ABSTRACT

Echoed Plexus

by

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May 2013

Director: Beth Blake

School of Art and Design: Painting and Drawing

This is a report of a creative thesis to complete the Master of Fine Arts degree at East Carolina University. The body of work presented focuses on the scientific theory of emergence as a connection between the structures of forms from the microcosm to the macrocosm. The work includes visual depictions of the micro and the macro created using both the Scanning Electron Microscope and the traditional methods of drawing and painting. These are metaphors for the duality of the idea of self as an immense and intricate system of millions of complex functions as well as miniscule cell within an infinite expanse of presence and instance.

Echoed Plexus

A Thesis

Presented To the Faculty of the School of Art and Design

East Carolina University

In Partial Fulfillment

of the Requirements for the Degree

Masters of Fine Arts: Painting and Drawing

by

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“The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires.”

William Arthur Ward

I would like to thank my family for your unflagging support and encouragement. I would also like to thank my mentors both old and new for passing on your insight.

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INTRODUCTION

"All religions, arts and sciences are branches of the same tree. All these aspirations are directed toward ennobling man's life, lifting it from the sphere of mere physical existence and leading the individual towards freedom."

Albert Einstein, "Moral Decay" *Out of My Later Years*, 1937

We as humans often navigate through our daily activities unaware of the vast number of organized structures that exist exceptionally far away from us, all around us, and even within our bodies. These structures and their functions are beyond the capability of our senses to observe. However, despite the limits of our vision, we continue to seek ways to comprehend what we cannot see. One way of understanding what we cannot perceive is through the invention of technologies that extend our sense of sight in order to visualize what our eyes are incapable of detecting. Another way that humans attempt to understand the unknown is through perception. We piece together information from several sources within our brains in order to connect and interpret raw data into meaning.

The duality between the microcosm and the macrocosm, realism and abstraction, and observation and interpretation are integral to my thesis work. The body of work consists of a series of 12 drawings organized into a grid to create a 7.5' x 15' unified whole accompanied by a set of smaller scale images taken from a Scanning Electron Microscope installed opposite the large drawing. This body of work represents an attempt to integrate balance between

technology as a metaphor for sensing, abstraction as a metaphor for interpretation, and humans (the viewer, or myself as artist) as a metaphor for the balance between the microcosm and the macrocosm.

CONTEXT: TECHNOLOGY AS METAPHOR FOR SENSING

For millennia, humans have depended to a large degree on the five senses for all observation and perception of physical reality. In the last 500-600 years, technologies have been developed that enable the extension of those senses in order to perceive an infinitely larger understanding of the existence of structures from the microcosm to macrocosm (Amato, 16). The invention of the magnifying glass in the thirteenth century enabled observation of objects at 10x magnification (See it Bigger). From that point on, observational technology has rapidly and exponentially expanded. Today, we have the privilege of extended senses through technologies such as microscopes, x-rays, telescopes, sonar, thermal imaging, and advanced computer modeling. Using these and other technologies, humans now have the ability to see through walls, out into space, and into the microscopically minute.

Before the advent of microscopic technology, the human eye could barely observe anything smaller than a grain of salt, measuring in at 0.5 millimeters. Light microscopes allow us to see red blood cells at 8 micrometers, and bacteria at about 500 nanometers. Viruses, measuring anywhere from 200-300 nanometers can be viewed with an electron microscope. Very powerful electron microscopes can even image molecules and atoms (Goodsell).

Because of these new technologies, scientific observation and discovery rely heavily on the visual information that is generated, and that information is beginning to blur the lines between scientific observation and art:

> …the inventors and scientists who have been devising and using the tools behind this new way of envisioning the world are creating portraiture of nature. Go to their offices and labs, attend their conferences, read their journals, and you can't help but notice how image-driven so much of science has become. For most of the scientists themselves, these images serve primarily as information…yet many of these same investigators evidently see something more. Why else would they frame their data and hang it on their walls? (Amato, 16-17)

Scientific imagery is being created and displayed similar to the way art has historically been created and displayed. The elements and principles of design have become an aesthetic consideration as scientists compose and colorize electron micrograph images to create contrast and emphasis. Fernan Fedrici, a molecular biologist from the University of Cambridge, is an excellent example of a scientist who has won aesthetic awards for his imagery (see figure 1). His scientific work includes engineering communications between bacteria and plant cells (Agapakis). Not only does he compose his bacterial scans using gestalt principles and select bacteria types based on color theory, Fedrici is now in collaboration to alter the growth of bacteria in such a way as to control how cells interact. These controlled bacterial interactions create patterns of color in their growth, resulting in an aesthetic of rhythm and movement using bacteria instead of paint (Agapakis).

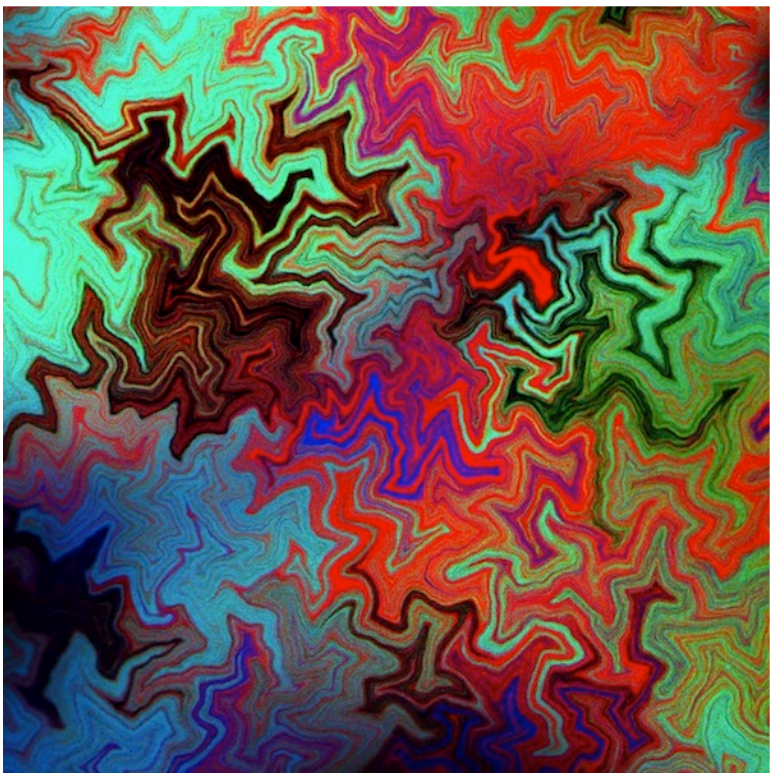

Figure 1: Fedrici, Fernan. “Psychedelic Bacteria: fluorescent Bacillus subtilis”. Non-edited microscope image of bacterial growth patterns.

Just as scientists are using observational imagery as aesthetic rather than purely informational tools, many artists have incorporated the tools of scientific observation as an aesthetic catalyst. With the advent of the microscope, a new visual language was created, Biomorphic Abstraction, or abstraction utilizing the shapes and forms of microscopic organisms. Using the technology of the compound microscope, scientists such as Ernst Haeckel and C. G. Ehrenberg made drawings of their microscopic observations in the late 19th century. Although Haeckel considered a career as a landscape painter, he decided on a career as a scientist. Haeckel’s drawings were constructed as scientific tools in order to understand the structure and function of unicellular organisms known as protozoans (Eibl-Eibesfeldt, 19). Although it is widely agreed upon that Haeckel’s

drawings are aesthetically pleasing (his drawings were reproduced in a book titled *Art Forms in Nature, 1904*) the purpose of his creations were to relate scientific knowledge (see figure 2). Haeckel's work was intended to represent:

> ...reason and objective understanding, which, through unbiased observation and experimentation are employed to investigate the laws of nature that underlie the innumerable manifestations of animate and inanimate nature; (Eibl-Eibesfeldt, 19)

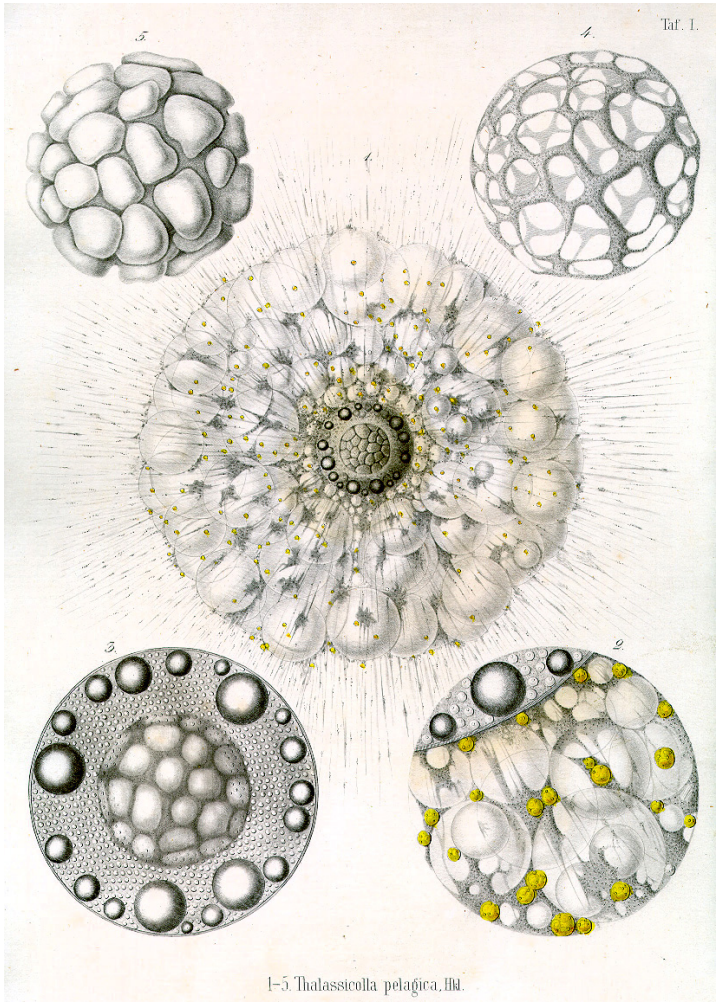

Figure 2: Haeckel, Ernst. "Die Radiolarien: Rhizopoda Radiaria." 1862. Copper Intaglio Print.

