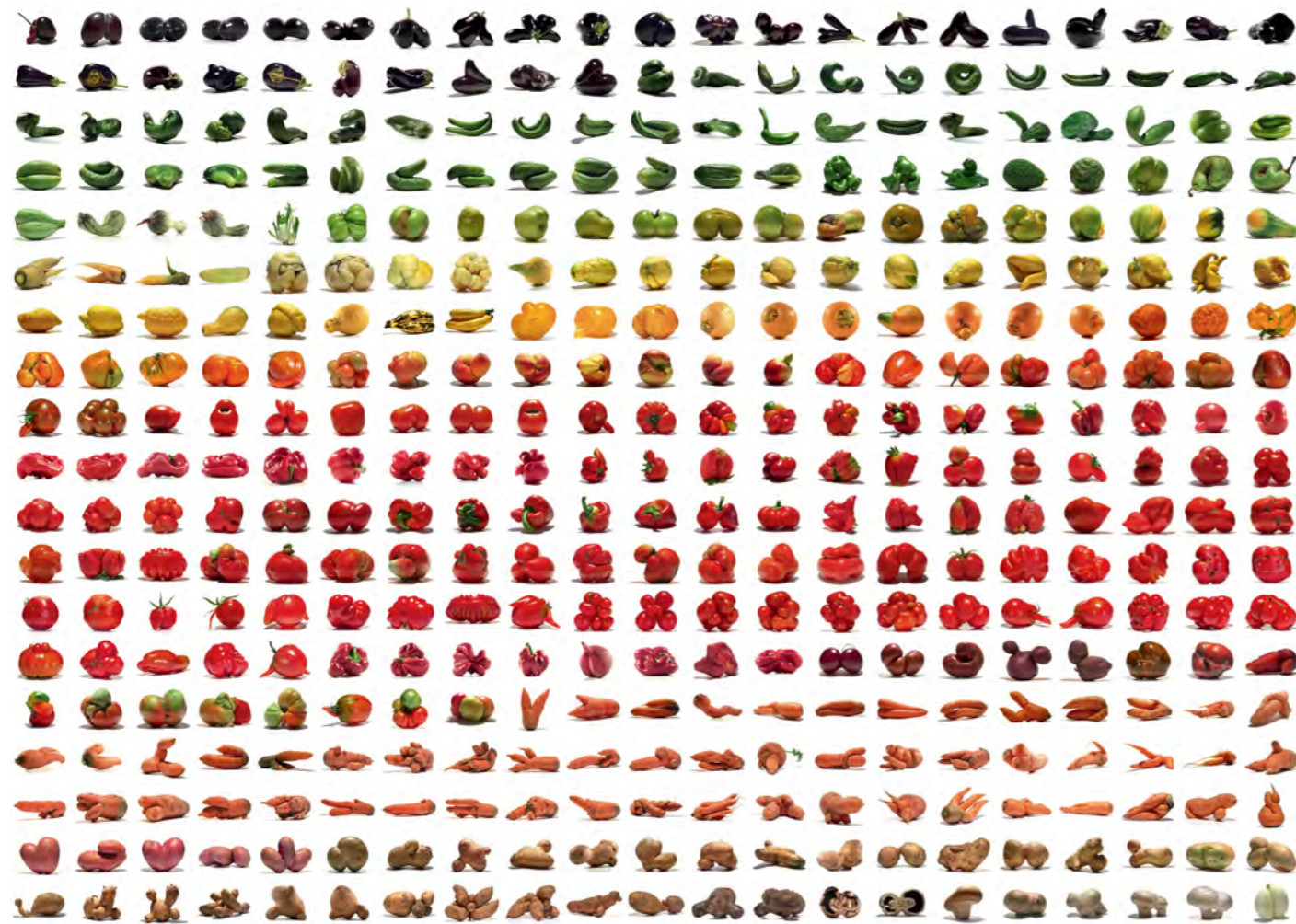
55

54–55 *Eulogy* • 2011
Silicone, fiberglass, human hair, clothing

56–57 *Aloft* • 2010
Fiberglass, stainless steel cable, felted human hair and wool, silicone, robotics, clothing



57



1

Uli Westphal

Westphal's work highlights the absurdity of our assumptions about nature in general, and agriculture in particular. While evolution may be the most elegant generator of form and function, it is, of course, not a process of design as it doesn't conform to any overarching plan or ideals. Westphal begins from this observation by embracing mutation and polymorphism as essential mechanisms of nature that ensure variation and thus survival. These are powerful forces that have been at work for billions of years, slowly yielding form through chance mutations that confer a small survival advantage. But natural variation has given way to standardization: humans have mechanized agriculture, resulting in roots, fruits, and vegetables that follow some arbitrary notion of perfection. We encounter these selected but essentially artificial products in the supermarket, a place that is perhaps our last and weakest connection point to nature. Westphal's work confronts these realities as it considers "the way humans perceive, depict and transform the natural world."

Mutatoes (2006–ongoing) presents images of some "survivors" of biological variation; examples of the everyday tuber or fungi in forms unrecognizable to most people. These varietal mutants were gathered from farmers' markets in Berlin and photographed with care. The resulting imagery gives the subjects a focus and drama normally reserved for sculpture, or perhaps a luxury consumer product. The effect is a show of respect, almost worshipful, for these products of the earth that would be deemed unfit for sale in most supermarkets. The vividly colored and curvilinear forms recall the energy and idiosyncratic style of abstract expressionism, but the orderly arrangement into grids and color spectrums gives the work a highly polished, almost industrial, quality. This blending of styles embodies the internal contradictions of contemporary agriculture, creating a work of global and unsustainable design.

A logical extension of Westphal's *Mutatoes* project is *Lycopersicum* (2014), which takes its title from the Latin name for the tomato species. This work is an homage to the spectacular variety this plant can achieve; a plant which suffers from the expectation of

a normal state being round, bright red, and weighing about 100 grams (3½ ounces). Modern agriculture has suppressed mutation and polymorphism in the tomato, but enough survivors have endured and offer an abundance of taste, textures, and colors. The tomato plant also traces the churn of history: it was widely used in Mesoamerica, then likely brought to Europe by Hernán Cortés in the 16th century, where it grew readily in Mediterranean soil. Over the following centuries it slowly transformed from ornamental plant to food ingredient. The tomato began its path to the uniform variety we know today when an all-red and simultaneously ripening variety discovered in the mid-19th century became dominant, at a time of wider mechanization of agriculture and mass production. Now *Lycopersicum* is enjoying a renaissance as chefs and gardeners demand heirloom varieties and the lost hues, flavors, and feelings of what was once known as the "golden apple."

