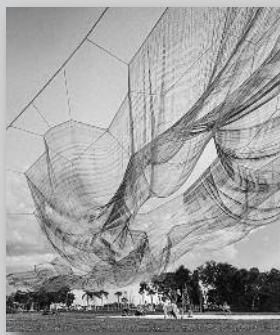


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(Front cover)
Janet Echelman,
Bending Arc (2020),
permanent sculpture
installation on the
St. Pete Pier in St.
Petersburg, FL. Photo by
Amy Martz. Courtesy
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Most appropriate to this difficult time are the works of several women who present enviable science literacy in their art. Re-assessing Western medicine, and taking on a range of scientific inquiries, the artists include Marta de Menezes, Christy Rupp, Lillian Ball, Janet Echelman, Tauba Auerbach, Maria Elena González, Victoria Vesna, and Rachel Sussman. Author Ellen Levy, a multimedia artist herself, whose scholarship explores connections between art, science, and technology, writes: "This text calls attention to a diversity of art by eight women whose content converges with recent scientific discoveries about nature. Without compromising a single category (they identify as ecofeminists, bioartists, and media artists), the artists create works that embody what physicist and feminist Evelyn Fox Keller designated a 'new consciousness of the potentialities lying latent in the scientific project.'"

Their artwork ranges from delicate structures made from bones to the musical possibilities of tree bark to large outdoor projects and experiences. Our cover features one of the latter, Janet Echelman's *Bending Arc* (2020), located at the new Pier District in St. Petersburg, Florida. This brilliant example of Echelman's art is her largest aerial sculpture to date.

This issue of the *Woman's Art Journal* celebrates the work of ten living artists, including two now in their nineties and still working. Their lifetime achievements continue to gain critical recognition for Amaranth Ehrenhalt (b. 1928) and Eunice Golden (b. 1927).

Amaranth Ehrenhalt spent more than thirty years in Europe, and her work is identified with that of the Abstract Expressionists she met in New York, and American expatriates active in Paris. Ehrenhalt's life has been filled with creative endeavors—in addition to her paintings, she has made prints and ceramics and designed scarves and textiles. She continues to astonish new audiences with large-scale paintings, such as her recently completed *Four Seasons*, comprising four panels and measuring 12 by 24 feet. Joan Ullman, a New York-based writer and psychologist, who interviewed the artist for this article, writes that "Ehrenhalt once likened her dazzling, tightly organized color-filled works to 'a symphony on a flat surface.' After a moment's reflection, she added, 'I have one word you can use if anyone asks you what my work is about: Nourishing. My paintings have a certain exuberance that makes for a cheerful day when people see them ... They're nourishing for the soul.'" Ullman agrees: "This seems a perfect word to conjure the joyous spirit one gets from viewing Ehrenhalt's vibrant paintings—not to mention the life to match: one as busy, buoyant, and—yes—brilliantly colorful as the artworks themselves."

Aliza Edelman, our energetic and accomplished Book Review Editor, continues to demonstrate her skills in documenting feminist pioneers. In the current issue she presents Eunice Golden, who has been closely identified with feminism since the earliest years of the feminist art movement. In 1970 Golden joined the Ad Hoc Women Artists' Committee, which was responsible for demonstrations and other practices in response to the discrimination towards women artists by museums and other art institutions. In 1975, she published "On the Censorship of Phallic Imagery" in *Art Workers News*. And the third issue of *WAJ*, in 1982, featured her article, "Sexuality in Art: Two Decades from a Feminist Perspective."

Lately, Golden's exploration of the male nude has been receiving considerable international recognition. In Germany, her series of *Male Landscapes* was shown at the Stadtgalerie Saarbrücken in a major exhibition entitled *In the Cut: The Male Body in Feminist Art*, and her 1973 film *Blue Bananas and Other Meats* was included in an international exhibition in Dusseldorf. We honor Eunice Golden for her decades of participation in the feminist art movement and congratulate her as she is recognized on an international stage.

Writing brilliantly about Golden's art, Edelman notes: "Working in various media, including drawing, painting, film and photography, Golden visualized male nudes as abstracted landscapes, a formal and conceptual approach that brazenly challenged centuries of mythological and allegorical depictions of female nudes by male artists, and likewise navigated histories of landscape painting. Golden's incisive and unsentimental anatomical studies on male corporeality offered an authoritatively feminist position from which to address postwar gesturalism and figurative abstraction...."

In our fourth article, Scottish art historian Naomi Stewart writes on the artist Dora Maar (1907-97)—not as a muse and lover of Pablo Picasso, but highlighting her own work as a "street photographer." In 1932 Maar set up a professional photographic studio in Paris. Although she produced images on commission for fashion magazines and commercial products, her photography became closely identified with surrealism, and Maar was frequently included in surrealist exhibitions. She became actively involved with Contre-Attaque, a radical leftist group founded by André Breton and Georges Bataille in 1935, and signed political manifestoes, including anti-fascist texts. In this spirit, Maar ventured out into areas where women of her ilk seldom were seen, and the subjects discussed in this article appear to be living on the margins of society. As Stewart writes: "In venturing as far as areas such as *la zone* (a wasteland occupied by the poor and immigrants where Maar captured a handful of images of women and children living in poverty on the outer limits of Paris), her photographic movements in the city are ostensibly linked to a critique of existing social and spatial conditions that dictate the areas conventionally (in)accessible to certain individuals/groups based on gender, class, and even indigeneity."

The pandemic has taken a toll on *WAJ*, as on everyone and everything else we know. Business shutdowns caused our Spring/Summer issue to be late going to print and kept potential reviewers from receiving their books. While reviews are fewer in number than usual, they are interesting, wide-ranging, and informative. The topics include a pioneering New York gallerist, the women printmakers of Atelier 17 in the US, the German artist and printmaker Käthe Kollwitz, Shirin Neshat and other Iranian artists, two South American artists—Beatriz González and Loló Soldevilla, and British Arts and Crafts women. We thank Aliza Edelman for bringing these reviews to light.

We give special thanks to Guy Griffiths, Ian Mellanby, and the staff at Old City Publishing for their patience, perseverance, and unwavering support.

Joan Marter and Margaret Barlow
Editors, *Woman's Art Journal*

NATURE

NEW CONTEXTS, NEW ART BY WOMEN

By Ellen K. Levy

Nature, a realm of biochemical and physical forces, has also long been contested territory, subject to shifting theories, histories, policies, stories, myths, and beliefs. To look at art and art history is to see a projection of changing ideas about nature in varying contexts and scales. Over the past thirty years, feminism and science (along with popular culture) have come far in defining what nature now means. This text calls attention to a diversity of art by eight women whose content converges with recent scientific discoveries about nature. Without comprising a single category (they identify as ecofeminists, bioartists, and media artists), the artists create works that embody what physicist and feminist Evelyn Fox Keller designated a “new consciousness of the potentialities lying latent in the scientific project.”¹

Nature Reframed by Feminist Science

The artists explore topics such as self/non-self (Marta de Menezes), the food web (Christy Rupp), cooperation and competition (Lillian Ball), pattern formation and symmetry (Tauba Auerbach), morphogenesis (Janet Echelman), nature and culture interrelationships (María Elena González), the science of self-organization (Victoria Vesna), and origins of life (Rachel Sussman). Their perspectives are informed by new scientific understandings and feminist writings that question traditional Enlightenment distinctions between nature and culture.² In addition to Keller, other key scientific influencers include an early environmental pioneer, Rachel Carson, who authored *Silent Spring* (1962), launching the environmental movement.³ Other feminists include Donna Haraway and Lynn Margulis. Haraway revealed Western science largely as a competition for power and resources among groups with different stakes.⁴ Margulis showed the prevalence of symbiosis (mutually beneficial relationships between organisms) throughout the natural world, thereby reformulating ideas of evolution.⁵ Feminists have devoted great efforts to dismantling old gender stereotypes, questioning assumptions that science is gender neutral or that women are necessarily defined by gender-related activities.⁶ Elizabeth Lloyd stated, “Scientific views about gender differences and the biology of women have been the single most powerful political tool against the women’s movements.”⁷

What do contemporary science and feminism offer artists? In many instances, contemporary science has become complex, dynamic, and receptive to holistic ideas. Ecofeminists are intrigued by ideas of cooperation in nature.⁸ As a whole,

feminism speaks of the possibility of a framework for understanding nature that is more directly related to women’s lives and experiences and that opens key dimensions of science, particularly ideas of evolution, that have been rejected or ignored.⁹ Artists are listening—and responding.