At the time in history in which these drawings were published and publicized, the visual language of the curved, flat forms of prepared slides made its way into the aesthetic language of the visual arts, more specifically inspiring the movement of Art Nouveau (Gamwell, 47-48, see figure 3).

Figure 3: Victor Horta, Interior of the Tassel House,1893.

Biomorphic form has persisted in informing abstraction into the present. Internationally recognized artist Ross Bleckner continued this tradition into the nineteen-nineties, painting shallow fields of color that resemble still lives of light

microscope images of cells beneath glass slides (see figure 4). Ross Bleckner is an artist living with the AIDS virus; painting using a microscopic language was a way to come to terms with an eminent mortality related to a disease that is incredibly invisible. Bleckner talks about a specific period of time when his painting was geared toward:

> …making extremely realistic pictures about what it means for cells to divide…and it's really a membrane. And when you think about it, that membrane is a one cell thick membrane between what's normal and what becomes abnormal (Big Think).

Figure 4: Bleckner, Ross. "In Sickness and in Health". 1997.

Even more contemporary than Bleckner's work are the process-oriented practices of artists who claim their work to be "pseudo-scientific" meaning that they create work using a process of mathematical rules, resulting in images the artist deems aesthetic. Casey Reas is one good example. Aided by computer technology, Reas utilizes the process of software algorithms to create images of growing forms that mimic the evolutionary processes of nature. These forms are projected from the ceiling of the gallery onto round substrates on the floor that mimic Petri dishes (see figure 5). Reas' work is not a reproduction of a growing organism, but what Reas might describe as an actual growing organism that follows the rules of emergent order (Rothenburg, 255-56). Emergent order, or emergence, is the scientific evolutionary idea that natural forms, either animate or inanimate, begin with randomness. This randomness is organized into complex systems when given an input of energy. For example, when baking bread a number of ingredients with no previous relationship are mixed together and put into a hot oven. During the process of baking, the product of bread forms from the mixture. The theory of emergent order allows for the idea that simplicity moves forward to complexity. Otherwise, what exists is entropy or a descent into chaos.

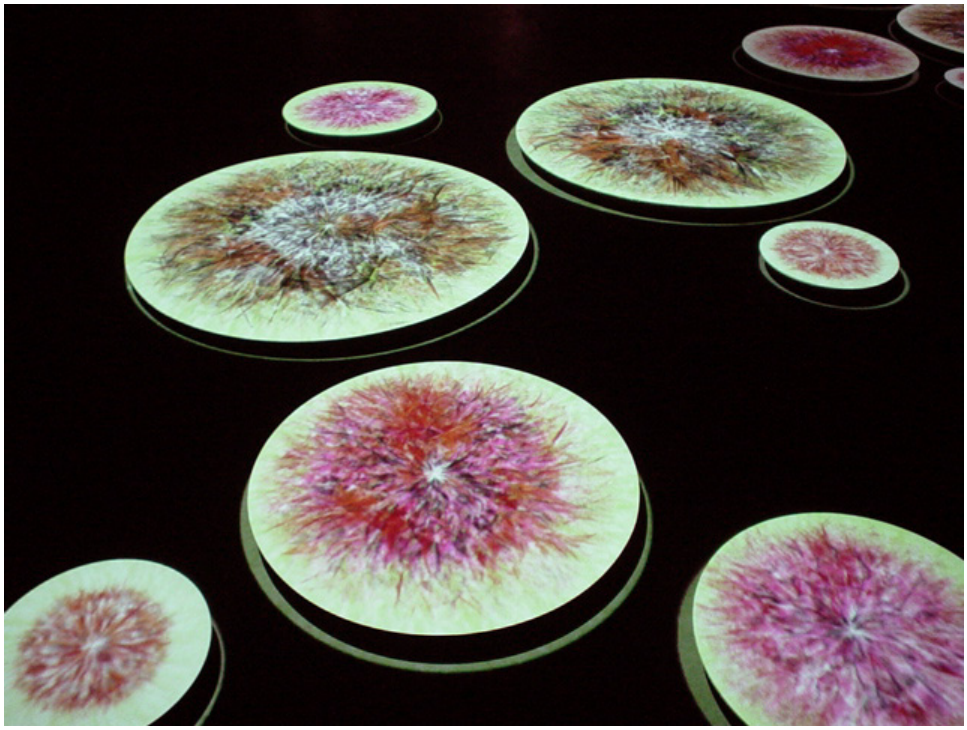

Figure 5: Reas, Casey. “TI installations at the BANK gallery and Telic” 2004.

My work shares a visual relationship with the biomorphic forms of microscopic imagery and a conceptual relationship with algorithmic processes. However, unlike Bleckner, who reproduces the biomorphic or Reas, who uses the rules of emergent order to generate new organisms that follow the rules of evolution, I am interested in creating abstractions that merge the distance between the microcosm and the macrocosm. This amalgamation includes the observation of natural forms, the controlled yet chaotic process of emergent order, and the concept of the consistent visual relationship between the micro and the macro.

Organized forms of branching, mesh-like structures can be observed in nature at every scale. The universe seems to function as Russian nesting dolls, each structural network lying within a similarly formed network. For instance, at

the micro scale, cells are patterned into branching systems within the body that grow and divide. That same body is formed in layers of branching systems such as the circulatory, nervous and lymph systems. Similarly, humans organize themselves into branching systems of settlements that grow and divide (see figure 6). Even the cosmos seems to be organized on a macro scale of branching systems of galaxies that are continually expanding. Each system from cellular division, to human population and movement, to large-scale formation of galaxy clusters expands, divides and repeats (see figures 7 and 8).

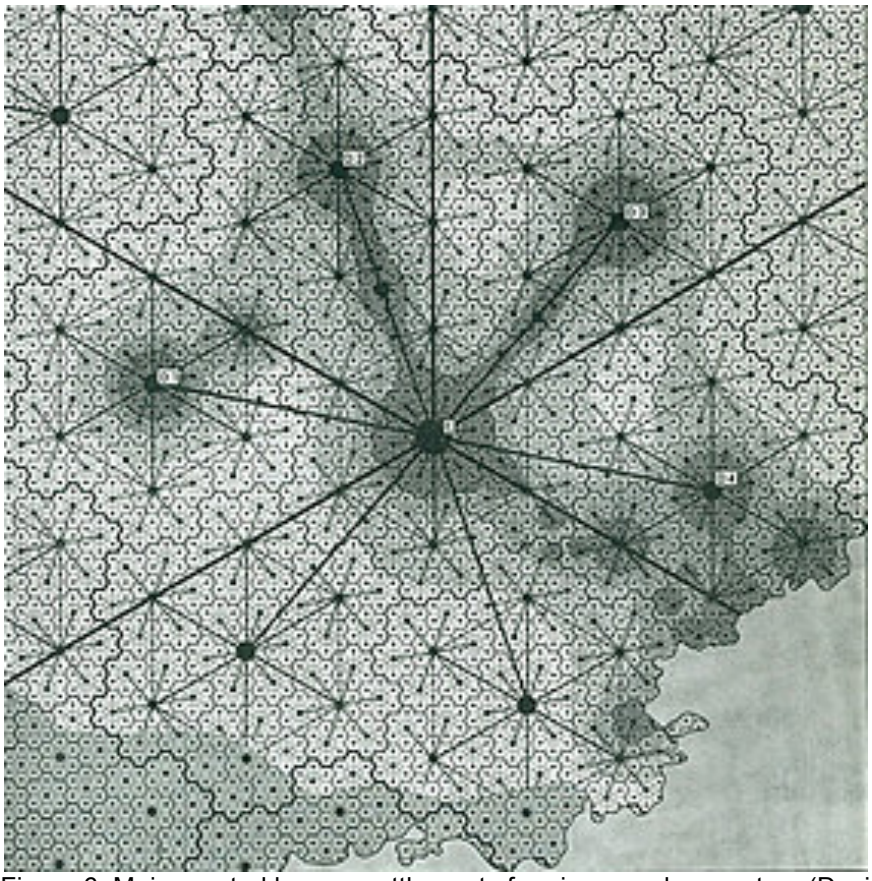

Figure 6: Major central human settlements forming an urban system (Doxiadis).