Supernatural (2010–ongoing) amalgamates food packaging imagery that artificially depicts nature, and then presents it as a ridiculous diorama. These idealized, isolated, and multiplied forms produce an uncomfortable effect, reminding us that the images we carry with us, the representations of the natural world we might claim to value and protect, may in fact be cynical lies. And how might this influence our understanding of the environment? Package designers provide a balm for our conscience, inviting us to think of happy cows and well-proportioned chickens on clean, lush grass, instead of the darker reality. The way in which we regard nature is also the subject of *Chimaerama* (2004–ongoing), another meditation on distortion. For this work the artist gathered one hundred Victorian animal illustrations that he cut into three segments and positioned so that each head fits onto each body and each body onto each tail. The individual segments can be recombined, by means of three switches, into a million new creatures.

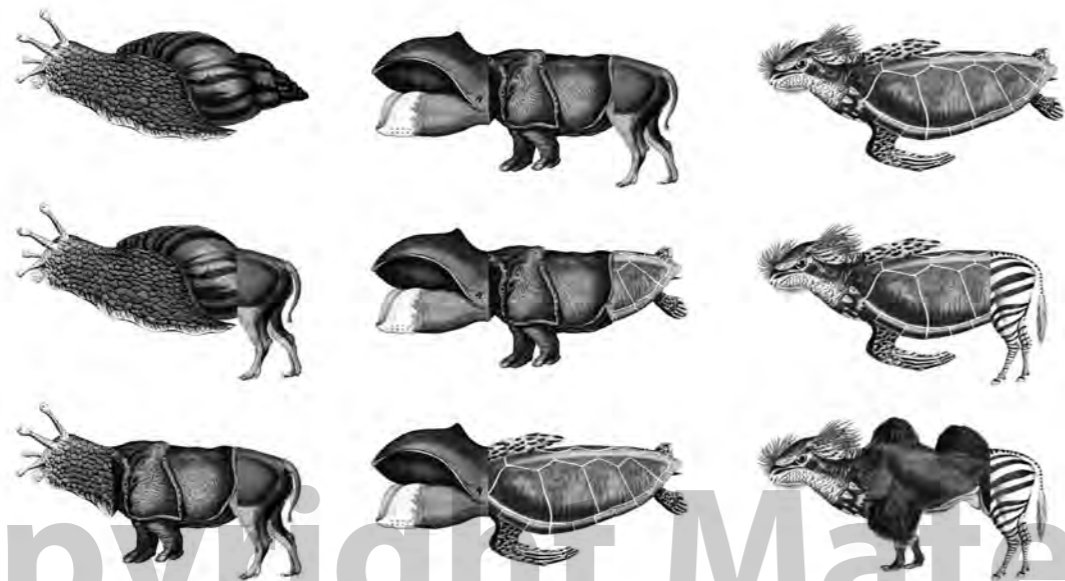
1 *Mutatoes* • 2006–ongoing
Digital photographs



2

2 *Lycopersicon III* (part of the Cultivar Series) • 2014
 Photograph mounted on 3 millimeters (1/8 inches) aluminum-dibond,
 sealed under 2 millimeters (1/12 inches) acrylic glass

3 *Current Version (Chimaerama #9)* • 2014
 HTML/jQuery, 3 channel interactive video loop



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4-6 *Netto, Aldi, and Albertsons* dioramas from *Supernatural* • 2010-ongoing
 Wood, fluorescent lights, glass, aluminum, pigment ink on back-lit film

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Yves Gellie

Gellie worked as a photojournalist for more than twenty years, capturing scenes of community, conflict, and warmth. He spent much time in the developing world, documenting the unfolding human dramas of events like war in Somalia and cocaine production in Columbia. His more recent focus has been to blend documentary and contemporary art. He often manages to capture ordinary settings like classrooms, community baths, or factory floors and imbue them with a sense of the eternal: that we are looking at arrangements of people, practices, and contexts that have been repeating for millennia. In this sense, Gellie literally frames an abstract frame, and presents it to us with impeccable technical execution. The results are poetic and engaging. Other works by the artist, however, take on a thought-provoking new dimension when they incorporate the unfamiliar, as his subjects communicate a reality that is ordinary but sharply unsettling.

This thread of the uncanny emerges in the artist's series *Deer Stalking* (2011), which lavishly documents hunting parties on private estates in the north of Scotland, where landlords maintain thousands of hectares of land to stalk deer. In total, Gellie captured fifteen *tableaux vivants* depicting groups in various stages of the hunt, in scenes that echo the compositions of artworks found on the walls of nearby castles. In the midst of virginal landscapes and reposing, dignified figures, the violence of the hunt seems, remarkably, part of the tranquility, as innate as it is inevitable. Could it be etched in human nature that we would only so lovingly preserve tracts of land as long as we could exploit them as grounds for a bloody game? But the figures betray neither malice nor glee at their labor; they seem rather to be enacting a ritual, and achieving blessed peace after considerable effort.

Suggestions about human nature and the emergent unnatural are amplified in the series *Human Version* (2007–9), for which the photographer traveled worldwide to capture images of laboratories working on humanoid robots. Here the ordinary mingles with the profound: bundles of cable, workstations in disarray, and mundane decor surround experiments in making what might be the future of humanity. It is



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7–8 *Deer Stalking* • 2011
Lambda prints

already well documented how the rise of automation in our era, particularly of learning machines, is upending our expectations about working life. In this series we are confronted with the startling verisimilitude of new robotic technology, and its logical implications for how we might replace not only workers, but also perhaps lovers and friends. If we can design a superior being, why wouldn't we want its companionship? Doesn't this serve our natural human selfishness to its highest degree, or logical conclusion? The robots may signal humanity's hubris, its newest savior, or perhaps its replacement. Gellie captures the exciting yet uncomfortable reality these beings represent when he says: "We are as fascinated as we are afraid."



