Advances in Social Science, Education and Humanities Research, volume 594
Proceedings of the 2021 3rd International Conference on Literature, Art and Human Development (ICLAHD 2021)

Small Universe: Exploring Microorganisms in Water from an Artistic Perspective

Jingying Zhen

Shandong University of Art & Design
Email: zhen8979@gmail.com

ABSTRACT
The scope of this thesis was shown visualization of microorganisms in water from an artistic desire and present the viewers with an opportunity to discover an invisible world, which is offering a possibility to see the combination of art and science. This included my observation of real microorganisms under a microscope in biology lab. I found the beauty within the details of this miniature world and shown by design work.
The purpose of this study was to combine biology and art, traveling in the real and imaginary world, researching, exploring, and then showing microorganisms using multiple approaches within digital media. This interdisciplinary research method helped us to think about the beauty of science, the perfect vehicle to capture thoughts and images of this 'moment in time,' which was the outcome that this paper wants to convey.

Keywords: *Biology in Art, Data Visualization, 3D Printing.*

1. INTRODUCTION

Humans are infinitely small within the universe, but we are also infinitely huge compared to microorganisms. It is amazing to think that if we try to define a drop of water as a planet, a new world will be discovered and displayed in front of us. My illustrations show another kind of beauty, the energy of microorganisms in water.

When I am working in the studio and trying to find inspiration, my creation starts with some observation behaviors, such as using ink to create sketches and non-representational art (see Figure 1). When I look at my palette of dry ink powders, they remind me of many things. For instance, the ink powder cake is like a blob in the middle of the night sky; as soon as I touch it with my water-filled brush, it explodes into life. When I bring these imaginary life forms to life in a cup of water, they spread randomly across the molecular structure of the water, conveying unknown and mysterious messages, just like the beginning and a start of an imagination world (see Figure 2). In the moment when I focused on the water, I start to wonder about: what kinds of life forms are living in water? Do they exist in my cup and move with the ink? How about inside drops of water? How can they move? How can they live? What are their needs? Can they communicate with each other? These questions inspired me, and I started to do some research about microorganisms in water based on scientific descriptions.

Figure 1 Jingying Zhen, Daily sketches, 2019.

Figure 2 Jingying Zhen, Ink in a cup of water, 2019.

When we use a microscope, microorganisms under water can be observed directly after being over 40x magnification; they are showing their unique beauty. Watching them was like exploring a new planet that has never been discovered. It is hard to imagine that there are so many life forms living in the water, like diatoms and bacteria. Under the microscope, these microorganisms are both clear and blurred. The clarity is in their vivid molecular structure, and the vagueness means that their most intricate details cannot be revealed.

In my artistic creations, considering the source of inspiration, I have chosen ink painting to represent these microorganisms. Ink painting also gives the same feeling as microorganisms – both clear and blurred. This is especially true when there is an irregular effect caused by the ink spreading into the grain of the rice paper, which is a non-fibrous sheet made from starch (see Figure 3). These uncontrolled effects are like the signals emitted by microorganisms when they move and communicate (if they do). In my imagery, I magnified and depicted the union of microorganisms based on my own understanding of my research. As my imagination drawn the microorganisms as creatures living on a special planet, I try to expand my understanding of other life forms, reflecting and showing this through my brushwork. I create them with acts of communication and reflection. I want to express the humans' thinking about life forms that cannot be seen with the naked eye, like microorganisms in water.

This research has pushed me to rethink the way other life forms exist. My illustrations serve as a door that leads into a less-known world, which inspired by my research. Viewers will catch the lifestyle of the microorganisms based on their interaction with the illustrations, 3D models, videos, and website. This process can be considered as getting to know a new friend, and finding energy in these small life forms.