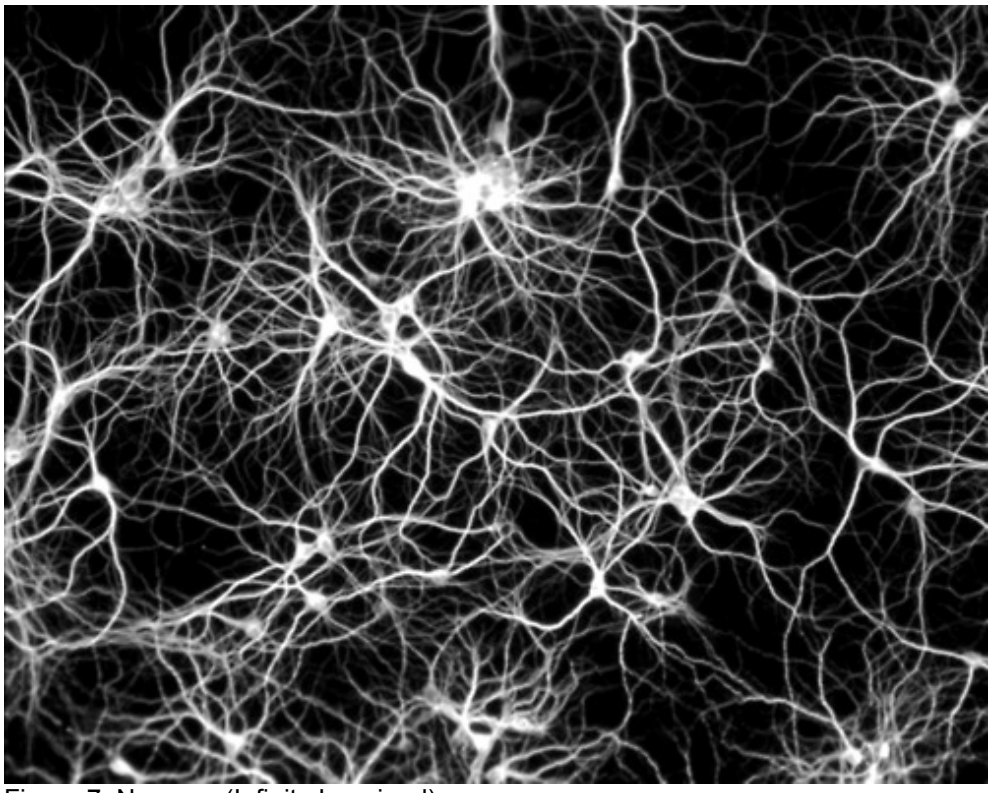

Figure 7: Neurons (Infinity Imagined).

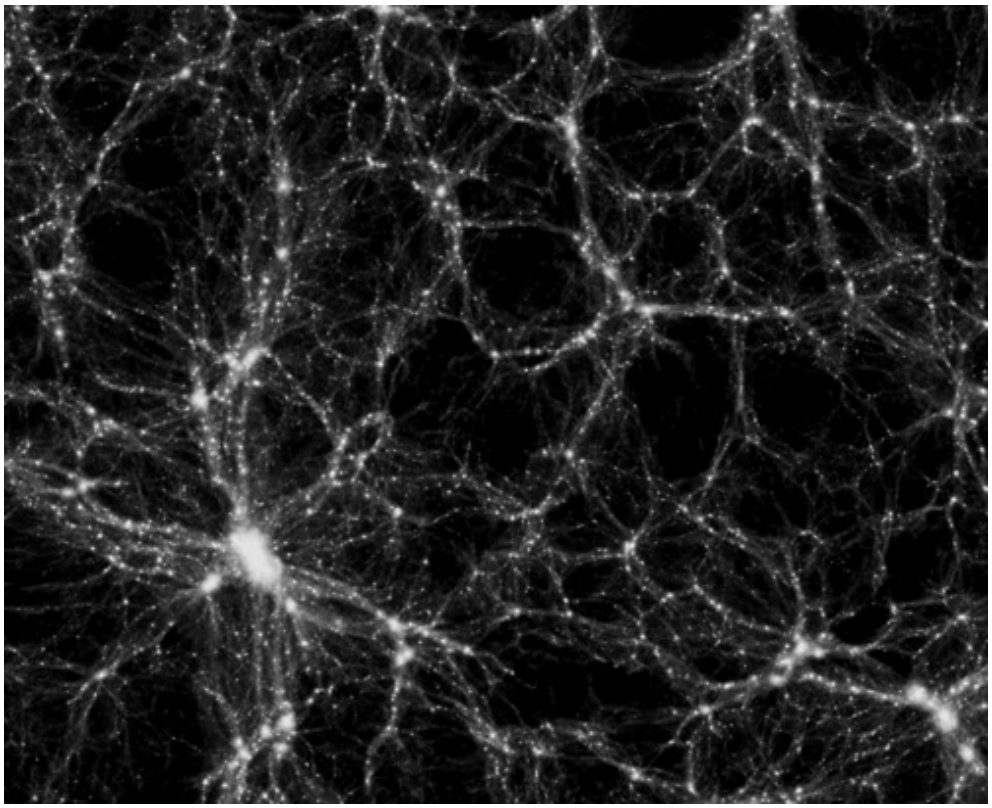

Figure 8: Galaxy Clusters (Infinity Imagined).

PROCESS DEPICTING CONCEPT:

ABSTRACTION AS INTERPRETATION OF SCIENTIFIC TECHNOLOGIES

The intention of my work is to simultaneously create areas of ambiguous space that seem miniscule as well as expansive in order to place humans at a relative midpoint within the context of an enormous existence of networks. Sources such as electron micrographs and galactic maps are catalysts for the reinterpretation of spaces that are indicative of similar topographies that differ tremendously in scale. The work imitates my view of myself as an immense and intricate system of millions of complex functions as well as a miniscule cell within an infinite expanse of presence and time.

Scientific technologies are the tools I used in order to imbue a visual language of the duality of these views. Science is a system of gathering information in a way that tests, theorizes, and retests. Scientific “answers” are continually modified as time goes by and collective knowledge of the universe increases. Microscopes and telescopes are just two such tools scientists use to help them understand the previously unseen and unknowable. Technologies within the scientific community continue to develop in order to create a greater and greater awareness of our environments, yet there is still much undiscovered and unknown by us as humans. We currently exist within a period in history in which we continue to have an exponentially clearer glimpse into the infinite limits of space. In the blip of the last one hundred years, biologists have discovered

and then structured DNA, and astronomers have discovered an infinite number of galaxies beyond the Milky Way.

As scientists use technology to make farther reaching discoveries, the more there seems to be an infinite amount of existence within the universe stretching in both directions from our midpoint perception of human scale; into the micro and outward to the macro. Yet with all we know, we are still not sure what percentage of the cosmos we as human beings occupy. Imagery that references science and technology have become symbols within my work for a quest for understanding the unknown on every scale, as an individual seeking self-awareness and as a member of a collective community of humans seeking to understand our environments and where we fit within all that surrounds us.

The duality between what can be understood as the observable “as is” in a scientific sense and what can be dictated as perception is demonstrated in my use of the technological method of microscopy in conjunction with traditional methods of drawing and painting. The technique of microscopy was utilized in a set of small images created with a Scanning Electron Microscope, or SEM (see figure 9). The scientific media of microscopy, specifically the SEM, is used as a metaphor in my work for documentation as a means to extend the senses in order to attempt to understand the unknown, as it really exists. The naked eye does not allow one to either see or understand the intricacies of objects less than 0.5mm. The SEM, however, extends one’s ability to observe a miniscule object up to one million times (Goodsell).