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9-10 Human Version • 2007-9
Lambda prints

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Špela Petrič



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The works of Petrič highlight the dimensions of human hubris and challenge conventional processes of truth-seeking, problem-solving, and relating to nature. The artist's practice is rooted in training as a scientist, having completed a PhD in Biochemistry in addition to her studies in philosophy and art history. Petrič, therefore, draws on her familiarity with laboratory protocols and the realities of contemporary scientific practice, with its attendant pressures to publish or profit, as part of the wider processes of knowledge building. The results are works that are both highly contextual and critical, executed with rigor legible to scientists but colored by a personal stance complicated by a simultaneous internalization of artistic and scientific impulses. The artist pokes fun at our cult of technology and impotent attempts to save nature—she proposes sex toys for plants and reveals the absurd disguises worn in our human quest to conquer the last enclaves of undisturbed biology in the seas, by presenting aquaculture as an analogue for colonialism. As the artist says: "Overcoming anthropocentrism is the ultimate exercise in futility, but a fruitful generator of concepts that challenge our Western worldview."

At first reading, *Solar Displacement* (2013) appears to illuminate the Faustian bargain that contemporary life imposes on people through pressure to stay awake, polite, and productive outside of our circadian rhythms. The artist describes this conflict as a "continuous negotiation" between cultural norms and biology.

In this work, rats acted as surrogates for human subjects, and were exposed to luminosity levels dictated by sensors carried by human subjects going about their everyday lives. The result was displacement of circadian rhythms in the closely observed rats, and their subsequent turn toward stimulants and altered social behavior. But the artist explains that this work was not about a romantic longing for a more "natural" existence. On the contrary, it highlights the way that our organic adaptations are in "jetlag" to our rapid social advances, but are an evolutionary step in the journey to the "next version of human."

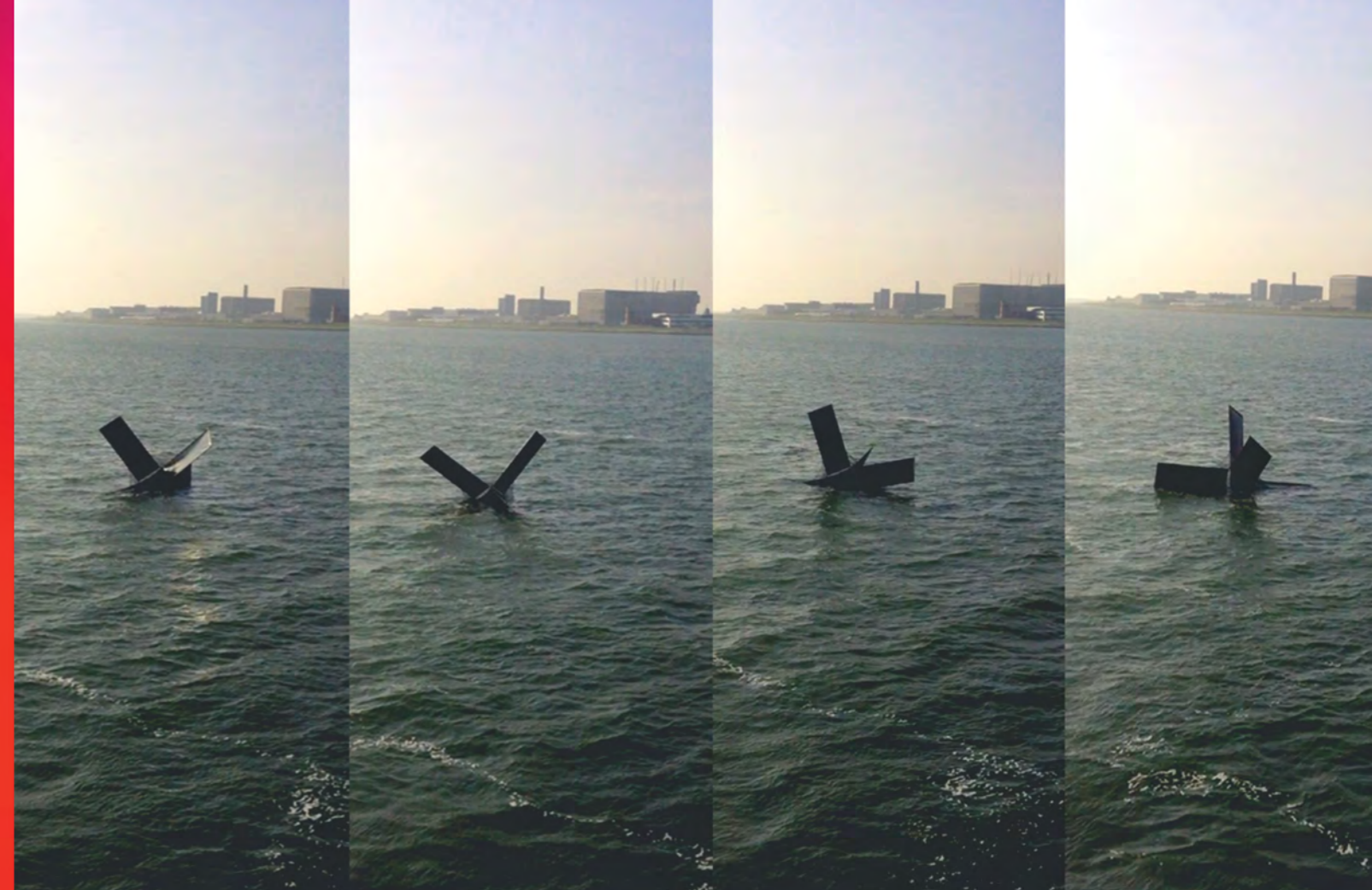
PSX Consultancy (2014) proposes designs for plant sex toys and a service of sex therapy for silent, flowering species. It is a absurdist indictment of many of the working assumptions of scientists, artists, and designers regarding how we think "for" other species and believe we are equipped to know what they "want." The humor is compounded by the project's context as a product of the BIO 50 Design Biennial of Ljubljana; the collaborative team, which included Pei-Ying Lin, Dimitros Stamatis, and Jasmina Weiss were continually asked, in earnest, whether their concept could be applied to save endangered species.