Throughout this text I identify a recent scientific paradigm about nature (shown in bold type as a paragraph heading). The next few lines provide evidence for this belief (noted in italics). I then analyze how work by each of the eight artists challenges its prior, conventional understanding. Each artist has developed a specific material form related to her understanding of how nature works. The artists stress materiality, interwoven systems, and issues of organismic growth and development that link them with ideas originating from D’Arcy Thompson’s pivotal 1917 publication, *On Growth and Form*.¹⁰ Crucially, all the artists have invented novel ways to intimate some of the interconnectedness of the world and its interdependencies. The art, whether engaging the organism, species, or ecosystem, gives rise to a collective complexity that provocatively challenges several prominent shibboleths held about nature.¹¹

I am a multitude

*Scientific research about symbionts (organisms living together) has offered proof from the gut that we are not autonomous entities!*¹²

The body’s ability to distinguish self from other (“non-self”) is essentially a definition of immunity.¹³ The immune system is traditionally viewed as a defensive network against a hostile exterior world. Haraway notes that military culture has appropriated the language of science; it calls upon discourses of immunity as metaphors for its defense strategies.¹⁴ Some feminist immunologists question whether immunological difference is necessarily a threat; they cite the importance of a variety of symbiotic activities in the gut that are critical to processes in physiology, immunology, and evolution. Today, science acknowledges that an individual’s immune system is in part created by the resident microbiome and does not function properly when mutually beneficial microorganisms are absent in the gut.¹⁵ Such organisms disrupt the boundaries that heretofore had characterized the biological individual.

In her art, the Portuguese artist Marta de Menezes grapples with ideas surrounding immunity and the biological self. In *Immortality for Two* (2014; Fig. 1), she and her husband,



Fig. 1. Marta de Menezes and Luis Graça, *ANTI-Marta Luis arm* (2018), from *Immortality for Two* (begun 2014), white blood cells of participants, oncogenes, 2 tissue culture flasks with medium and an injection of CO₂, heat lamp, microscope, table, 2 suspended video projectors connected to computer; displayed on table of variable dimensions, ca. 86 5/8" x 43 1/4" x 31". Photo: Marta de Menezes.

immunologist Luís Graça, explored the self in relationship to the non-self. They assumed the role of scientific subjects and investigated their immunological differences. The spouses exchanged skin grafts, which were rapidly rejected. The outcome was necessarily far from a conventional art form, consisting of the visible residue of transplanted skin grafts in the form of bruises caused by antibody rejection. In art terminology, the marks on the body can be thought of as indexical traces caused by the rejection of the grafts. A video in the installation documents the process involved in creating the work. The live cells were initially exhibited in the absence of any visible lab equipment and accompanied by dynamic projections of the growing cells. De Menezes points out on her website that "Only in the virtual space of their projection can the 'immortal cells' (derived from immune cells from each spouse) interact."¹⁶

De Menezes recasts issues of identity that in large part stem from defining the boundary between "inner self" and "outer world." The ways she conceives this relationship guide the kinds of forms she develops and technologies she deploys to achieve them. The technology is critical because, as Jan Sapp and his team of scientists state, "We perceive only that part of nature that our technologies permit."¹⁷ The data gleaned from current immunological and genomic tools offer scientifically adventurous artists a way to explore content previously inaccessible. For example, to implement the project *Truly Natural* (2017), de Menezes relied on data obtained from CRISPR, a genetic engineering tool that uses a sequence of DNA and its associated protein to edit DNA sequences and modify gene function. Specifically, she utilized research data from a laboratory that had edited the genome of a spontaneously mutated mouse with CRISPR-Cas9.¹⁸ With this data, de Menezes created a document of the removal of mutations selected by the process of domestication. She explored an undefined boundary between the natural and non-natural by itemizing what is involved in returning the mouse to an earlier state where no genes had been subject to man-made manipulation.

In a related vein, in collaboration with philosopher María Antonia González Valerio, she made art works charting the evolution of corn, including *The Origin of Species – Post Evolution – MAIZ* (2018; Pl. 1). She gathered genomic data about corn and created charts of its development in order to explore once again what would be scientifically involved in re-creating an organism closer to its feral state.¹⁹ De Menezes summarizes, "The silencing of a transgene by CRISPR-Cas9 creates a tension by generating a natural plant by means of genetic intervention, it questions the limits of the natural, where all crops are a consequence of co-evolution with humans.... The question about genetically modified corn is then not just about transgenics, health, agroindustry and transnational companies taking control of a huge variety of seeds. The

question is about a complex unity of corn, production, consumption and the spaces in which that is taking place."²⁰ In a brochure, she states that she selected corn because she considers it to be a bio-artefact that has long undergone domestication, and its ubiquity is intertwined with its cultural meaning.

"We are what we eat" is not a metaphor

*In the microbial world (e.g., the organisms in our guts), "you are what you eat" is literally accurate. The acquisition of new genomic material by organisms with single cells or few cells by eating is now considered a fundamental process in evolution.*²¹

Christy Rupp is a US activist artist who links systems of consumption, health, and economics and the government's role in regulating these relationships. The food web is comprised of organisms that eat other organisms. Rupp sometimes deploys

stealth tactics to call attention to this web and its attendant sanitation problems, notably trash. Art critic Carlo McCormick's attention was caught early on by Rupp's rat pictures that were pasted near piles of garbage during the 1979 New York City garbage strike. McCormick noted in discussions with the artist that Rupp commented that "as planetary cohabitants our habitats mutually influence one another."²²

My first encounters with Rupp's work were warnings to potentially be inserted by guerrilla tactics in supermarkets to inform consumers that some of the products were GMOs (she did not actually insert them). Her *Labels for Genetically Engineered Food* (1999) were made in vinyl and applied to deli containers. Her point was that the state has a responsibility to let people know what they eat.

Following her arrival in New York City, Rupp documented how we construct our ideas regarding wildlife and nature. The waste stream became her central focus. She uses a variety of media to make art, including welding, paper, wax, felt, plastics, glass, credit cards, organic bones, twigs, and cloth, and acknowledges that science is the foundation of her work.²³

Rupp draws attention to the dysfunction of nature. Her weapon is humor, which is effective at eliminating a moralizing tone. Her art is not intended to be "merely" contemplative and to promote reflection but motivational—to change behavior. As such her art ties into questions of anthropogenic environmental change. The food system raises a variety of social justice issues, including global hunger, widespread obesity, numerous health problems, environmental degradation, the exploitation of workers, and the marginalization of farmers. Control of agriculture in the Western world is largely in the hands of corporations. They often turn a blind eye to the mistreatment of animals and offer lax enforcement of dietary and health regulations for confined animals.²⁴

Feminist ethics often entail issues of vulnerability, relationality, and dependency faced by subsistence farmers. Maria Mies and Vandava Shiva have been especially vocal about these issues, and many ecofeminists take inspiration from their writings to critique the status quo and visualize a better situation.²⁵ In her art, Rupp confronts harmful conditions resulting from the food web. Her project, *Extinct birds previously consumed by Humans*, was exhibited at Frederieke Taylor Gallery (2008) in New York City, and included her powerful skeletal portraits of extinct birds made from the bones of chicken we consume. A prime example is *The Great Auk* (2008; Fig. 2).