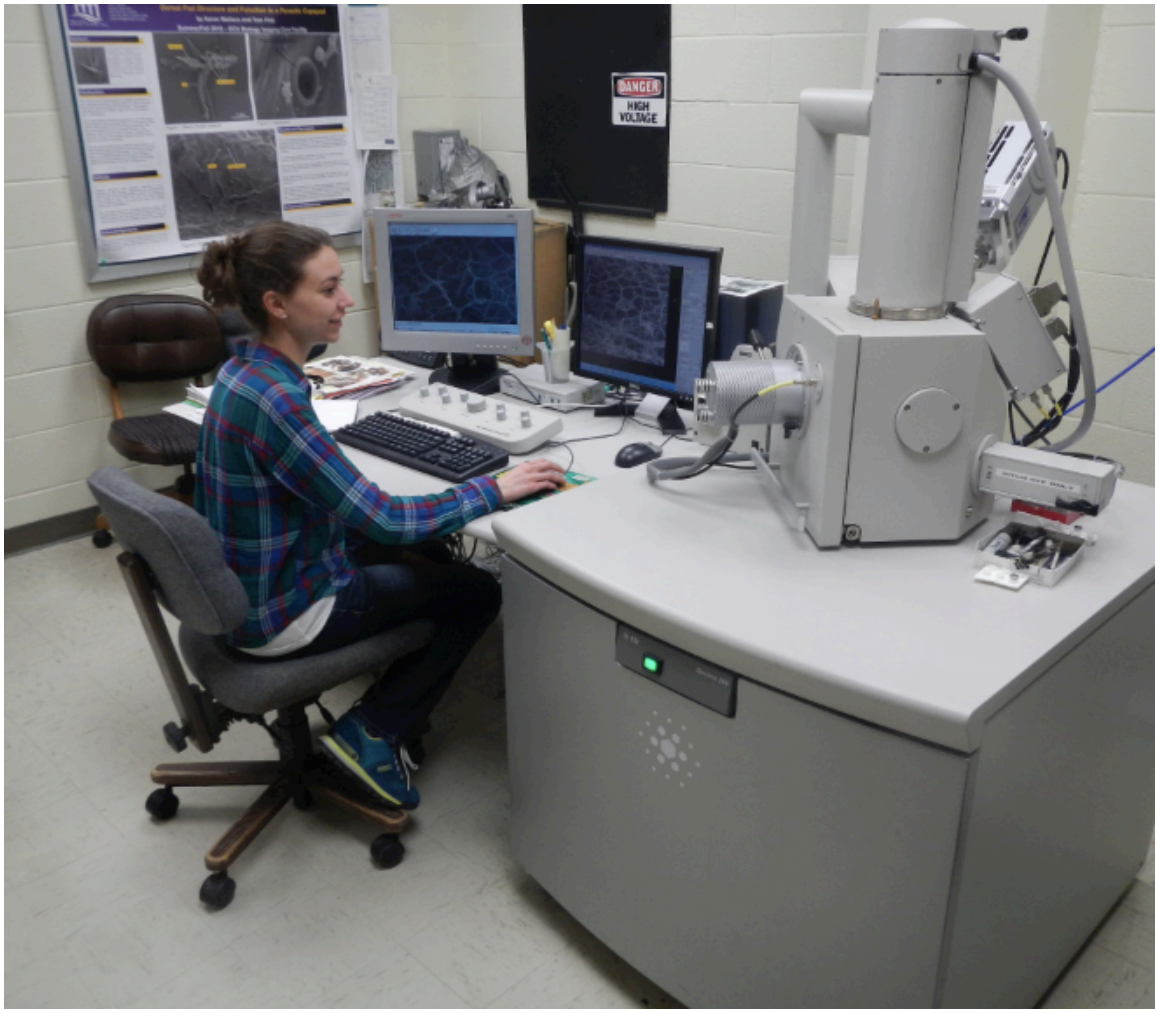

Figure 9: Working on East Carolina University's Quanta 200 Scanning Electron Microscope.

The idea of emergent order suggests that the universe is consistently organizing itself from a state of chaos or randomness. Unlike the use of microscopy, the processes of drawing and painting are used as allegories for understanding and interpreting information rather than merely documenting it. Our senses, and the extension of senses such as vision through technologies, are the tools we use to observe our environment. In contrast, our thoughts concerning what that information means dictate how we form our perceptions of what we encounter. My process of drawing and painting in the large piece titled *Nexus* is representative of the processes of emergent order. I began with somewhat random washes of pigment that I splashed and poured across sheets of paper (see figure 10). Then, I used charcoal and pastel to impose a composition and create a series of networks that appear intricately controlled (see figure 11). This way of working mimics the processes of emergent order found in nature in that chaos is organized given the input of energy, mimicked by me as the artist. This method of drawing is an allegory for the interpretation of information into meaning. The viewer may ask questions concerning the unknown presented to them.

Figure 10: *Nexus* in progress; acrylic washes on paper.

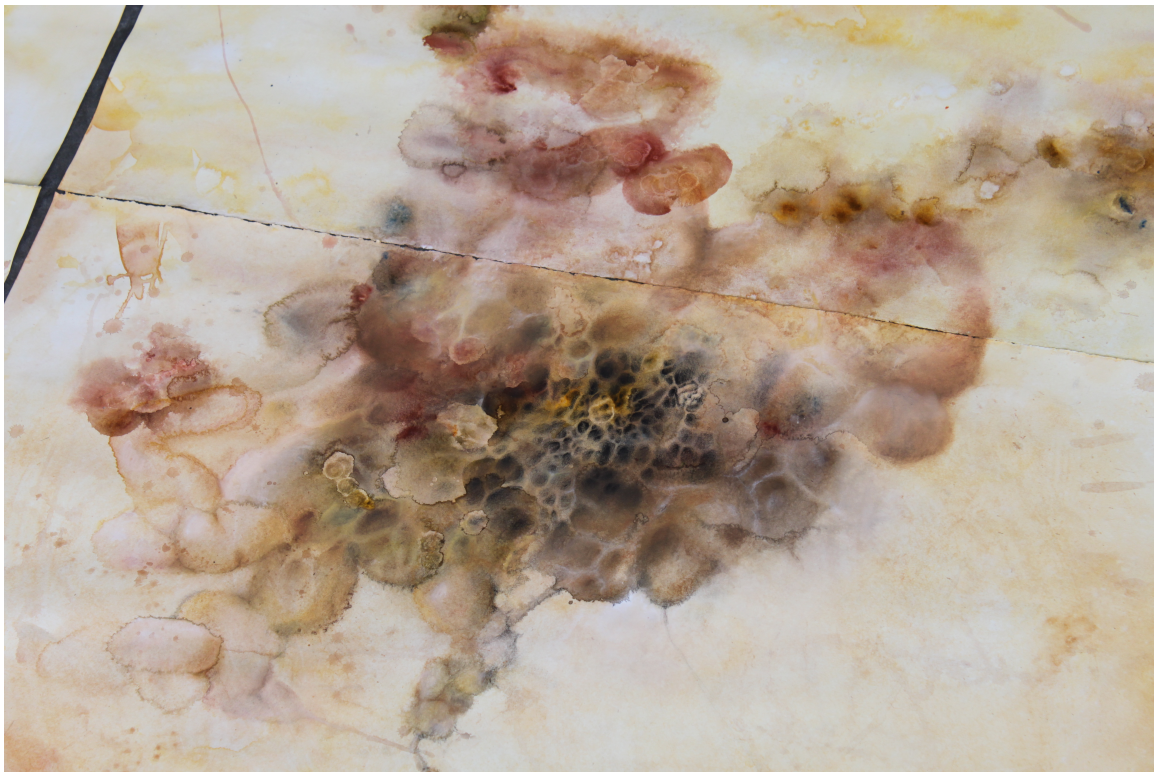

Figure 11: *Nexus* in progress (detail); charcoal and pastel drawn on top of acrylic washes.

The visual language of abstraction is another tool used to create an ambiguity between the micro within the macro. Abstraction is generally thought to be the process of distilling information down to its purest form. My definition of abstraction includes not only distilling down natural forms, but also simulating the growth patterns of these forms to emphasize a relationship between the similar complexities of micro and macro configurations. This definition of abstraction allows the viewer to interpret and ask questions of what they are experiencing more than a concrete, narrative experience. The viewer is encouraged to observe the drawing as a visual representation of microscopic forms found under a microscope or as a vast landscape of networks that could be much larger than human scale. My intention is to urge the viewer to make an inference concerning where we as humans fit on the proverbial scale of size. We are somewhere in between very small and very vast, but the viewer might ask, “Are we closer to the vast or the miniscule in proportion to what exists in the cosmos?”

Imperative to *Nexus* are the relative ideas of perception and perspective. This 7.5’ x 15’ drawing is constructed of multiple sheets of paper that are displayed as separate rectangular sheets, yet they connect to one another visually because of the continuation of imagery across the borders of each page. This encourages the viewer to perceive the piece as a whole made of many parts, reinforcing the concept that the macro is also constructed of smaller parts; the micro repeats itself into the construction of the larger networks of the macro. The viewers’ perspective based on their position within the gallery is significant to the piece. If they remain far away from it across the gallery, they may view it as a

whole; on inspecting it closely they should discover it is a composition containing other compositions, a network comprised of smaller and smaller networks of drawings (PLATES I, II, III, IV, V). Ambiguity created through the process of abstracting natural networks is reliant on the possible perceptions of the viewer based on the information they are presented with and the information they already possess.

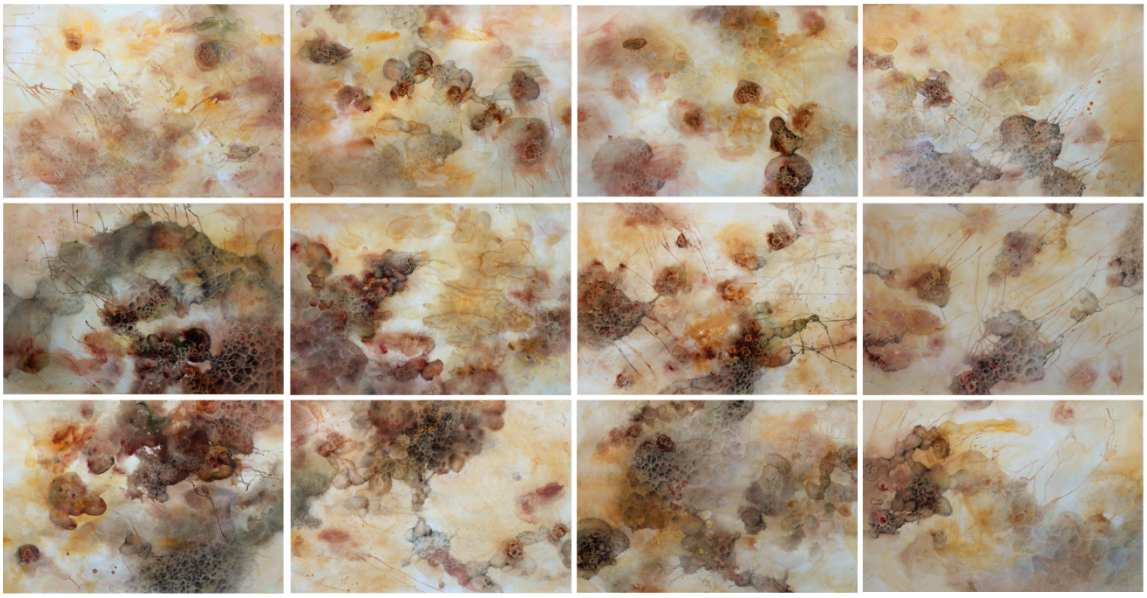

PLATE I: *Nexus*. Acrylic Wash, Charcoal, Pastel on Paper.

PLATE II: *Nexus* (detail 1).