Petrič explores the paradox of the utilitarian object for the non-human further in the project *Naval Gazing* (2014), a collaboration between the artist and the Royal Netherlands Institute for Sea Research (NIOZ). For this work, a windmill-like structure was designed for release into the North Sea; the tetrahedron shape

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of its appendages intended to catch wind and propel it in a gentle yet unpredictable path. Eventually, the work is intended to accumulate growth of sea plants, bivalves, and whatever else decides to make it home, at which point the weight of new organisms will sink it. The work is rich in its associations with Dutch naval history, colonialism, and the use of windmills to “make” land by creating polders. In the context of a research institute investigating aquaculture (the cultivation of the sea) the project helps pose the question: “Can the human fathom an investment into structures and processes which are non-utilitarian for the human?”



32

- 29 *Solar Displacement* • 2013
Wood, plexi glass, Arduino, Raspberry Pi, LED lights, thermal cameras, piezo sensors, *Rattus norvegicus*, Android phone application
- 30–31 *PSX Consultancy* • 2014
In collaboration with Pei-Ying Lin, Dimitros Stamatis, and Jasmina Weiss
3D prints, glass, digital prints, *Dianthus caryophyllus*, *Sarracenia purpurea*, *Curcuma alismatifolia*, *Abutilon spp.*, *Cyclamen spp.*, *Canna spp.*
- 32 *Naval Gazing* • 2014
In collaboration with the Royal Netherlands Institute for Sea Research (NIOZ) and funded by the Bio Art and Design award of ZonMW, the Netherlands Organisation for Health Research and Development
Aluminum, PVC plastic, nets, *Fucus vesiculosus*, *Ulva lactuca*, other marine organisms

Sarracenia

Sarracenia purpurea

The Diether Plant's Food and Sex Pest

PLANT STATEMENT

“Like our plant nature, we don’t hunt, it’s too much trouble. We seduce.”

THE PROBLEM

“When we flower, and bear seeds, most efforts will be put into reproduction, while other parts of our body won’t be our priority. In my case, I won’t be able to digest as well as I normally do, since all my efforts are put into sex. Also, the bugs that pollinate me mustn’t get trapped by the pitchers. I need a strategy to maintain resources and attract the pollinators to the flower.”

THE SOLUTION

The pitchers are supplemented with an augmentation, which provides an alternative food source that’s generated by algae through photosynthesis. The structure containing algae directly blocks Sarracenia’s mouth to avoid it from eating pollinators. An additional augmentation on the flower carries sacs with blood to attract mosquitoes and nectar to attract the bees, drawing them away from the pitchers.

31

Bio Visualizations

California Academy of Sciences; Lewis Lab
at Northeastern University; Tom Deerinck

Images have long served to illuminate concepts and exercise our imaginations, particularly when they bring to light invisibly small scales or incomprehensible distances. Visualizations adjust perspective and, much like figurative language, highlight similarities or patterns where none had seemed to exist, and form bridges of meaning. Fields of study from astronomy to urban planning have long benefited from the use of visualization techniques, but it is biology in particular that has enjoyed many recent advances making images both accurate and affordable to make.

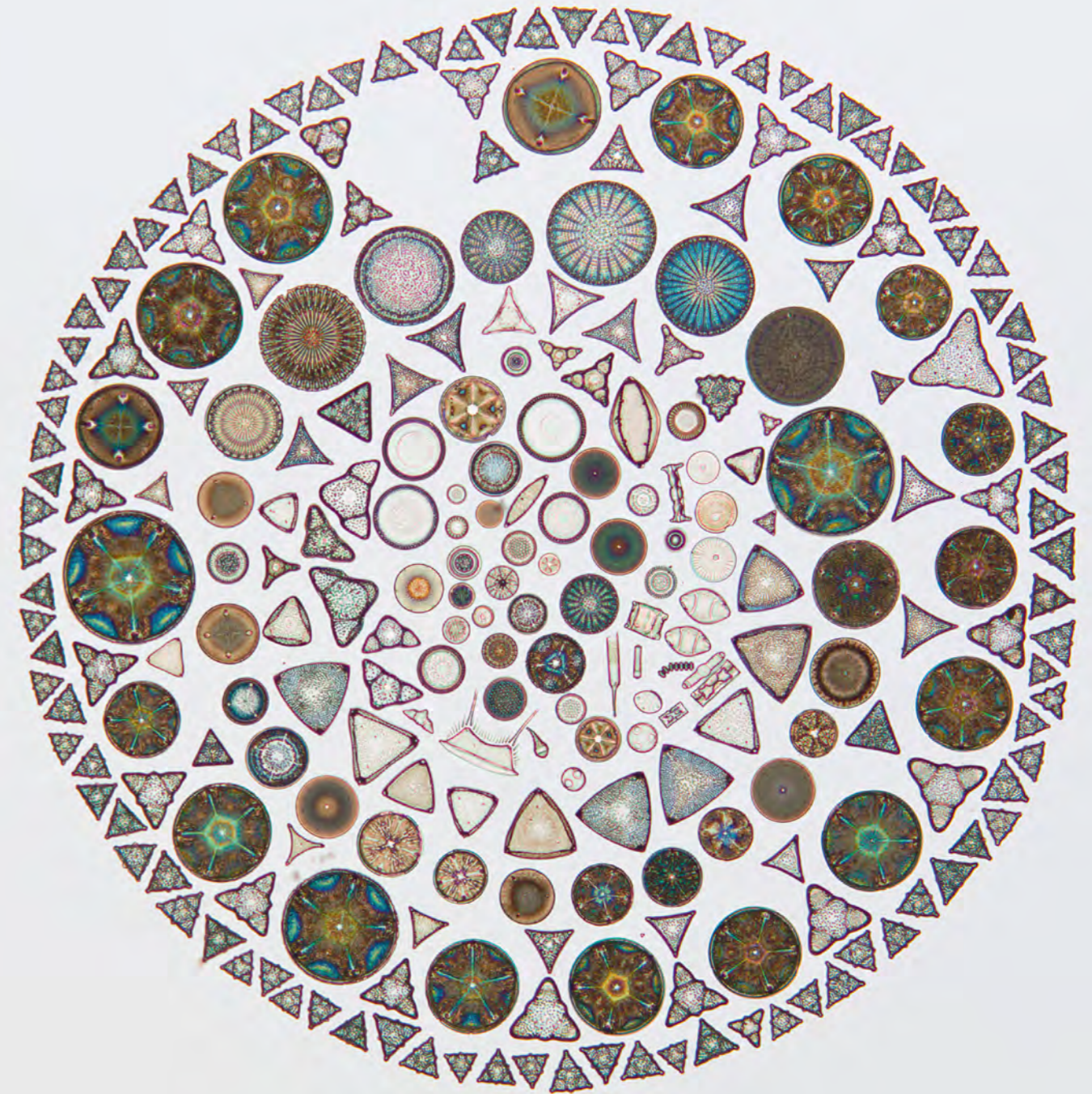
Often these images of biology have unmistakable aesthetic qualities: contrast, variation, intricacy, and fractal-like repetition, as in the photographs of plants by Karl Blossfeldt published in 1929, or the X-ray crystallography of ribosomes by researchers at the National Synchrotron Light Source (NSLS), or the more recent video renderings of cellular processes by Drew Berry. In these cases and several others, visual experience helps us to understand the biology as sets of systems and structures, interrelated and in motion.