Rupp draws a critical link between late capitalism and the food web. She critiques the industrialized global food system, calling attention to the politics of health and food and the effects of corporatization. Food-web theory has become recognized as a guide to the care of complex ecosystems,

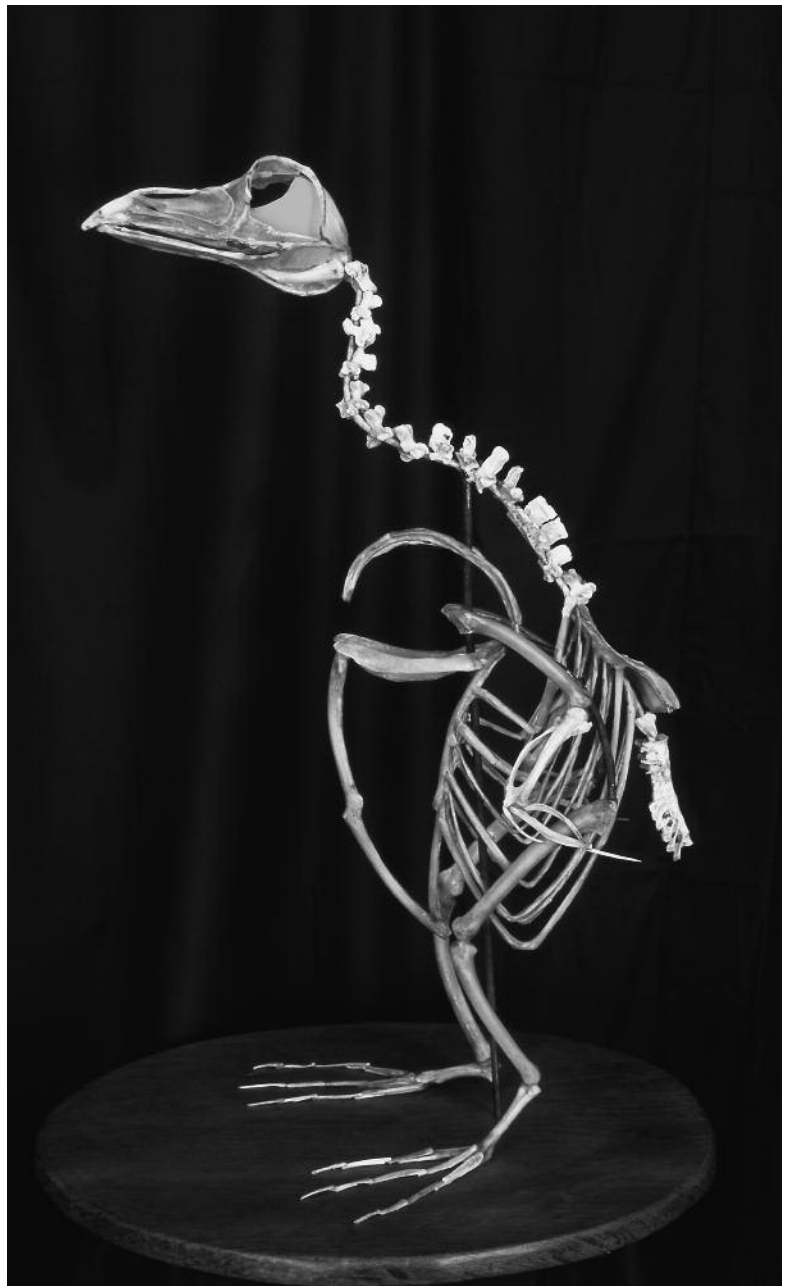


Fig. 2. Christy Rupp, *The Great Auk* (2008), from the series *Extinct birds previously consumed by Humans*, welded steel, fast food chicken bones, paper, mixed media, 32" x17" x 22". Photo: Christy Rupp.

particularly protection of species. Rupp's portrait of the long extinct auk in 2008 drives home this realization. Rupp's ongoing sculpture series, *Moby Debris* (2019–; Pl. 2) is a collection of discarded plastic made into micro-planktonic organisms. On her website she states she wanted to evoke the contents of a whale's stomach thereby invoking the food chain. Her sculptural installation *Catastrophozoic* in 2019 was replete with netting and discarded plastics. It formed a taxonomy comprised of depictions of birds from centuries of art history and captured a sense of the sprawling damage to species that is perhaps best described as rhizomatic devolution. Her



Fig. 3. Lillian Ball, *WATERWASH Bronx River* (2011–present), recycled glass, native plants, vortex sculpture
WATERWASH Bronx River RTB apprentices planted 8000 native plants, Photo: Joachim Cotton.

installation may remind us that a more apt metaphor of how life has evolved is now considered not a branching tree but a rhizome.²⁶ As Margulis and microbiologist Carl Woese elucidated, the evolution of early multicellular organisms was horizontal, through ingestion, as opposed to vertical, through descent.

More than just the fittest survive

*To the contrary, in nature cooperative processes frequently occur and enable survival.*²⁷

Throughout her career New-York-based Lillian Ball has asked us to envision what the world would be like if cooperation and play were basic features of the world. Early on, Ball created a model of cooperative interaction in the form of a game. *GO Doñana* (2008; Pl. 3) was a four-screen interactive video installation that illuminated different land use perspectives regarding the Doñana National and Natural Parks. The parks are UNESCO wetland and dune sites near Seville, Spain, whose biodiversity was threatened by a mining disaster and water shortages. Ball's goal was to use the game to introduce an art audience and members of the public to the complex issues and possible resolution of differences raised by such ecosystems.

Social scientists today elaborate frameworks in which rational decision-making is formulated.²⁸ Economists and biologists use gaming to simulate complex behavior (e.g., the Prisoner's Dilemma).²⁹ Participants act out the conflict between social incentives to cooperate and private incentives to defect.

GO Doñana and *GO ECO* are based on the ancient game of Zen Go, which uses strategies to capture territory through balancing tactics. Here is Ball's description of *GO Doñana*: "Digitally manipulated images with sound are projected on three walls . . . to make viewers feel as if they are surrounded

by the park. Viewers moving into the central square 'game board' (projected on the fourth wall) activate the video/sound viewpoints of scientists, farmers, environmentalists, landowners, and park guides. When a player stands still for 3 seconds, their 'move' is recorded by a camera sensor transmitting a corresponding one of 70 different video clips through the computer." Ball summarizes that, "The game can only be finished when both sides capture territory, a solution that enables participants to win together by working to maintain a delicate equilibrium."³⁰

Another manifestation of the GO project, *GO ECO* (2007), is informed by Ball's participation in the ongoing community preservation of an interdunal swale wetland in Southold, NY. All the GO games encourage teamwork to maintain sensitive areas. The game format allows players of many ages to be empowered and learn about the issues through an art experience that maps paths of action.³¹ The most recent iteration, *GO H.O.M.E. Bimini*, is an interactive video game about threatened mangrove wetlands in Bimini, Bahamas. It has a digital camera interface that picks up players' movements and relays them to the computer that triggers the videos. Three different versions of interactive software are used in the GO projects.³²

Ball's openness to collaborative play is manifest in an ongoing project, *Waterwash ABC* (2011; Fig. 3), for which she designed the wetland, water features, picnic area and grassland, and permeable recycled glass pathway.³³ The artist's concept is based on a prior public storm water management Waterwash project in Mattituck, NY, on Long Island's North Fork.³⁴ Ball's works embrace the goals of conservation biology to restore biological diversity and achieve success through communities working together.