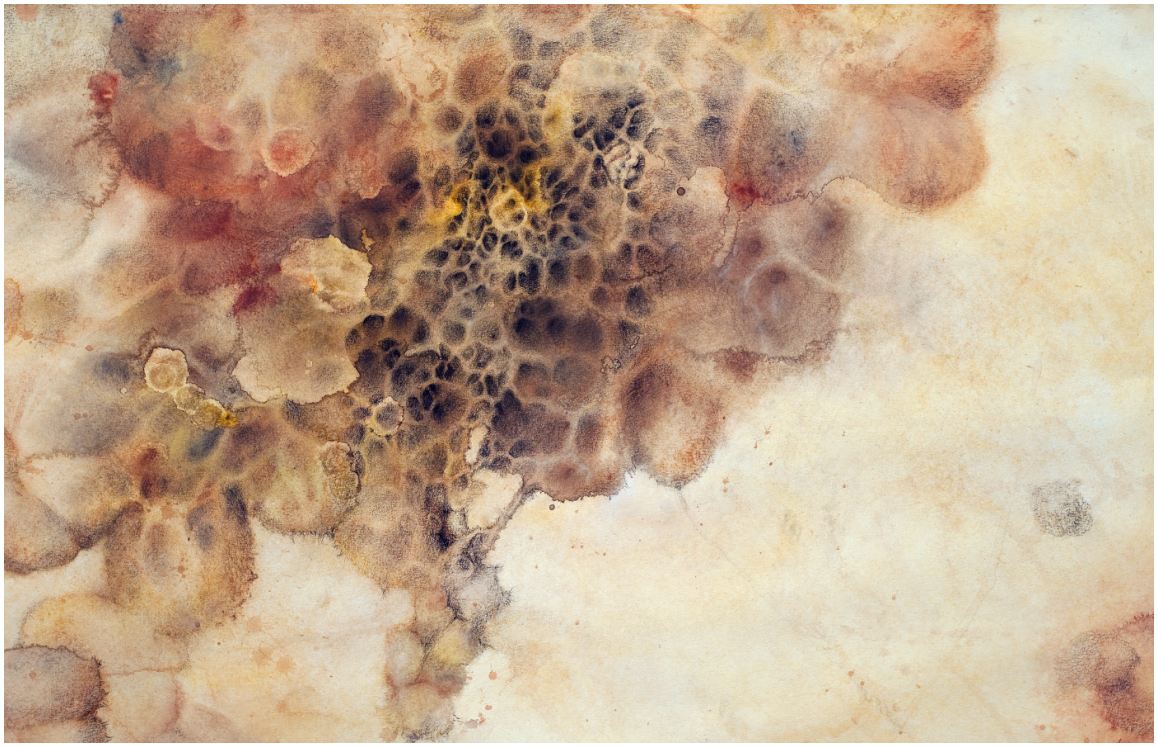

PLATE III: *Nexus* (detail 2).

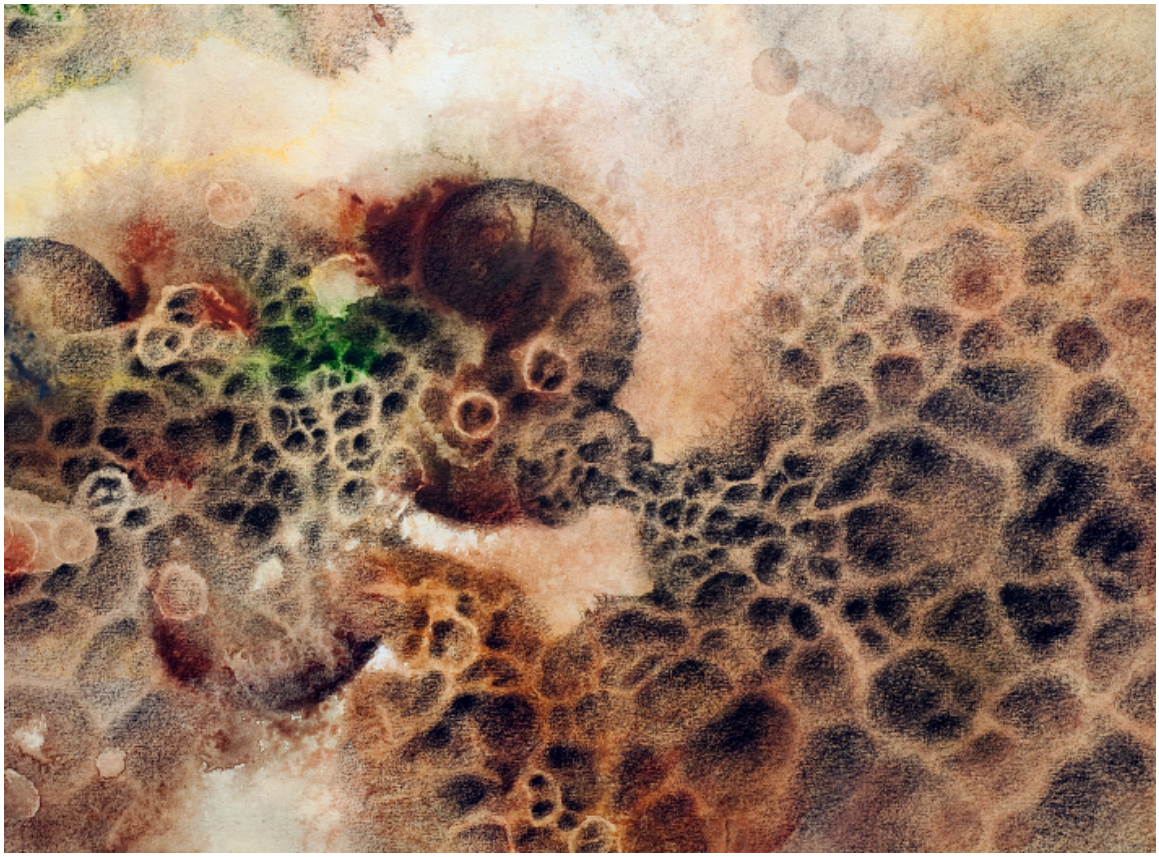

PLATE IV: *Nexus* (detail 3).

PLATE V: *Nexus* (detail 4).

MICROGRAPHS AS AMBIGUOUS SPACE: HUMANS AS MIDPOINT BETWEEN MICROCOSM AND MACROCOSM

The smaller micrographs positioned across from the large piece, *Nexus*, are intended to be a juxtaposition of scale. They emphasize the individual parts in natural networks that not only create a larger whole, but are also made up of a series of repeating networks. My intention is that as the viewer stands within the installation of drawings and micrographs, they metaphorically stand at an indeterminable point between the microcosm and the macrocosm (PLATE VI). As the viewer takes part in the installation, they form their own perceptions of the visual information they are presented with.

PLATE VI: Installation of *Echoed Plexus* in Gallery.

Each of the smaller pieces was created from a SEM scan of a different specimen at magnifications ranging from 150 to 3600 times larger than actual size (PLATE VII). The SEM technology allows for the observation of the details of ordinary objects not able to be seen with the naked eye, a magnifying glass, or even most light microscopes. When specimens are observed at this

magnification the ability to identify the images as micro rather than macro is challenging.

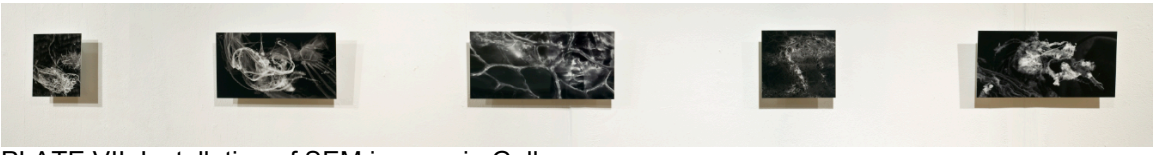

PLATE VII: Installation of SEM images in Gallery.

The piece titled *Animal, Vegetable, Mineral* (PLATE VIII) is a depiction of two balls of dust lying atop the scales that make up the wing of a moth. The naked eye would not be able to detect the specks of dust upon the wing, but at the magnification of 151x, the dust appears as an intricate structure that likely contains plant fibers, minerals from soil, and skin particles from the moth or other smaller insects.

Animal, Vegetable, Mineral refers to the reasoning game of “20 Questions” which is based on Linnaean Taxonomy (Linnaean Taxonomy). While playing “20 Questions” the answerer tells questioners whether or not the subject of the line of questioning belongs to the animal, vegetable, or mineral kingdom. *Animal, Vegetable, Mineral* presents the viewer with all three of the kingdoms found on earth contained in two specks of dust. This sets up an unanswerable question for the viewer concerning what is being observed. The viewer is left to answer the questions “What is it?” and “How large is it?”