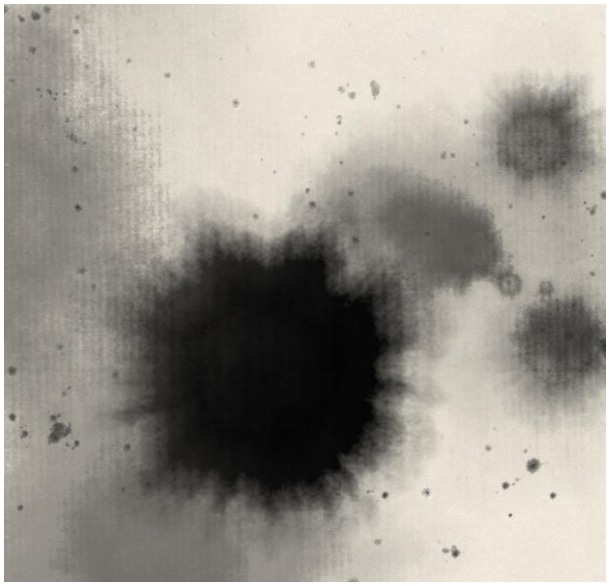

Figure 3 Jingying Zhen, Ink in wet rice paper, 2019.

2. LITERATURE REVIEW

I used a light-and-dark style associated with ink painting gradation on rice paper to express the characteristics of the microorganisms, and also used 3D printing to show the physical properties of microbes. The world of microbes is very attractive; therefore, besides study on the biological research, other researches on art and aesthetics are also important to my work. As a basis for my research, I wondered to see how other artists created the idea about a Microcosm. I have studied three artists, Yayoi Kusama, Rogan Brown, and Tara Donavan. Each of these renowned creators of art have a certain flair and distinction, that reflect what I want to achieve as my own impression of the relationship between the world of invisible to our eye and the one we live in, our reality.

2.1. Yayoi Kusama

"The earth is one of a million dots." -- Yayoi Kusama (Smigiel, 2018)

Yayoi Kusama's artworks are extremely imaginative. She uses dots to create a gateway between the world of reality and fantasy. Kusama's view is that the dots are an irreplaceable thing in this world, as they represent, for example, the sun and the moon, as well as various planets down to invisible atoms and electrons. From her work (Suzuki and Weinstein, 2017), different people see these dots with different perspectives; some think they are tiny, like cells, and others imagine them to be enormous, like planets. They can be interpreted as anything. Smigiel (2018) referred to her work as being a complex and diverse framework of phenomena that we can observe in contemporary culture. In Pumpkin (see Figure 4), the dots created by Kusama are like the miniature organisms of bugs, which are connected with

countless cells, giving life to artworks, in the form of shapes our minds can comprehend. Her artworks expand my thinking about the concept of the single individual, and I have begun to discover the world from another perspective.

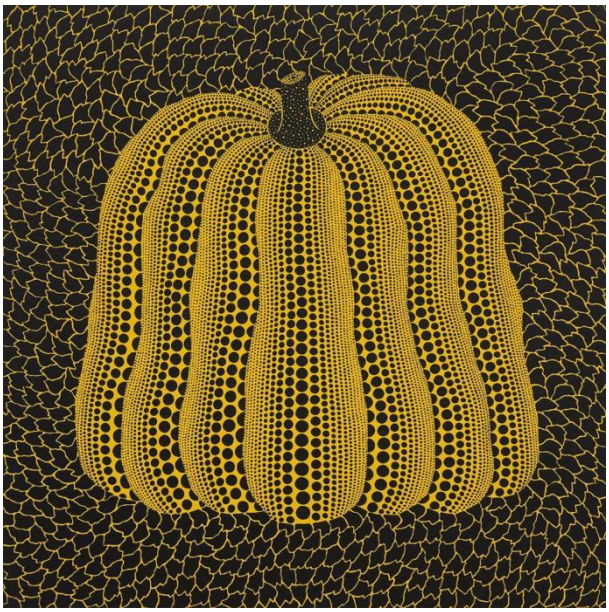

Figure 4 Yayoi Kusama, Pumpkin (Yoshitake et al., 2017).

2.2. Rogan Brown

"Art is the midwife of science." -- Rogan Brown (Brown, 2014)

Rogan Brown's work focuses on cell structures, microbiomes, fossils, and anything else we might find in a Petri dish. He begins by drawing sketches, and then uses laser cuts to carve a model, presenting precise sculptures. For his artworks, Brown dramatically expands the proportions of the microscopic objects by taking their scientific complexity and magnifying it (Hane, 2019). In the artist's words (Breedlove, 2015), "Each piece suddenly comes alive when it is placed vertically in the light. Photos only catch them at a certain moment. In reality, the pieces move with the changes in the ambient lighting, so they are always slightly different." In my view, to see a World in a Grain of Sand is the best expression of this characteristic (see Figure 5). Viewers will have different response when observing Brown's artworks at different times of day. Studying artworks brought me the reflection that science sometimes is limited when confronted by the vast scale and complexity of nature. The intricate details in microcosms can be discovered when art shows the true beauty exposed under the 'scope.'