A respected team of scientists (Scott Gilbert, Jan Sapp, and Alfred Tauber) pointed out that, "Only with the emergence of ecology in the second half of the 19th century did organic

systems—comprised of individuals in cooperative and competitive relationships—complement the individual-based conceptions of the life sciences....”³⁵ Ball’s art is a paradigmatic example of this hard-won realization.

Morphogenesis is considered an important evolutionary process

*Morphogenesis contradicts ideas of evolution that are primarily or solely gene based and has resurged as central to explaining how embryonic cells act in coordinated fashion.*³⁶

The fact that Janet Echelman’s sculpture is initially conceived as a soft material (netting) highlights flexibility as an operative principle. Her work metaphorically enacts a process of morphogenesis. In my conversation with the artist she noted that the works can resemble sea anemones and undergo shape-shifting in real time when acted upon by wind. In *Sculpture* magazine this polymath elaborated on her work, *She Changes* (2005; Pl. 4), designed for the cities of Porto and Matosinhos in Portugal. It is appropriately known locally as *anêmona* (sea anemone). The installation consists of three steel poles, cables, a 20-ton steel ring, and a knotted, braided fiber net of different densities and colors. Echelman’s netting initiates a range of analogies. In a forthcoming anthology about the ongoing influence of D’Arcy Thompson on the arts, I noted that as netting folds and unfolds, it can suggest phases of evolutionary development such as cell and organ differentiation.³⁷ Echelman’s distorted net also suggests an unforced relationship to a deformed grid that can undergo topological transformations, Thompson’s best-known image. In Echelman’s hands, the netting initiates a scale-free model of gridded networks. They become dynamic systems that change in the models she makes for each sculpture as she adds or subtracts new nodes and links and as she distorts the grids. Echelman taps into a foundation of complexity science; simple manipulations cause complex results.

Critic Lilly Wei perceptively noted that *She Changes* is “the not-Serra, not-monument monument.”³⁸ Echelman agreed that it is very much a feminist work and explained its genesis: “I began with the history of the site, a centuries-old fishing village that became an industrial zone in the last few decades. There are references to smokestacks and their red-and-white striped patterns, the angled masts and cables of Portuguese ships, the patterns and forms of fishing nets and Portuguese lace.” She further explained that she hoped to involve the viewer in creating a sense of a relationship that was “personified” and formed an emotional bond. The reason she cited for including support poles outside the traffic circle was to physically include the drivers within the art.³⁹

Echelman’s art responds to a given place, its history and its



Fig. 4. Janet Echelman, *1.8* (2016), initially sited in London, colored lighting, WiFi, and interactive computer programming. Fibers are braided with nylon and UHMWPE (Ultra high molecular weight polyethylene), Net: L 100' x W 45' x D 20'; installation: L 180' x W 180' ft. x H 70'. Courtesy of Studio Echelman.

characteristics, and also to the viewers. She displays an acute sensitivity to nature’s patterns and principles of growth and expresses this through siting and the handling of her materials. She explores complexity and morphogenesis, creating environments and unexpected configurations. Her works respond dynamically to the forces of water and light that surround us. The wind blows and you anticipate a new configuration.

An early work of Echelman appears to have folded back on itself to form a cavity, reminiscent to me of the process of cell differentiation. As I point out in the Thompson anthology, Echelman noted that her works may conjure Pre-Cambrian life forms, before the advent of multicellular life.⁴⁰ In conversation she agreed that she had referred to Stephen Jay Gould’s book, *Wonderful Life: The Burgess Shale and the Nature of History*, which

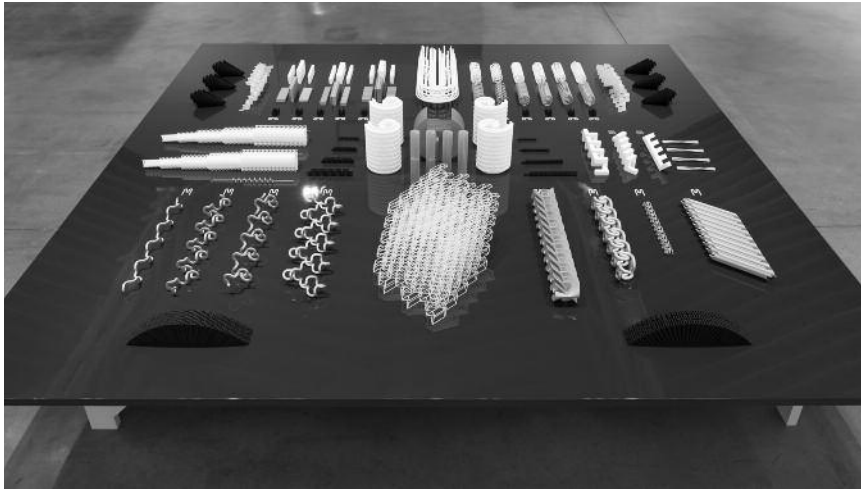


Fig. 5. Tauba Auerbach, *Altar/Engine* (2015), 3D printed nylon and plastic on table of aluminum, wood and paint, an array of 126 elements ranging from 18" x 18" x 10" to 5/8" x 1" x 2". Table: 15" x 108" x 108". Collection: The Museum of Modern Art, New York. Photo: Steven Probert.

considers questions of contingency regarding the great diversity of fossils from the Burgess Shale. Gould asks whether and to what extent the same life forms might result if the process were to recur, finding it unlikely.⁴¹ Echelman similarly courts chance in the morphing of her forms; the effects of weather interacting with her structures are unpredictable.

Echelman's *Earthtime* sculpture series (*1.26*, *1.78*, *1.8*) explores the interconnectedness of natural systems.⁴² This series of works travels the world and has been installed in over twenty cities to date. In describing *1.8* (2016; Fig. 4), which was initially sited in London, she explains that the title refers to the length of time in microseconds that the earth's day was shortened because of an earthquake that emanated from Japan and redistributed the earth's mass.⁴³ In the same online description, she states that the form of the work was inspired by data sets of the tsunami's wave heights. The sculpture was said to have surged 180 feet through the air between buildings above Oxford Circus in London before being installed at other major cities, internationally.⁴⁴ She works with a range of media professionals and materials, utilizing high-tech fibers in addition to netting. She often invites interaction, empowering spectators to alter the animations projected onto her work. Echelman's art links metaphorically with cellular processes but shown at a scale writ large, which galvanizes public awareness of issues fundamental to nature and growth. A fact sheet points out that the most recent sculpture, *Bending Arc* (2020; front cover), made during the Covid 19 pandemic is impressively composed of 1,662,528 knots and 180 miles of twine; the aerial sculpture spans 424 feet and measures 72 feet at its tallest point. According to the press release, it evokes colonies of nested barnacles. Seen from the ground, as if rising up from the earth, it is imposing, even spectacular.