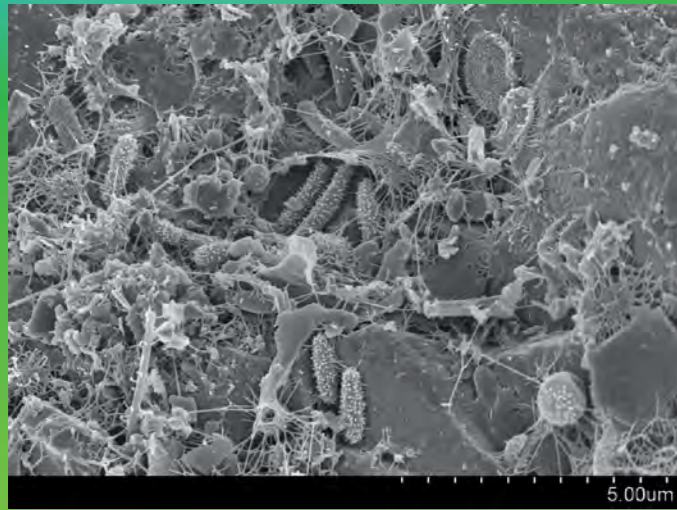
The tradition of arranging microscopic life in interesting or visually pleasing ways stretches back to the earliest forms of cellular magnification, which became a hobby for educated tinkerers in Victorian England. Arrangements of diatoms (a group of algae) for aesthetic effect, for example, were particularly popular and a natural extension of serious research and categorization of the organisms, which were stained and preserved together depending on their origin or form. A. L. Brigger was a notable diatom scientist who made such arrangements. He served as a Research Associate at the California Academy of Sciences, and in 1977 he gifted his collections of marine slides to the Academy, which continues to study them to this day. Brigger's arrangements often have radial symmetry, reflecting the form of some of the most intricate, circular-shaped

diatoms; organisms that when arranged together bear a likeness to both stained-glass windows and diagrams of microprocessors.

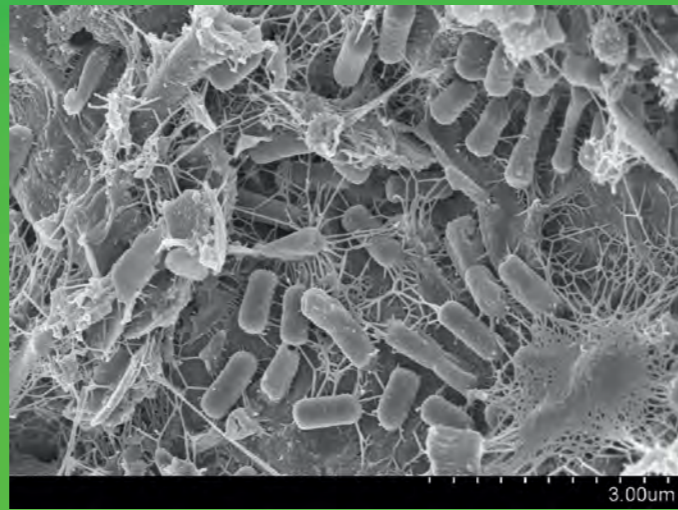
On a still smaller scale, that of micrometers (one millionth of a meter), visualization now allows us to see legions of bacteria spawned in the crevices of a single grain of sand: *Life on a Grain of Sand*. The source of these images was a grain collected on a beach near Boston in 2009 by researchers from the Lewis Lab at Northeastern University. The dramatic, labyrinthine connections of biofilm among them appear as threads, tangled together in vibrant, overlapping layers. These images may help emphasize the stubborn and robust nature of microbial life, the study of which continually reveals wider boundaries to the concept of habitability.

Also at a cellular scale are the visualizations of Tom Deerinck, which were made possible with the help of advanced microscopy. In *HeLa Cells* (2010) we see cancerous human cells stained to reveal the distribution of microtubules (cyan), and cellular DNA (red). These cells exhibit the unique property of immortality: under the right conditions they divide indefinitely, and have been cultured continuously since they were harvested in 1951 from a cancer patient named Henrietta Lacks. The cells have proven extraordinarily useful for medical research. As of 2009, over 60,000 scientific articles had been published relating to research carried out on them. *The First Synthetic Life Form* (2010) is another image by Deerinck showing the product of a team lead by J. Craig Venter. The image is of a human-designed and computer-manufactured microbe; its DNA is based on that of *Mycoplasma mycoides* but pared down to its bare essentials to survive and replicate. According to Venter, this is the first organism to have "a computer as its parents."