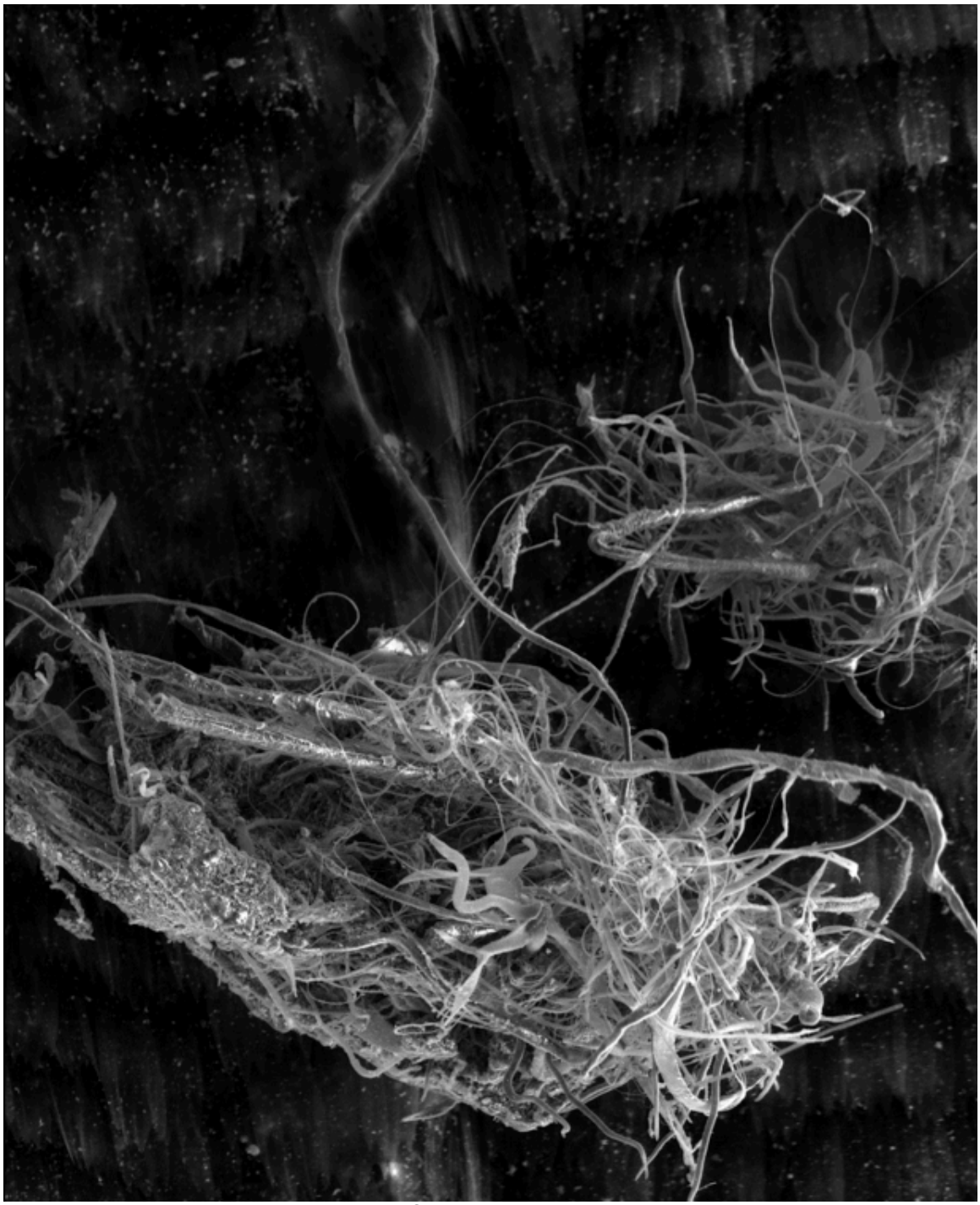

PLATE VIII: *Animal, Vegetable, Mineral.* Scanning Electron Micrograph.

Invader/Ally (PLATE IX, X) is an electron micrograph of Wild Tomatillo, a plant found in many of the back yards in North Carolina and across the American Midwest. The veins of the seed pod containing the small tomatillo fruit can be seen underneath the microscope as branching systems with larger veins converging into smaller and smaller systems of transport for water and nutrients throughout the fragile pod. Under the electron microscope, the pod looks as though it could be a massive entity such as a vast structure of galaxy clusters rather than a diminutive weed (see figure 8).

The Wild Tomatillo is often overlooked as a backyard nuisance though its molecular qualities may be quite significant. Researchers in Kansas began a study of the plant in 2010 discovering 15 molecules previously unknown to the scientific community. Of the 15 new molecules, scientists have found that several of them have strong anti-cancer properties that have been shown to attack brain, skin, breast, thyroid, and pancreatic cancers (Pearce).

Although seemingly insignificant, the molecular qualities of Wild Tomatillo are huge indeed, and the inspection of the plant on a micro level may continue to lead to developments of medications. These medications show promise because they would come from a widely available source that targets cancer cells with less toxicity to the human body than current treatments (Pearce).

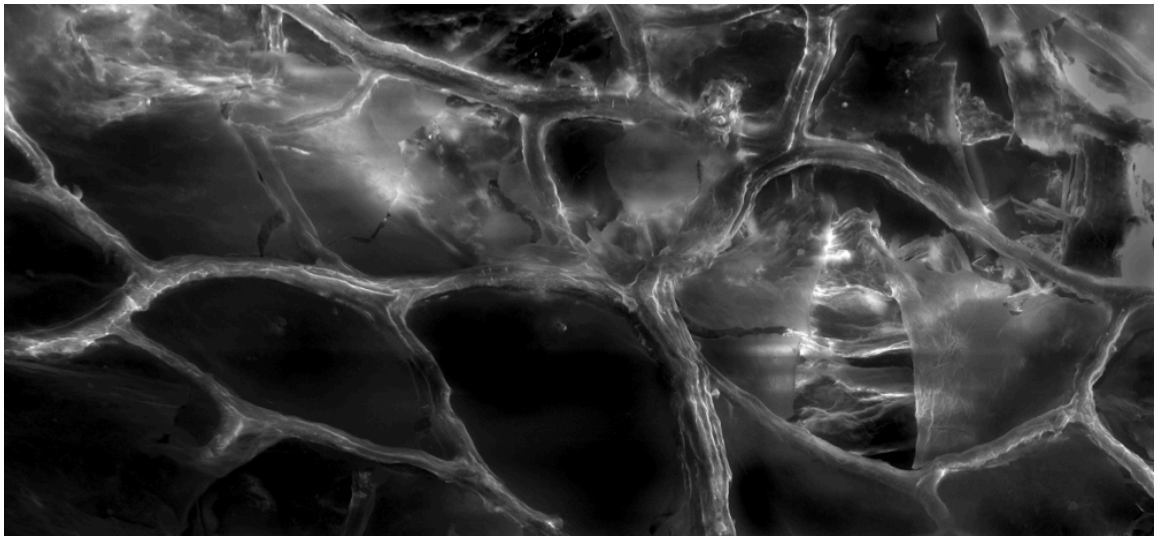

PLATE IX: *Invader/Ally.* Scanning Electron Micrograph.

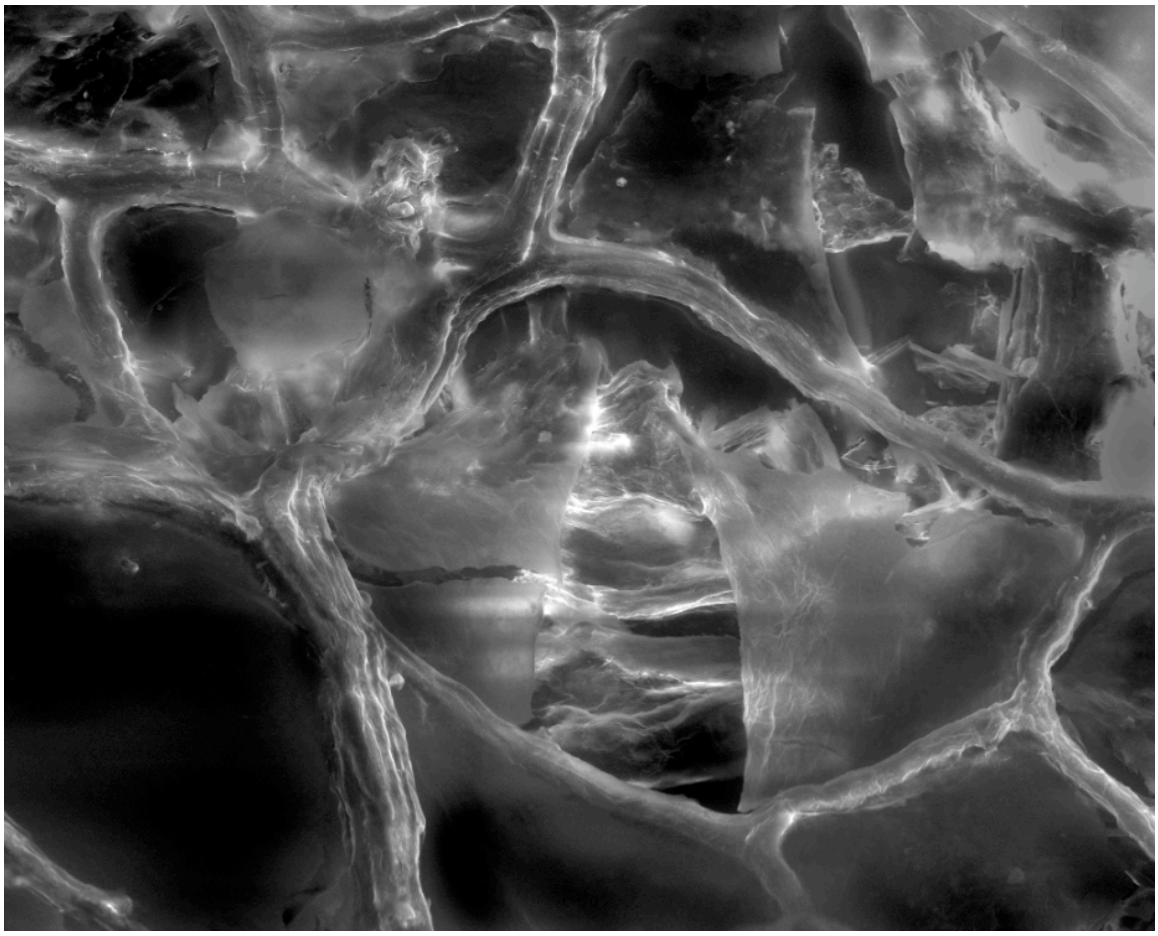

PLATE X: *Invader/Ally* (detail).