Patterns found in nature are often generated by material forces

*The conventional belief is that genes produce patterns found in biological entities. It is not generally realized that such patterns are often formed from the forces that act in the physical world.*⁴⁵

Tauba Auerbach typically creates form by applying simple gestures to a variety of materials. For example, she used

broken glass as a model to create images that resemble aerial views of a network; she sprayed and folded fabrics that seemed to mimic geologic formations. Patterns akin to those caused by pressure in rock strata become manifest in the process of crumpling and folding. Referring to geologic shapes, science writer Philip Ball points out that such "structures have an inevitability about them, being driven by the basic physics and chemistry of growth."⁴⁶

The New Ambidextrous Universe, Auerbach's 2014 show at the ICA in London, explored geologic and biologic processes that involve symmetry and handedness. In *Prism Scan II (Cross Polarized Mesosiderite)* (2014; Pl. 5), she repurposed a meteorite image from a book, *Color Atlas of Meteorites in Thin Section*, that had been taken with polarized light.⁴⁷ Mesosiderites are meteorites that consist of mixtures of metal and silicates. Auerbach scanned the photograph through a section of corrugated glass and printed it. The waves in the glass subtly re-ordered the image, drawing the viewer's attention to resultant fluctuations. According to Auerbach, "The halftone of the source image is spread out and compressed periodically according to waves in the glass, and the orientation of the image flips backward and forward in each period of the wave."⁴⁸

Auerbach's investigation of "chirality" (handedness) is in keeping with her interest in polarization. Much of Auerbach's art probes permutations of symmetry. Chirality is a configuration that displays an orientation preference and often refers to the handedness of life's molecules.⁴⁹ An object or a system is chiral if it is distinguishable from its mirror image. Chirality is a property found in nature, including pinecones, quartz crystals, and snails. It is a feature of life on earth.⁵⁰

The 2014 exhibition included a collection of floor-bound forms, cut by waterjet from plywood and aluminum. They intriguingly appeared unnaturally tilted in a way that defied my expectations of wood. I recall forms in metal and borosilicate glass that were threaded, various three-dimensional structures, and plywood forms that were basically planar. *Square Helix (Z)* (2014) is a long, thin sculpture that explores the chirality of the double helix structure of DNA.⁵¹ *Square Helix (Z)* was mounted on a plinth, consisting of two metal rods in complementary colors, one orange and one blue.

A feature of chiral interactions in biology is that chirality propagates from molecular structures to supramolecular assemblies in different phases that connect to the handedness of the individual helices.⁵² By repeating related forms in different contexts and scales, Auerbach playfully captures the sense of the versatility of DNA. For example, she references *Square Helix (Z)* in a book (essentially the show's catalogue) called *Z Helix*, bound with spiral binding coils. "The book developed," she says, "around the manufacturing conventions of coil bindings (which are far more widely available as Z helices)."⁵³ In an interview with David Riley, Auerbach further discusses chirality in relation to those conventions.⁵⁴ In my view, the book binds *Square Helix (Z)* to an alternate existence in the domain of printing. Auerbach's search for variants of related forms in a variety of circumstances is apparent in *Knit Stitch* and *Latch* (both 2014) that place her recurrent form in the context of fabric design. A later work, *Chiral Fret (Meander)/Extrusion/Ghost* (2015) consists of woven canvas on a wooden stretcher that shows Auerbach's roots in drawing and the materiality of canvas.

Color is similarly diversified. In *S. Helix* (2014), she bent a glass rod and placed it on a colored plinth. The viewer could see orange, gold, pink, and yellow hues through the refraction of the glass due to the application of a "chameleon" paint. Iridescent paint creates a prism that refracts light, so the color depends on the angle it is viewed. *A Flexible Fabric of Inflexible Parts* (2015) is comprised of eleven pieces of borosilicate on a chameleon painted table.⁵⁵ For me, the optical interventions through paint recall the use of corrugated glass in *Prism Scan II (Cross Polarized Mesosiderite)* that destabilizes the image.⁵⁶

Referring to *Altar/Engine* (2015; Fig. 5) and to other works in her exhibition, *Projective Instrument*, at Paula Cooper Gallery (2016), the press release points out that the forms she uses and re-uses—the wave, the vortex, and the helix—resemble underlying structures in the natural world. It also states that each element begins with the structure of a helix; iterations are distorted; rotationally symmetric patterns are crossed, interlaced, twisted, and then extruded multiple times.⁵⁷ This inventive artist typically exploits fundamental but little-known principles of form that result in patterns that mimic the growth and development of living forms in nature.

Trees communicate

*The conventional belief is that plants do not meaningfully communicate. To the contrary, they have been shown to communicate through the air, by releasing odorous chemicals called volatile organic compounds (VOCs), and through the soil, by secreting soluble chemicals into the rhizosphere and transporting them along thread-like networks.*⁵⁸

María Elena González constructed an ear labyrinth in 1989 using acoustic material that proved prophetic of her later work in its emphasis on touch and sound. Immersed in the woods during an art residency, she found inspiration while walking trails, encountering varieties of trees, and forging connections with the natural world. Like native peoples before her, González saw

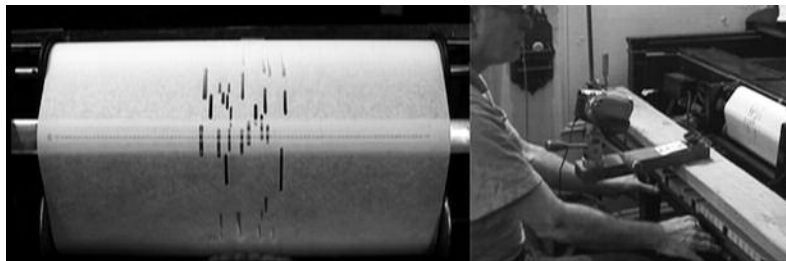


Fig. 6. María Elena González, *Skowhegan Birch #1* (2012), split screen video with sound, running time: 00:06:24. Photo: © María Elena González. Courtesy of the artist and Hirschl & Adler Modern, New York.

potential and beauty in bark. Native Americans early recognized its use as a building material and frequently incorporated the outer bark of white (paper) birch, with which they made canoes and wigwam covers.⁵⁹ González transmuted the numerous fissures of birch bark into rubbings and drawings that were then turned into "scores" for player pianos. Her art embodies an exquisite "attunement" to nature, itself, in its imaginative exploration of the sounds fissured bark might make.

A description issued by the Minnesota Historical Society states that birch bark is composed of cellulose and lignin, with small amounts of waxes and oils. The way a tree grows creates the patterns seen in the grain of the wood. The wood thickens and pushes against the surrounding bark. The growth of the inside of the tree outpaces the outside layers that begin to split. Bark textures can be explained as adaptation to the resultant pressure; the fractures of different species produce characteristic patterns.⁶⁰

González endows trees with a voice. Her series *Tree Talk* was inspired by her encounter with a fallen birch tree in the woods of the summer artist colony, Skowhegan School of Painting and Sculpture in Skowhegan, Maine. After collecting and flattening the bark, for works like *T2 (Bark)* (2015; Pl. 6), González "then scanned its striated patterns to see what kind of sounds would result. I then digitally translated the bark patterns and had them laser cut into a roll for a player piano. When played, the scroll has an unexpected "score": the phrasing, polyphony, and rhythms seem deliberately composed and modern."⁶¹