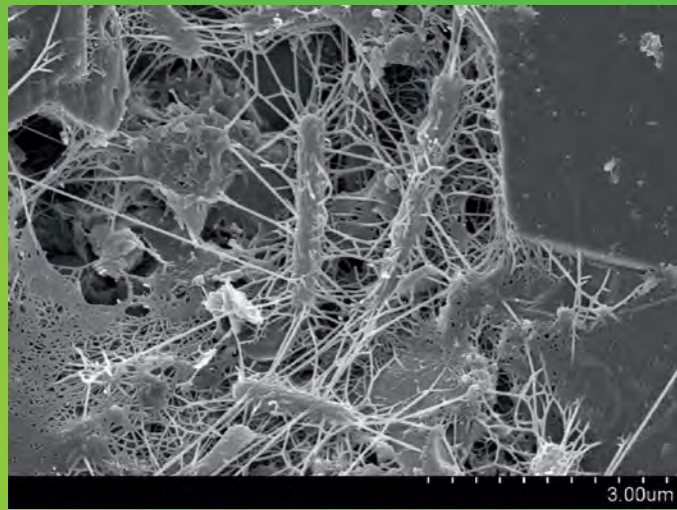




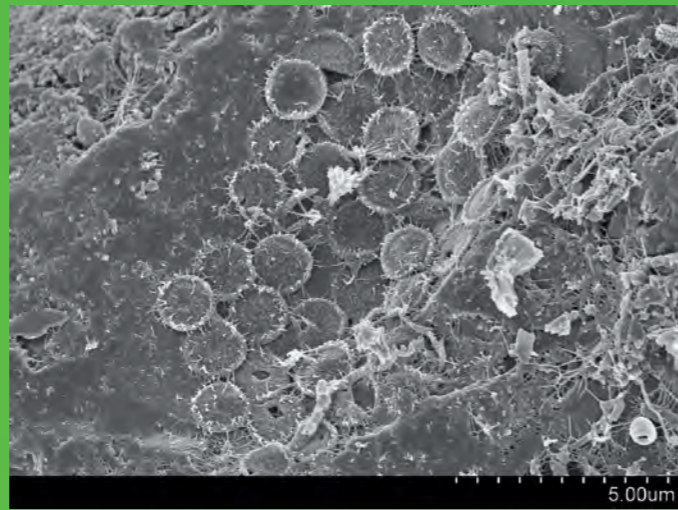
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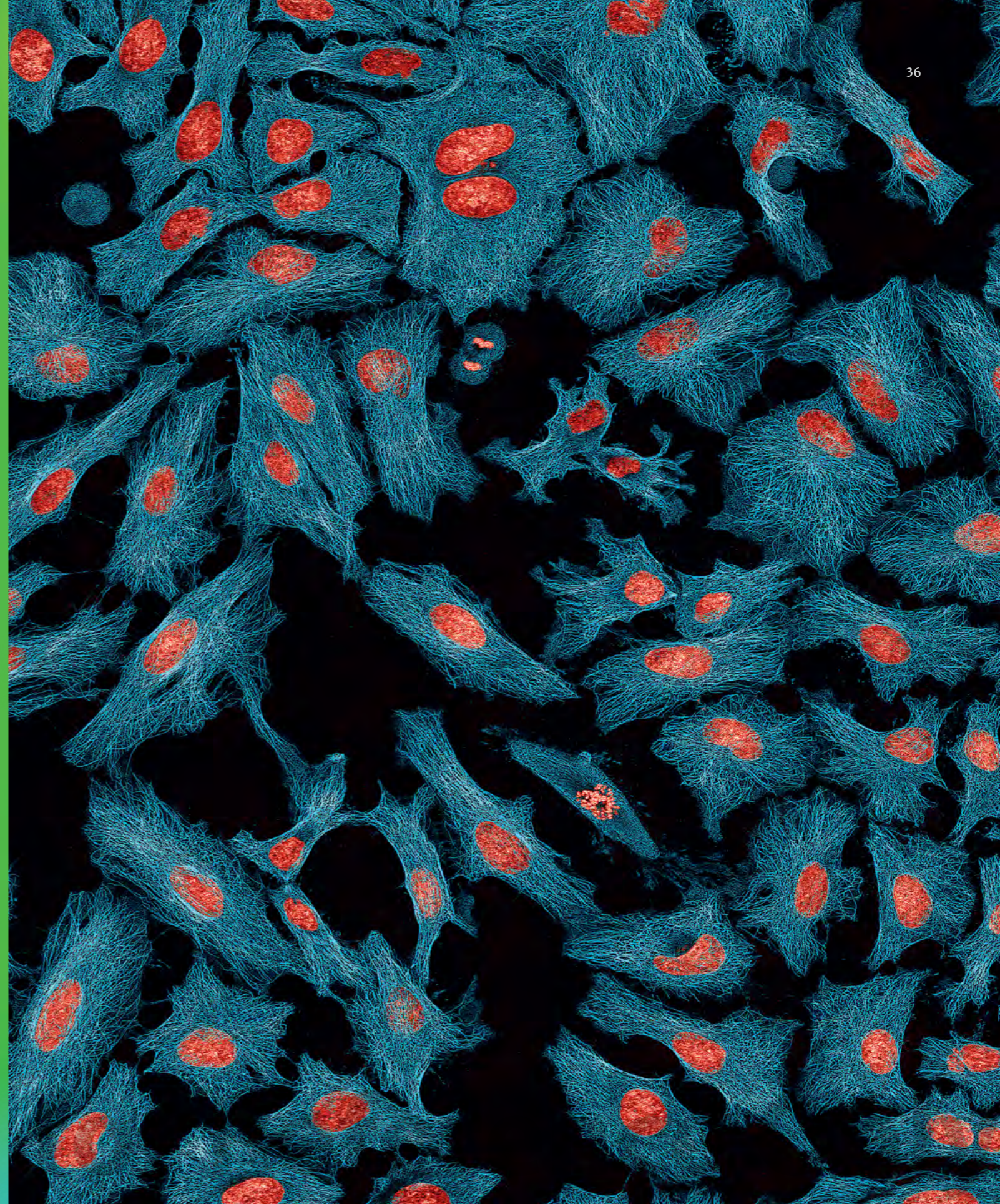