Figure 5 Rogan Brown, To see a World in a Grain of Sand (Brown, 2014).

2.3. Tara Donovan

"My work relying on the nature or physical peculiarities." -- Tara Donovan (Donovan et al., 2008)

Tara Donovan has been recognized for her dedication to a process and her ability to discover how the inherent physical characteristics of an object might allow it to be transformed into art (Donovan et al., 2008). She uses commonplace consumer materials, like toothpicks, tape, pencils, buttons, and paper plates to create dazzling sculptural installations, which usually mimic the organization of geological or biological forms (Molesworth, 2009). Donavan's pieces are organic and highly structured. In Untitled (see Figure 6), Donovan's artwork presents a mass of simple objects, without disguising what they are, while suggesting a range of richly poetic associations. Her work has inspired me to think about how to control the balance between structure and conceptual thinking.

Figure 6 Tara Donovan, Untitled, 2011 (Boyd, 2019).

3. THEORY AND METHODOLOGY

Based on my research of microorganisms, my artwork portrays qualities that capture both clarity and vagueness. This reflects how microorganisms can be clearly observed under the light microscope or even the electron microscope, but they become vague when we withdraw our eye from the scope. Considering my

inspiration, I started to work primarily with ink painting to represent these life forms. Ink is created with organic material, and when the ink spreads on rice paper, another natural material, it conjures up the ephemeral feeling I get at twilight. In related series, I utilized the 3D printing process to build several transformations from the two- to three-dimensional forms, to more clearly represent the structure of the microorganisms. Otherwise, I also used videos to show the movement of these small organisms. This multi-dimensional expression enhanced the conception of the microorganisms I want to show.

Morphology of Microorganisms

The types of microorganisms that I researched were those growing in fresh water, in an unpolluted lake. There are tens to hundreds of these tiny life forms per a milliliter of water (Robyn, 2015). Common microorganisms in water are bacteria, fungi, phage, viruses, protozoa, algae, etc (Nuraisah, 2015). Due to my interest in these microcosms, I focused mainly on the smallest viruses and bacteria. To illustrate how much smaller microorganisms are than other objects in our visible world, I created a comparative chart aligning visible objects with their placement on the electromagnetic spectrum, indicating each item's relative size and consequently, their visibility (see Figure 7). The smallest size that human eyes can distinguish is 10^{-3} meter.

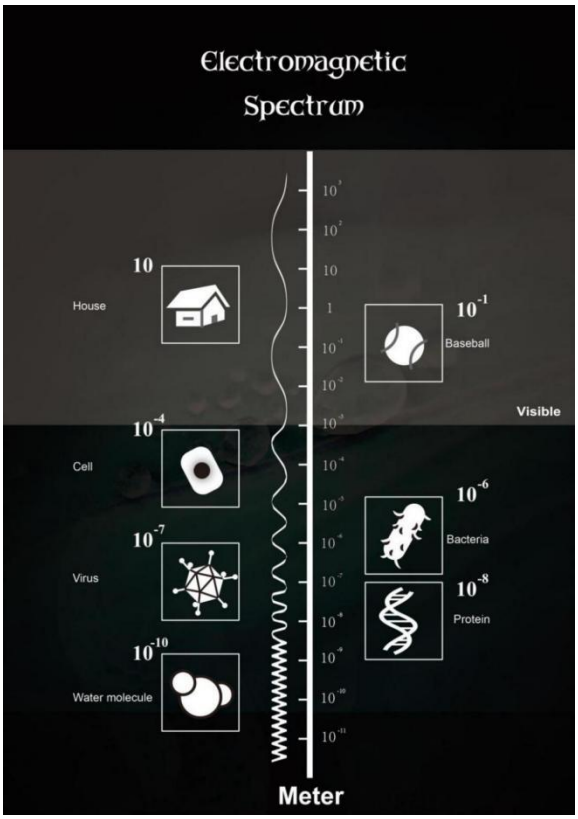

Figure 7 Jingying Zhen, Electromagnetic spectrum, 2019.