Through carrying out this novel process she claims a synesthetic moment in which she foregrounds the interconnectedness of the senses shared by nature and humans. Her work reminds us that nature and music are connected in their origins and permeate each other. Early in history, flutes were made of bone or mammoth ivory. The artist forms a poignant contrast between an old technology (the player piano uses a binary system) and the natural tree markings that inspire the installation. González captures the universality of the project by forming an analogy between physically scoring the birch tree and mentally scoring its music. It reminds me of the analogy made between Leonardo da Vinci's depictions of tree branches and blood vessels. González notes the symmetric relationship of cylindrical tree trunks to the similarly shaped piano roll. The information

González gleans from measuring the bark intervals are transformed into a pattern of holes on rolls of paper, like birch bark, also a tree product. When air is sucked through the hole in the paper, the vacuum lifts a corresponding membrane, which opens a valve, which closes a little bellow in the player piano. Pedals or electrical impulses drive the bellows. The sound ranges from melancholy to rousing as in a John Philip Sousa marching band. The inclusion of the image and sounds of a player piano in her installation via video transforms her project into something akin to a Rube Goldberg machine (2012; Fig. 6). Data about geometry, placement, and intervals passes from the physical world of the trees to the mathematical world of sound. Whereas many artists create records of their art production in the form of data, González also makes recordings, thereby illuminating the process of linking one medium to another. Each tree has a personality that González strives to capture with velum collages and rubbings made from the bark. A subtext of González's art is the evolution of music from its basis in sounds in nature; another is the synesthetic connection between visual and aural senses. Unsurprisingly, González finds affinities with author Richard Powers's novel, *The Overstory*. Powers draws connections between acoustic biology and the communication of trees; trees speak in his masterwork.⁶² In related ways, both Powers and González re-invent nature as culture.

Feelings are critical to the ability to self-regulate

*Older science viewed homeostasis as working mechanically, like a thermostat.*⁶³ Neuroscientist Antonio Damasio's investigations of the brain show that "feelings" accompany homeostasis, which offer an organism a great advantage in monitoring its internal state.⁶⁴

Victoria Vesna's 2016 project, *Noise Aquarium* (Fig. 7), aims to heighten our awareness of environmental dysfunction caused by humans, in particular the effects of microplastics and underwater noise upon plankton species that live in the depths of the ocean.⁶⁵ Self-organizing systems maintain the system in typically preferred states. In response to imbalance from noise, physiological organisms must restore their internal balance (homeostasis).⁶⁶ *Noise Aquarium* establishes a scenario where people may choose to enact and become implicated in a form of organismal disruption. To do this, Vesna creates an installation in which virtual marine organisms projected on a screen respond negatively (e.g., withdraw) in response to the movement of viewers who also cringe at the commotion caused by sounds of fracking, sonar, and other anthropogenic frequencies. One person at a time gets up on the interactive pedestal and tries to center one of the plankton species enlarged many times. If the participant interacting in the work manages to center themselves and be completely still, the plankton comes forward in full enlarged view, the noise recedes and, according to Vesna, "we hear the call of the whale—gratitude to the bottom from the top of the food chain."⁶⁷

By eliciting these responses, she causes humans to re-enact impulses they share with organisms. Her installation points to commonalities and empathy felt among all species. In this way, her installation helps promote human awareness of

environmental policies on communities of organisms with which we share related impulses.

Homeostasis was originally viewed (and is still viewed by many) as the efforts of an individual organism striving for a balanced state essential to well-being. Author Siri Hustvedt points out that Damasio recasts homeostasis as far more than an individual activity. It is a social regulator that helps communities of species with nervous systems and therefore some form of affect to survive.⁶⁸ The traditional scientific concept of emotion has been turned upside-down in recent decades. Emotion and affect were once regarded as "qualia" that could not be measured and were therefore of mostly speculative value to science (e.g., the difficulty of trying to convey the "hotness" of bath water). As a feminist and artist, her contribution to the scientific research on noise pollution is emotional, intuitive, and empathetic; she imaginatively focuses on an understanding of noise disruption from the point of view of the *invertebrate*.

To me, *Noise Aquarium* is in a see-saw balance with an earlier project of hers, *Nanomandala* (2004; Pl. 7), which linked the visible world, a meditation ritual, and the invisible nanoworld. Vesna collaborated with nanoscientist James Gimzewski to create an installation consisting of a video of a Tibetan sand mandala, the "Chakrasamvara," projected onto a disk of sand. With a nod to *Powers of Ten*, the 1977 video by Charles and Ray Eames, in her own video, Vesna shows the scale of sand increasing from molecular to a large field that comprises the entire 8-foot diameter mandala, with three views: photographic, optical microscopy, and, finally, beyond the visible realm with the Scanning Electron Microscope (SEM).⁶⁹ The actual physical sand mandala was made by Tibetan Buddhist monks.⁷⁰ Their chanting seemed to foster a calm, meditative state among the viewers. A decade later, in *Noise Aquarium*, Vesna recreates an immersive situation of the *Nanomandala* but with added complexity where the audience has to struggle to find the balance and that shows that we are all implicated in the noise. By staging a simulation of the effect of noise on underwater invertebrates, she helps people to viscerally understand its threat to achieving bodily equilibrium (e.g., homeostasis).

The project as a whole was motivated by research indicating that anthropogenic noise such as sonar is a major global pollutant. Data collected by scientists show that noise negatively impacts the behavior and physiology of individual invertebrates as well as causing disruptions to the community.⁷¹ Noise pollution disrupts food webs; most underwater species are invertebrate and fulfill important functions of pollination, decomposition, and the release of nutrients. The hearing of marine invertebrates is related to the detection of pressure waves through thin membranes (tympana).⁷² Acoustic noise can damage flagellar structures like hairs or antennae. In a brochure of the project, Vesna speculates about the impact of noise on plankton, which was not known at the onset of the project but has since attracted more attention.⁷³

Life's origins are unknown

Life's origins are still unconfirmed, but recent scientific studies



Fig. 7. Victoria Vesna, *Noise Aquarium* (2016-present), sound system and animated 3D-models obtained with scientific imaging techniques of the extremely diverse plankton spectrum. Team credits: Dr. Alfred Vendl (imaging), Martina Fröschl (animation), Dr. Stephan Handschuh (3D visualization), Glenn Bristol (programming), Ruth Schnell (dynamic projection), Dr. Thomas Schwaha (animal morphology), Paul Geluso (sound recording). Photo: Glenn Bristol.

present several promising hypotheses.⁷⁴ Physicist Jeremy England has developed a formula that indicates that when a group of atoms is driven by an external source of energy (like the sun or chemical fuel) and surrounded by a heat bath (like the ocean or atmosphere), it will often gradually restructure itself in order to dissipate increasingly more energy. This could mean that under certain conditions, matter inexorably acquires the key physical attribute associated with life.⁷⁵

To understand essential mysteries such as time, photography became a central resource and remains so for Rachel Sussman. Photography enabled Eadweard Muybridge to determine that all four of a racehorse's hooves leave the ground while galloping. It enabled others to document how life ages at regular intervals. Sussman photographs the *Oldest Living Things* (2014) that consist of millennia-old organisms that would resist time-based documentaries of either rapid movements or life cycles.⁷⁶ Her subjects are found in extreme environments such as the permafrost and will long outlive most cameras.⁷⁷ Certainly the subjects that Sussman portrays raise questions about

hardiness and survival, but, most importantly these subjects enable her to probe the beginnings of life.

In 1953, Harold Urey and Stanley Miller showed that organic molecules (in this case amino acids) could be created from inorganic materials by natural environmental conditions, without the mediation of enzymes. This resulted in new thinking about life's origins.⁷⁸ Some astrobiologists speculate that microbes able to subsist at extreme conditions (and appropriately called extremophiles or lovers of extremes) might offer answers about how they survive via chemosynthesis. Indeed, many of the shapes Sussman documents arise by chemical and physical principles seemingly related to Urey and Miller's 1952 experiment.