The swirling, gaseous patterns of macrocosmic nebula (see figure 12) can be seen mimicked in *Nimbus* (PLATE XI, XII*). Nimbus* is an SEM image of sea plankton; specifically the tentacles of the salt water copepod. The patterns of the copepod were observed under the microscope using a high enough voltage to get a somewhat transparent, x-ray image of the specimen. The delicate movements of the tissue of the plankton also mimic the patterns created by saltwater blooms of plankton that collect in the ocean (see figure 13). These smoky swirls can be seen from space. Individual plankter are barely visible with the naked eye, but are the major food source for everything from tiny fish to massive whales and are vital to the food chain and therefore, vital to life on earth (Conservation Report).

PLATE XI: *Nimbus.* Scanning Electron Micrograph.

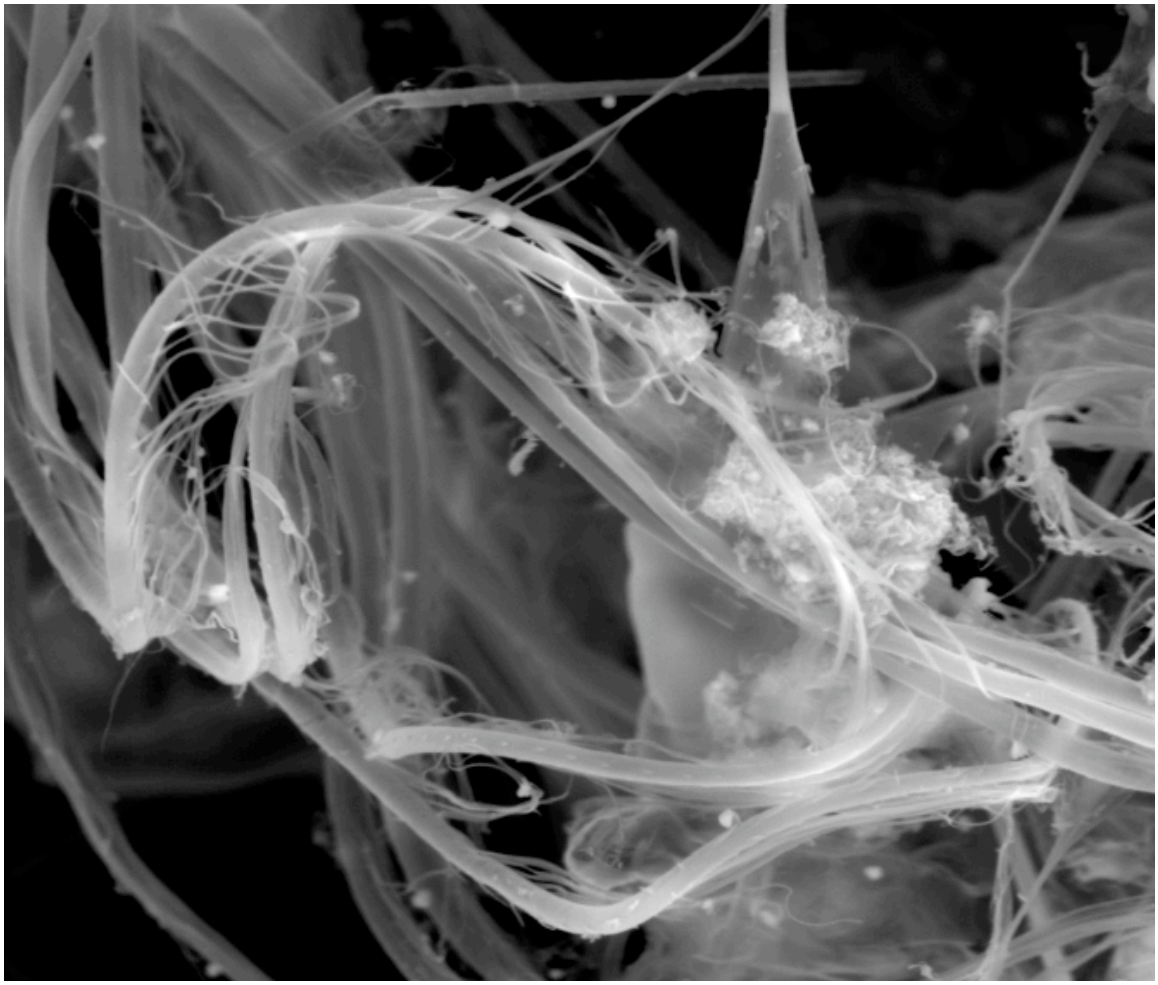

PLATE XII: *Nimbus* (detail).

Figure 12: Carina Nebula (NASA, Hubble Telescope).

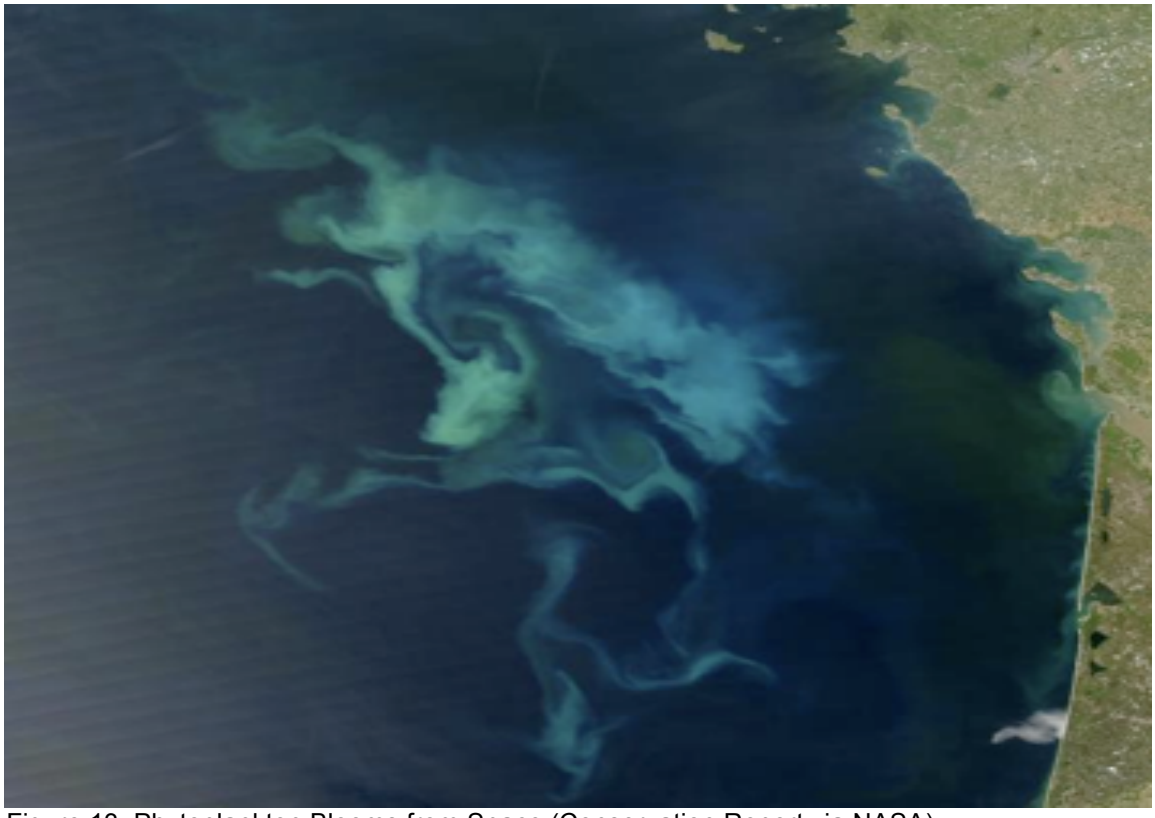

Figure 13: Phytoplankton Blooms from Space (Conservation Report via NASA).

Bulwark/Adversary is a micrograph image of the hairs on the surface of a sage leaf entwining grains of pollen (PLATE XIII). Referencing a macro-scape of planetary bodies, the image is not only a duality of macro/micro, but also a duality of protector and foe. Pollen grains protect the delicate material responsible for the reproduction of plants as it travels indeterminate distances from one plant to fertilize another. While acting as protector to genetic material, and food for insects, pollen grains also act as irritants, causing allergic reactions in humans.

Even though humans may dread the inevitable yellow coatings of pollen that appear each spring, the genetic information imperative to the survival and reproduction of plants is tied to our sustainability. Plants provide us with food, oxygen, medicine, textiles, and materials for construction of our homes. Without the transfer of genetic material protected in a microscopic grain of pollen, our survival as a species would be impossible (Campbell, 566-70).