Viruses are the smallest forms (10^{-7} meter on the electromagnetic spectrum) (Nuraisah, 2015), and can be observed only under an electron microscope. A virus is not an independent living organism and needs a host cell to replicate. Each appendage or "foot" on their exterior surface helps them to get substance from the host to reproduce more viruses (see Figure 8).

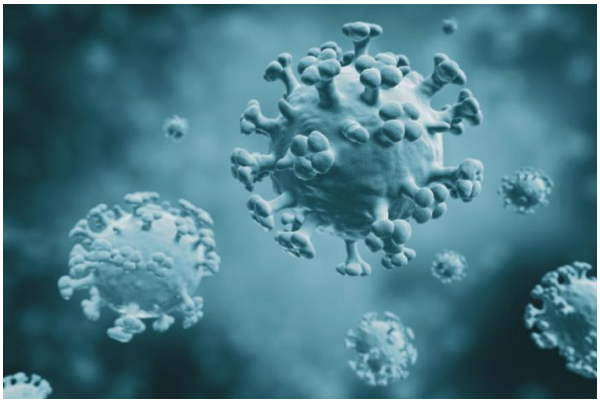

Figure 8 Virus appendages (Tucker, 2015).

Bacteria are the second smallest type of microorganism (10^{-6} meter on the electromagnetic spectrum) (Nuraisah, 2015), and they can replicate each more rapidly than viruses. A bacterium is a single-celled organism that is essential for all life. They either exist as parasites or live independently, and get food from both living and dead organisms. Bacteria have three basic shapes that include spirochete (coiled or spiral), coccus, and bacillus forms (see Figure 9). Flagella are hair-like structures used by bacteria to swim. Some bacteria do not have flagella, and need some medium to spread them around.

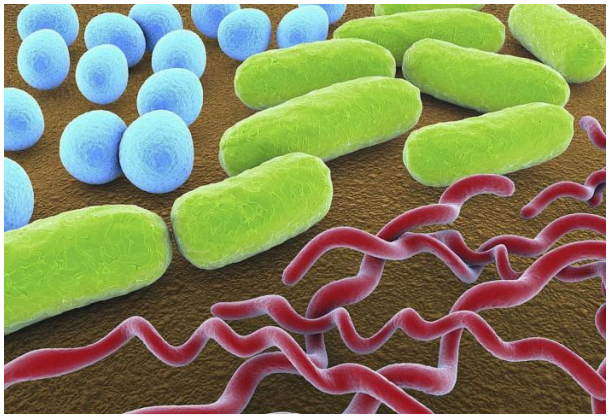

Figure 9 The three basic shapes of bacteria include cocci (blue), bacilli (green), and spirochetes (red). (Bailey, 2019.)

In order to observe the characteristics of microorganisms, I collected a water samples in the Glenmere Park, Greeley, CO (see Figure 10). It was flowing water in the lake. As also shown in Figure 10, Dr. Han who is in Biological Science Department helped me to use the light microscope (MICROSCOPE

19AX E191047) to observe water samples. In Figure 11-1, we can see some impurities that are not normally seen under the light microscope with 10x magnification. On the right of Figure 11-2&3, under the light microscope with 40x magnification, we can see diatoms that were undergoing photosynthesis, and the bacteria shown as a small black spot.

Figure 10 Glenmere Park and light microscope by Jingying Zhen, 2020.

Figure 11 Microorganism under light microscope by Jingying Zhen, 2020.

Because the light microscope I used was not enough to see smaller objects, I booked with the biological laboratory to use the inverted microscope (AXIO Observer. Z1). During the process, the instrumentation specialist Chad Wangeline helped me to observe some bacteria slides (see Figure 12).

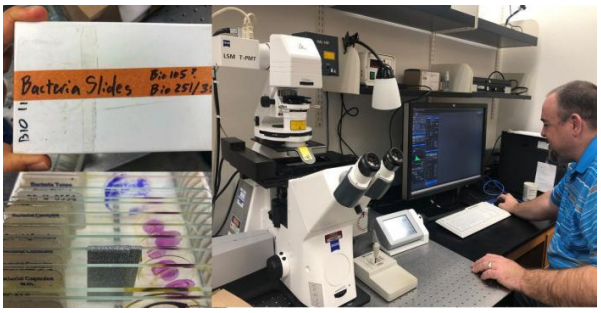

Figure 12 Jingying Zhen, Bacteria Slides and the Instrumentation Specialist Chad Wangeline operating the inverted microscope, 2020.