Sussman searches out the fossilized remains of complex marine microbial ecosystems called stromatolites (2014; Pl. 8) in Western Australia. They are communities that are part-algae and part bacteria that are known as autotrophs (self-feeders). To make a living, they survive by harnessing carbon from carbon

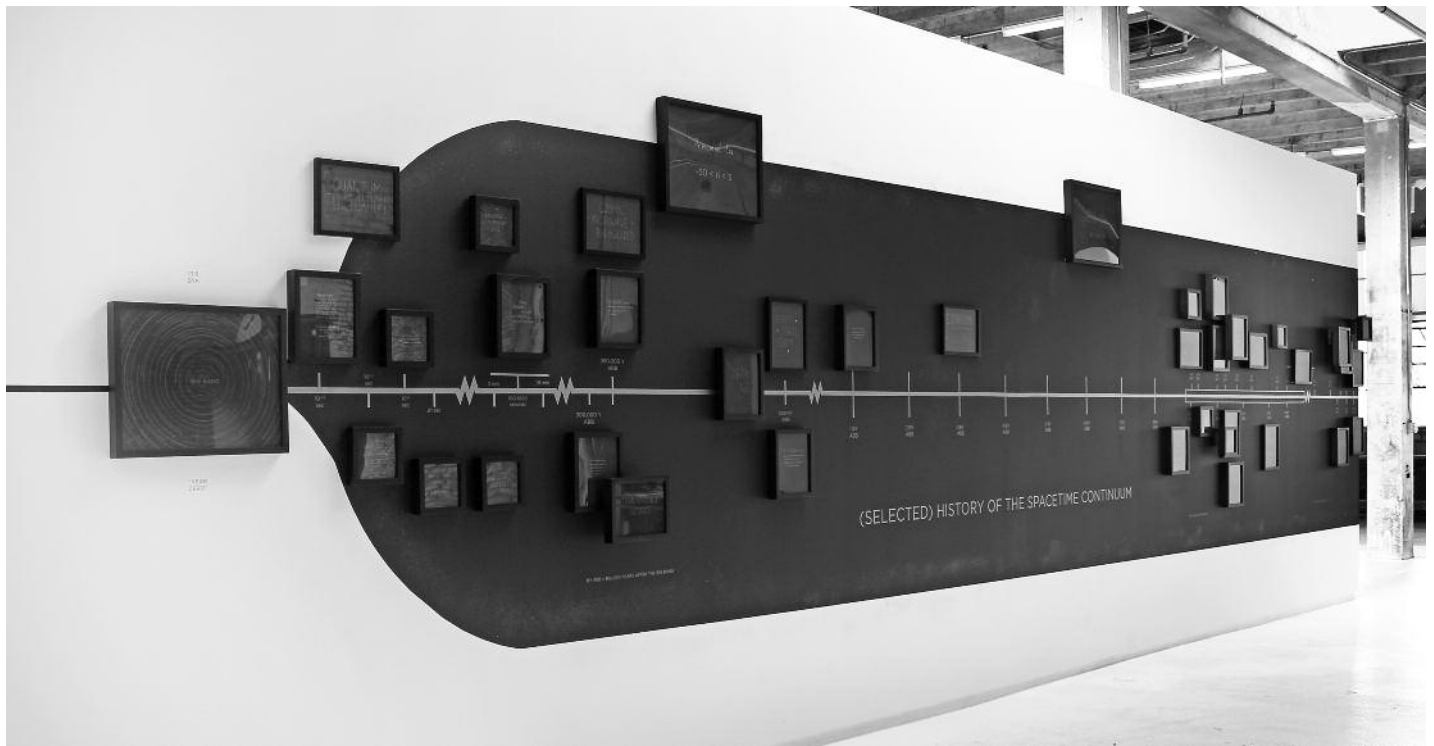


Fig. 8. Rachel Sussman, *A (Selected) History of the Spacetime Continuum* (2016), paint, china marker, paper, glitter, vinyl, L 100' x H 10'. Photo: Rachel Sussman.

dioxide in the atmosphere.⁷⁹ Other feeders known as heterotrophs (this includes you and me) do not photosynthesize, but feed off the autotrophs and consume second-hand organic compounds.⁸⁰

Her quest takes Sussman to Siberia, another extreme location, to photograph a soil sample containing actinobacteria living under the permafrost. These bacteria are between 400,000 and 600,000 years old and are still active; they conduct DNA repair at temperatures below freezing.⁸¹

Sussman's photographs of 2000-year-old whitish brain coral off the coast of Speyside, Tobago, show a spherical shape that is grooved to capture prey. The coral resembles brains because, for different reasons, both need to increase the proportion of surface-layer to total mass in order to provide more surface area.⁸² In her book, Sussman portrays the coral and many other survivors in their environmental niches in such a way that their forms intimate how they came to have their shapes.⁸³

Sussman continues an investigation into time, longevity, and the origins of life in the cosmic arena. I am tempted to define this artist as an extremophile, herself, on the evidence not only of her projects, involving the origins of time and space, but due to her sustaining a long art residency at SETI (Search for Extraterrestrial Intelligence). The program is defined by a quest to find signals of life (biosignatures) in the cosmos and allies Sussman with astrobiology's goals. One such project is a handwritten timeline of the universe in her exhibition, *A (Selected) History of the Spacetime Continuum* (2016; Fig. 8). The timeline starts before the Big Bang and extends

billions of years into the future. I saw the work in a 2016 exhibition curated by Denise Markonish, *Explode Every Day: An Inquiry into the Phenomena of Wonder*, at MASS MoCA. Among the entries in Sussman's timeline was a handwritten annotation about a major extinction event "that results in the death of 99% of all species." This was followed by another annotation that states, "Tidal acceleration moves the Moon far enough from Earth that Solar Eclipses are no longer possible." Her work terminated in a "Dark Era" where the universe becomes dead. The timeline's visual focus is on intervals, juxtapositions, configurations, and sequences, all of which interact with the text and the viewer's interpretation.

While each of these artists primarily focuses on one main aspect of nature in any given project, the works point to co-dependencies among multiple systems. For example, the works of de Menezes and Rupp implicate intertwined systems of food, politics, and ecology. They make visible the downsides of mercantile capitalism and industrialization, which are connected intimately to our use of natural resources.⁸⁴ Some of the artists (e.g., Rupp and Ball), but not all, would meet a strict definition of ecofeminism throughout their careers with regard to remediation and/or activism. Ecofeminism, itself, offers a significant critique of problematic dualisms and addresses the advantages of cultural diversity to achieve its aims.⁸⁵ Many of the works that have been discussed may make us more aware that all life is impacted by the loss of water and food quality, by degraded habitats, and by anthropogenic global warming; all the works encourage environmental reflection and response.⁸⁶ González and Vesna explore a powerful

synesthetic, spiritual link between nature and culture that is under threat. Echelman and Auerbach explore the uncanny basis of morphology and form generation based on living systems, and they work with the stuff which comprises these systems. Sussman explores time and the origins of life as a function of an organism's material being but also as a profound mystery that calls for preservation. All artists discussed in this text have brought materialist, ethical, and philosophic concerns into scientific areas previously little-explored through art. Their thinking is in line with feminist materialisms that integrate conceptions of agency and embodiment as explored by Karen Barad, Jane Bennett, Diana Coole, Samantha Frost, and, more recently, Linda Weintraub among others.⁸⁷ The artists refute boundaries, borders, and dichotomous views of nature, instead viewing human culture and nature as interwoven.