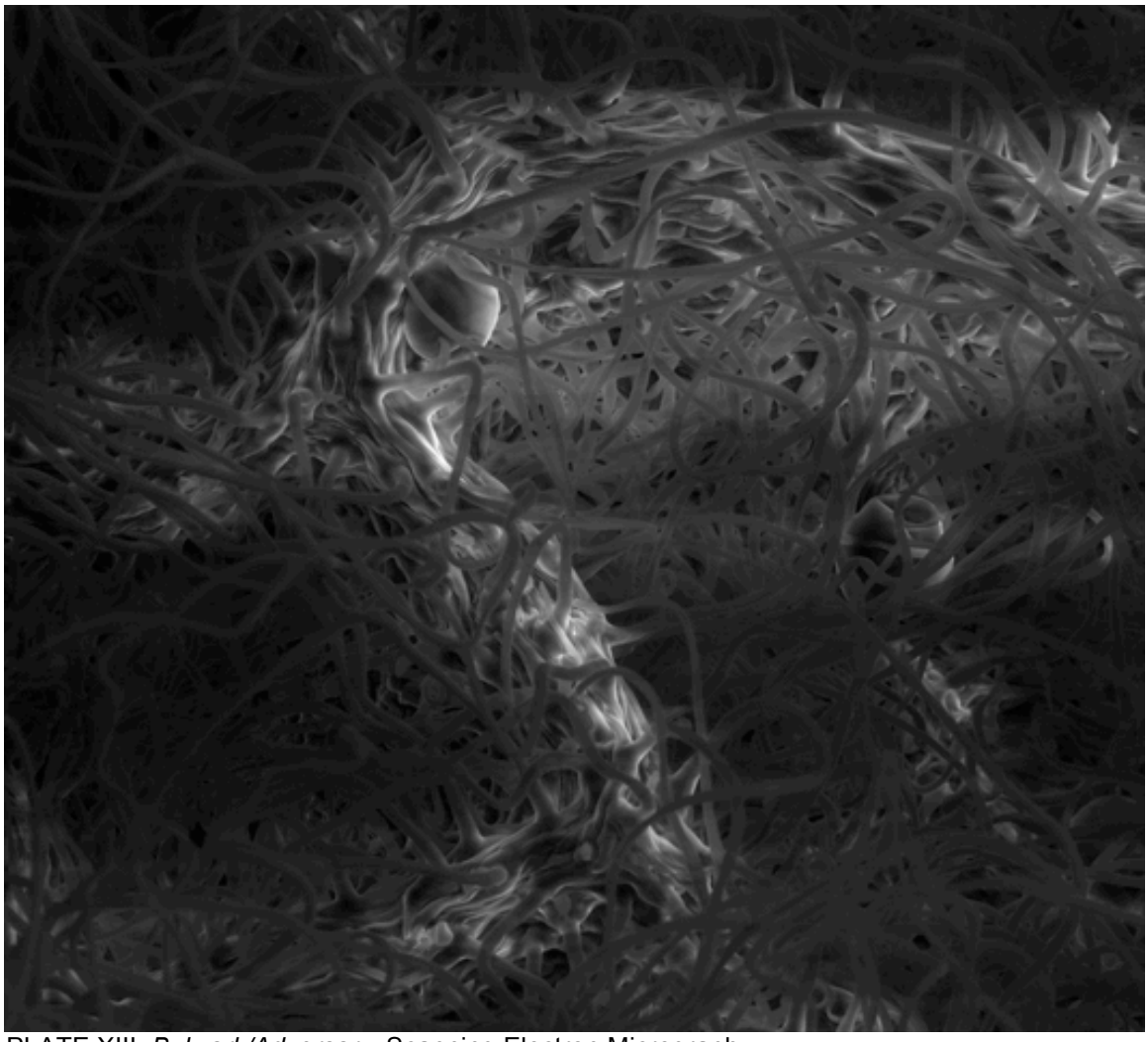

PLATE XIII: *Bulwark/Adversary.* Scanning Electron Micrograph.

Abstruse is an uncommon word meaning “difficult to understand”. The piece titled *Abstruse* visually relates to the patterns seen in the other micrographs, but unlike the other images, the specimen is unidentified (PLATE XIV, XV). Although the material can be identified as coming from the waters off of Manteo, North Carolina, I can only guess at the contents of the specimen. *Abstruse* as an unrecognizable specimen is important to the body of thesis work because it acts as a metaphor for the unknown. As humans, we may have very different reactions to what we do not know or understand, each important to scientific and personal discovery. When we ask ourselves questions about what we don’t comprehend, we come to terms with the unknown. There is so much in existence we still can’t perceive with technology as an extended sense of sight. With all that remains undiscovered, we are left with the question of whether we will ever have the capability to comprehend all that is unknowable.

PLATE XIV: *Abstruse.* Scanning Electron Micrograph.

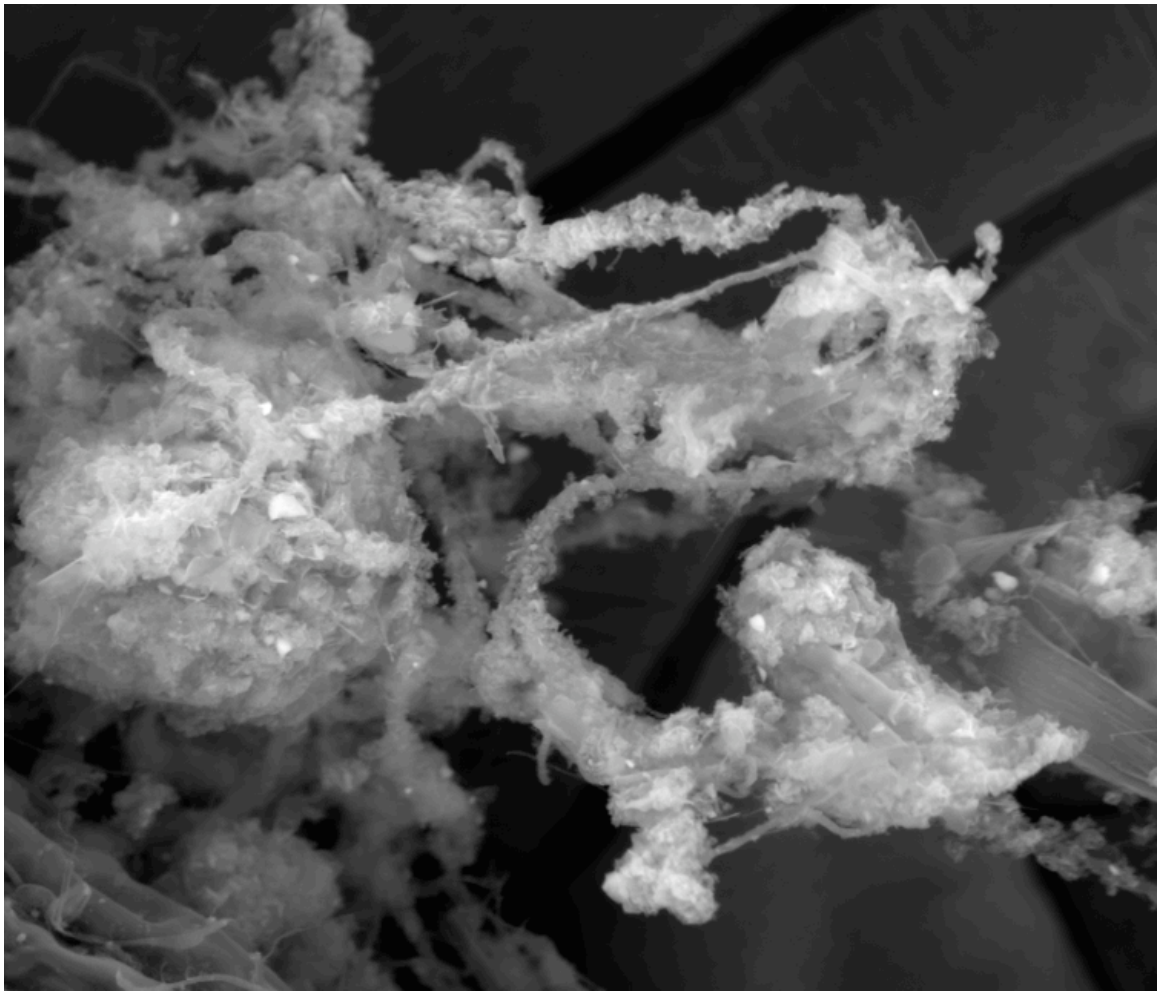

PLATE XV: *Abstruse* (detail).

CONCLUSION

"Man seeks to form, in whatever manner is suitable, a simplified and lucid image of the world, a world picture, and so to overcome the world of experience, by striving to replace it to some extent by that image. That is what painters do and poets and philosophers and natural scientists, all in their own way. And into this image and its information each individual places his or her center of gravity of the emotional life, in order to attain the peace and serenity which cannot be found within the confines of swirling personal experience."

Albert Einstein, "Principles of Research," 1918

Every scientific discovery and new technology extends our knowledge. As we absorb information and analyze it into meaning, we form perceptions of our origins, our environment, and ourselves. Scientific technologies as aesthetic tools are a metaphor within my work for gathering knowledge. When we extend our senses in order to understand the significance of the microcosm and conversely, our insignificance within the macrocosm, we are better able to place ourselves within the immensity of the cosmos. The practices of painting and drawing are one of many tools in which we as humans demonstrate meaning to the information we gather. When we create perceptions of our observations we are able to make determinations concerning our own significance within the vastness of occurrence and existence.

The ambiguities of microscopic and macroscopic spaces, observed and interpreted visual information, and scientific and hand-worked media are integral to my thesis body. These ambiguities are meant to communicate that we are in

between both ends of many dualities; we are minute and magnanimous, real and perceived, observer and creator.

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