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- 31-34 Anthony D'Onofrio, William H. Fowle, Eric J. Stewart,
Kim Lewis (Lewis Lab at Northeastern University)
Life on a Grain of Sand • 2009
Collected from intertidal sediment on a beach near Boston
Scanning Electron Microscope (SEM)
- 35 Tom Deerinck
The First Synthetic Life Form • 2010
Developed by J. Craig Venter
Transmission electron microscopy
- 36 Tom Deerinck
HeLa Cells • 2010
Multi-photon fluorescence microscopy



36

Copyright Material



Jon McCormack

The focus of McCormack's work is the creation and testing of digital models that simulate morphogenesis, or the processes by which living things take shape, as well as ecological phenomena such as interdependences and feedback-loops. Since the 1990s his work has tracked alongside, and indeed influenced, the development of software modeling of this kind, used to enhance research by yielding spectacular visualizations and sound experiences, often with a significant temporal dimension. In blending aesthetic output with formal research in measuring, understanding, and replicating biological phenomena, McCormack's work recalls the influential, exhaustive *On Growth And Form* (1917) by D'Arcy Wentworth Thompson, as well as the work of contemporaries such as Tom Deerinck (microscopy, see pages 148–51) and Drew Berry (animated molecular machinery, see pages 146–47).

The alluring images of *Fifty Sisters* (2012) were achieved with a combination of modeling tools developed by McCormack over the past two decades: from discrete, string rewriting L-systems in the 1990s to his Cellular Developments Model (CDM) today. CDM goes further than earlier software by incorporating continuous changes in stimuli-rich environments and recycling system components in a hierarchy. In other words, the model now more accurately replicates complex interrelations and adaptability that characterize the actual ecology outside your window. Such complexity resists neat description but is adaptive to visual experience, as shown by the flower-like forms that McCormack creates, with all their intricacy and variety, as vividly colored as the products of natural selection. But these forms are also supremely artificial, almost machine-like in their aesthetic perfection. This contrast is amplified by the integration of oil company logos as starting components of the morphological system, distorted by the evolutionary modeling yet still recognizable in the finished works.

The underlying narrative of *Fifty Sisters* superbly matches the combination of visual elements used in the works. Oil and coal began as plants millions of years ago and use of them is now rapidly altering the climate, a process accelerated by the corporate actors represented in the composition. The title of the work plays on "seven sisters," a term used to describe the cartel of firms that dominated international oil production and distribution for decades. The abstraction of these corporate identities using plant morphogenesis has a pleasant, if dark, irony—an impression enhanced by the fact that the images are generated by models run on computers, which are themselves produced with and powered by fossil fuels.

In *Eden* (2004), the artist created a model to replicate evolutionary selection, and used this as the basis of a dynamic gallery experience expressed in sound and light. The installation begins with a population of virtual organisms represented on the walls of the gallery, each with different genetic information and sound-making behavior that can change and mutate across generations. The feedback loop depends on visitor behavior: where someone stands and for how long is detected and used to generate "food" for the artificial environment, supplying nearby virtual organisms with nutrients and survival advantage. The longer a visitor stands to hear the sound of that organism, the more food will be created for it. Over time the installation's modeled organisms "evolve" toward producing sounds that people will stay to hear.

1–4 *Fifty Sisters* • 2012
Evolved digital images of plants
derived from oil company logos



3

5 *Eden* • 2004
 Installation based on software that
 creates an interactive, self-generating,
 artificial ecosystem



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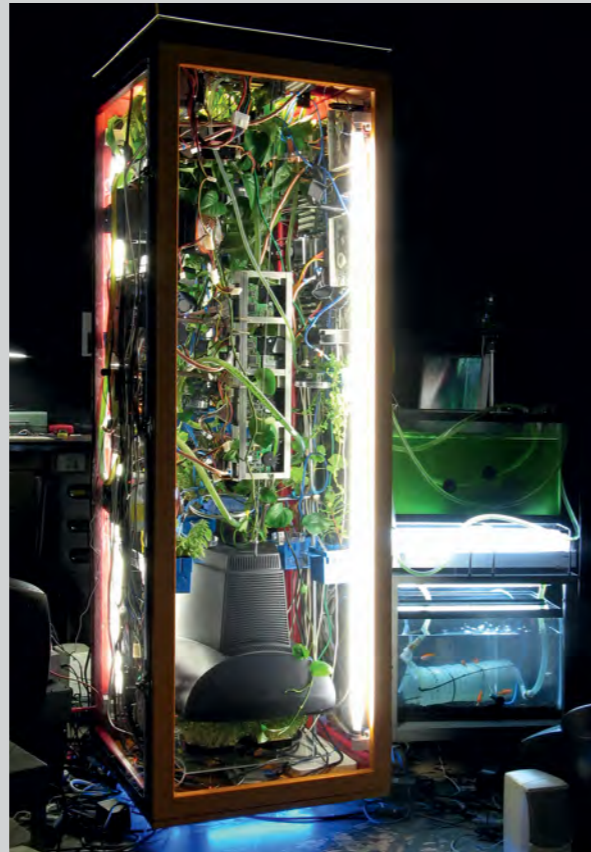


5

Angelo Vermeulen

Vermeulen is an artist and biologist with a wide range of expertise accumulated over the course of substantial academic and creative careers. As a trained scientist currently working on his second PhD, Vermeulen is as at ease collaborating with practicing scientists as he is constructing multimedia installations in galleries and building communities through hands-on activity and gaming. The artist's work confronts ambitious questions such as: "How do we define the relationships between the natural and the artificial and how and when can they interface? Is it possible to set up a measurable, evolutionary system in a gallery setting? Is the nature of digital art media and its production truly immaterial?" Vermeulen takes on these subjects with the resourcefulness and curiosity of a polymath, and has a distinctive ability to explain his motivations with clarity: to demonstrate the "unity of reason and intuition."