Current science views evolution itself as far from a fixed entity. Scientists are actively investigating the cellular processes that regulate gene expression and profoundly affect biological properties in the expanding field of epigenetics that studies heritable changes not resulting from alterations in the DNA.⁸⁸ The point is that as new understandings of nature based in reality are validated and as shibboleths are cast aside, they raise critical new questions. Keller says, "A healthy science is one that allows for the productive survival of diverse conceptions of mind and nature and of correspondingly diverse strategies. In my vision of science, it is not the taming of nature that is sought, but the taming of hegemony."⁸⁹ This is also true of art. In my own view, the different artistic approaches serve collectively to re-examine our place within nature and make a bid to attentively and urgently consider how we can better create a healthy future. Diversity based in knowledge and reflection may help us glimpse the holistic nature of the world and its potentialities. ●

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Notes

My profound thanks to members of the EcoArts Listserve and Ecoartspace for pertinent discussions of ecofeminism.

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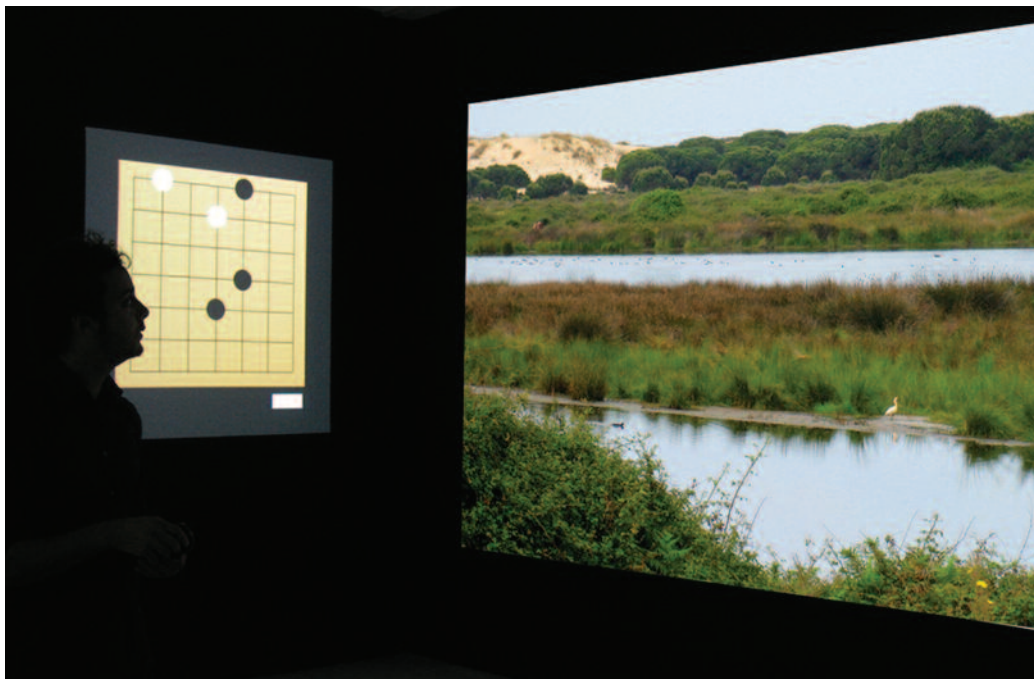
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Pl. 1. Marta de Menezes and Maria Antonia González Valerio, *Phylogenetic Tree of MAIZ from Origin of Species - Post-Evolution - MAIZ* (2018), CRISPR-Cas9 data from Saibo Laboratory, wall chart of variable dimensions. Credits: Dr. Nelson Saibo, Principal Investigator at Plant Gene Regulation Laboratory, ITQB, Portugal. Photo: Marta de Menezes.

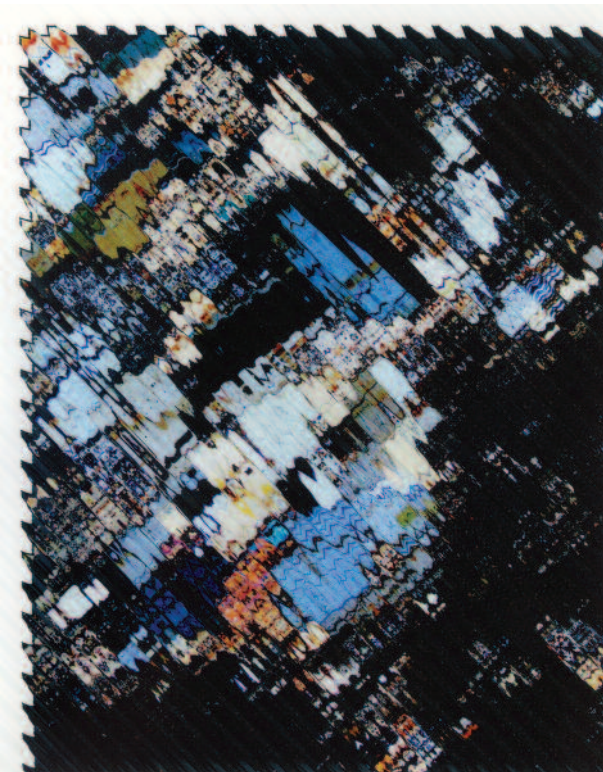
Pl. 2. Christy Rupp, *Moby Debris* (2019), detail of 5 of series of 20, plastic, welded steel, each about 14" x10" x 4" wall mounted. Photo: Christy Rupp.



Pl. 3. Lillian Ball, *GO Donãna* (2008), multimedia interactive installation with projectors, dimensions variable, ideally shown in 236" x 314" room. Photo: Lillian Ball. Courtesy of the artist and Fundacion Biacs.



Pl. 4. Janet Echelman, *She Changes* (2005), Waterfront, Cidade Salvador Plaza, Porto and Matosinhos, Portugal, painted galvanized steel and knotted, braided fiber, dimensions of net: L 150' x W 150' x D 80'; installation: L300' x W 240' x H 160'. Credits: Studio Echelman Team— Philip Speranza (Design Support), Engineering: AFA Consult (Porto), Aeronautical Engineering: Peter Heppel Associates (Paris), Architect: Eduardo Souto Moura (Porto). Photos: Joao Ferrand, David Feldman, Daniel Coulon.



Pl. 5. Tauba Auerbach, *Prism Scan II (Cross Polarized Mesosiderite)* (2015), C-print, 55" x 44". Photo: Steven Probert. ©Tauba Auerbach. Courtesy Paula Cooper Gallery, New York.



Pl. 6. María Elena González, *T2 (Bark)* (2015), birch bark, tape and permanent marker on cardboard, 57" x 483". Photo: ©Jaka Babnik. Courtesy of the artist and Hirschl & Adler Modern, New York / MGLC Archive, Ljubljana, Slovenia.



Pl. 7. Victoria Vesna in collaboration with James Gimzewski, *Nanomandala* (2004), Video, sand mandala, optical microscopy and a scanning electron microscope, 8' diameter table, 8" depth for sand, raised 18" (speakers go under) for the projector. Size depends on the height of the ceiling, display computer, projector, color surveillance camera, Photo: Victoria Vesna.



Pl. 8. Rachel Sussman, *The Oldest Living Things in the World* (2014), Stromatolites #1211-0512 (2,000-3,000 years old, Carbla Station, Western Australia), Photo: Rachel Sussman.