The ongoing work *Biomodd* (2007-) has existed at different times and places as a "living cybersculpture" of computer systems entwined with an ecosystem. The computers are a server for a multiplayer game, and as more participants join the virtual community to play, so the hardware components become warmer, fueling the surrounding plants, which include algae. Their metabolism, in turn, has a cooling effect on the hardware. This interdependency is echoed throughout the realization of the project: in the community of artists, scientists, and designers who build the *Biomodd* each time, among the gamers who directly participate in the game, and in the physical components of the installation, including microprocessors and the chloroplasts (organs within plant cells which conduct photosynthesis). Further, each installation of *Biomodd* is not a stand-alone work but rather part of a series that varies in each location



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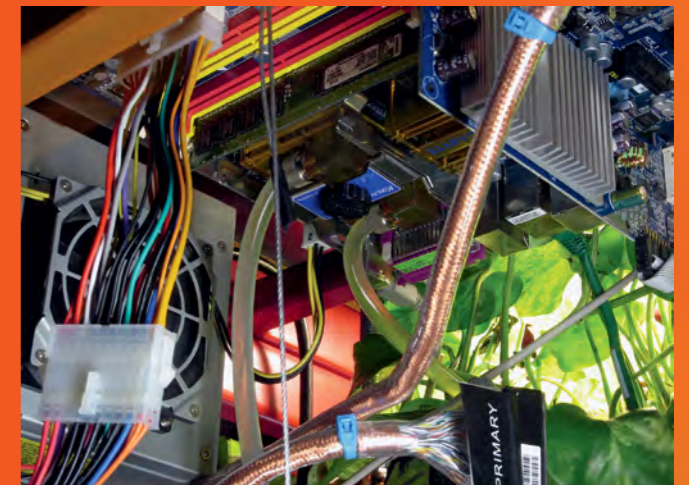
depending on the wishes and culture of the local community. *Biomodd* was first erected in the United States in 2007 and has since been created in the Philippines, Slovenia, New Zealand, Belgium, the Netherlands, and Chile, with plans to build another in the United Kingdom. The artist has thus become a community architect, an initiator of interactions and new perceptions among those willing to engage.

Vermeulen's 2005 collaboration with Luc De Meester, *Blue Shift [LOG.1]*, essentially hacks the evolutionary mechanism of selection for the purposes of a gallery experiment. Lights emitting the color yellow are set above tanks of water fleas—a species that has evolved to swim up toward yellow light but then to dart downward to avoid predators when it detects blue light from above. The artists have reversed this system for the water fleas: exposing them to predators if they swim away from a blue light from above, which for this installation was triggered by the presence of gallery viewers. The result is a weeding out of the water fleas with the "normal" survival response and the

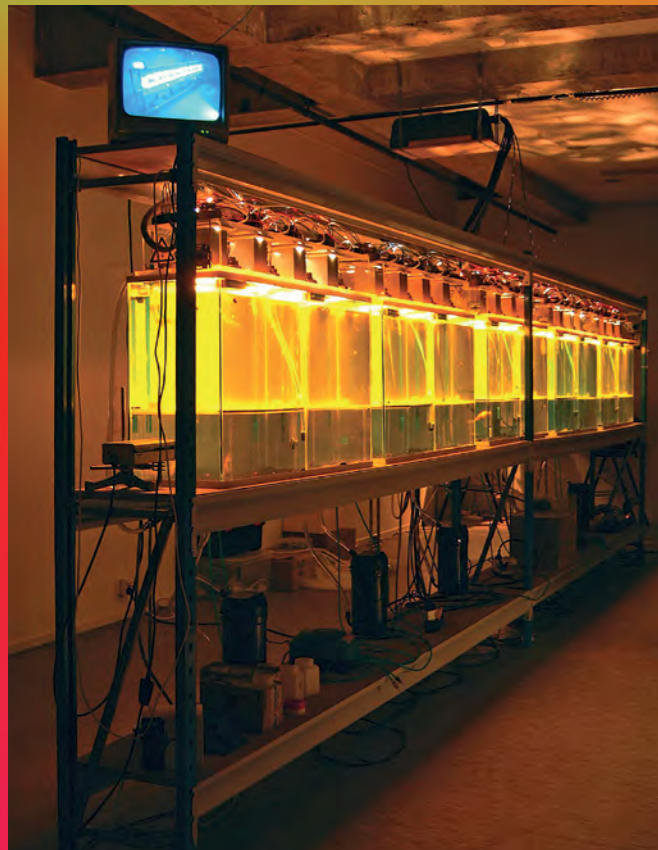


46

- 45 *Biomodd [ATH¹]* • 2008
In collaboration with volunteers and students
Reused computer parts, peripherals and monitors, arcade game seats, audio mixing table, speakers, plants, algae culture, gold fish, aquariums, lighting, air and water pumps, tubing, metal casing, Plexiglass
- 46-47 *Biomodd [LBA²]* • 2009
In collaboration with volunteers and students
Reused computer parts, peripherals and monitors, plants, algae culture, goldfish, aquaponics system, aquariums, lighting, air and water pumps, tubing, coconut wood, woodcarving, glass panels



47



48

beginning of a population of mutants adapted to a new, designed environment.
Corrupted C#n#m# (2009) is an exploration into the material quality of media and its potential to be altered by biological processes. The work challenges the often-made assumption that media's existence and production are largely immaterial. By growing bacteria and mold on data-containing media like computer hard drives, each containing digital files that had been converted from VHS tape, the goal was to subsequently recover visual information with glitches that could be said to have been authored by these biological processes. The title of the work includes a corruption of the word "cinema," with its vowels replaced by hashtags, a sort of transcription error that can happen in data sets. In a later iteration of the work (*Entomograph*), Vermeulen, in collaboration with silversmith Walter Bresseleers, captured and translated the behaviors of Madagascar hissing cockroaches to create disruptions in video data.



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- 48 **Blue Shift [LOG. 1] • 2005**
 In collaboration with Luc De Meester
 Industrial storage rack, aquariums, PVC spacers and false bottoms, water filtration pumps, aeration pumps, tubing, yellow and blue lighting system, motion detection sensor, logic module, CCTV system, Daphnia culture, goldfish
- 49 **Corrupted C#n#m# • 2009**
 Reused computer equipment, hard drives, monitors, lighting, projector, DIY laboratory equipment, aquariums, mold cultures, plants, meal worms, crickets, goldfish, foldable tables, chairs, wall painting
- 50-51 **Entomograph from Corrupted C#n#m# • 2010**
 In collaboration with Walter Bresseleers
 Metal trestle supports, glass and plywood panels, terrarium, cockroaches, laptops, hard drives, electronics, audio equipment, CCTV camera, DVD player, television monitors, drawings