For instance, a hydra is a multicellular predatory microorganism demonstrating defensive contraction, was taken from a sample of pond water. In Figure 13, Hydra can be clearly observed under the inverted microscope with 50-1000x magnification. It is almost transparent in a high magnification observation. Meanwhile, we also saw other bacteria slides of Amoeba and Mycobacterium (see Figure 14). These pictures remind me again of ink in water.

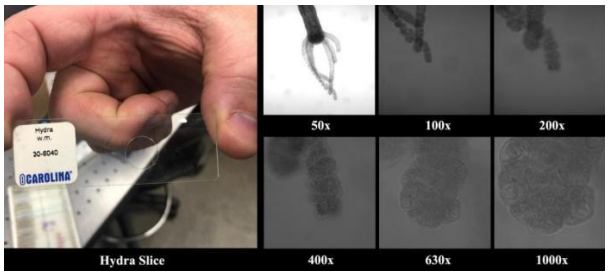

Figure 13 Chad Wangeline & Jingying Zhen, Hydra Slice under inverted microscope, 2020.

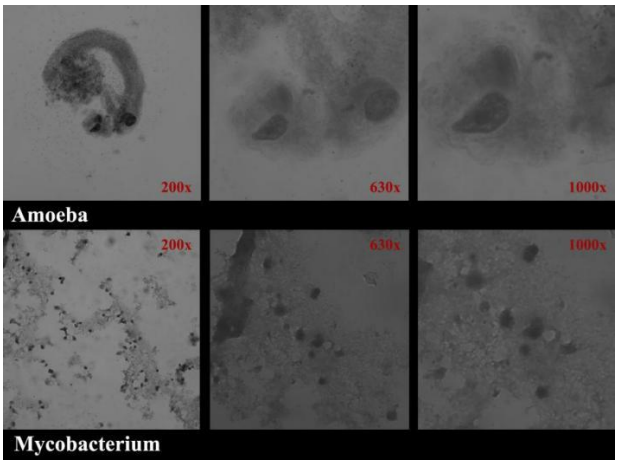

Figure 14 Chad Wangeline & Jingying Zhen, Amoeba and Mycobacterium, 2020.

The Process of Creating the Artwork Sketches

After doing some research, I organized my information and produced some sketches that merged my understanding of the basic forms of microorganisms and the imaginary creations swirling around in my mind (see Figure 15). The main features that I investigated in these sketches were virus' feet and bacteria's flagellum. I imagined some of the forms having "hands" or "feet" to help them stand up or lie down when I saw the small organisms moving slowly under the microscope. In my vision, some of them even had mouths to draw breath. I created textures for their surface skin, which is their physiological structure used to release pheromones to achieve the role of chatting with other microorganisms or microbes. This was an absorbing step. These imaginative ideas kept me preoccupied with creation, just like inventing new life forms.

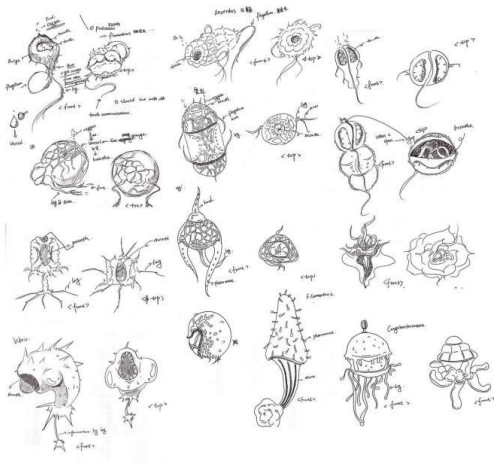

Figure 15 Jingying Zhen, Sketches of Microorganisms, 2020.

Ink Illustrations

For illustrating my creations, the next step was to translate my pencil sketches into ink paintings. I wanted to get a random texture effect as the ink spread on the paper. First I applied a thin layer of water on the rice paper to help the ink spread more freely and vaguely in some areas, while other areas remained crisp. Next, I drew some ink dots to simulate the more vague aspects of these creatures and their connection to their environment. I still wanted the ink to appear to spread a little more. These dots also helped me to enrich detail of the illustrations. Finally, I used a scanner to import and combine the ink images in Adobe Photoshop, and used a Wacom table and pen to add final details (see Figure 16).

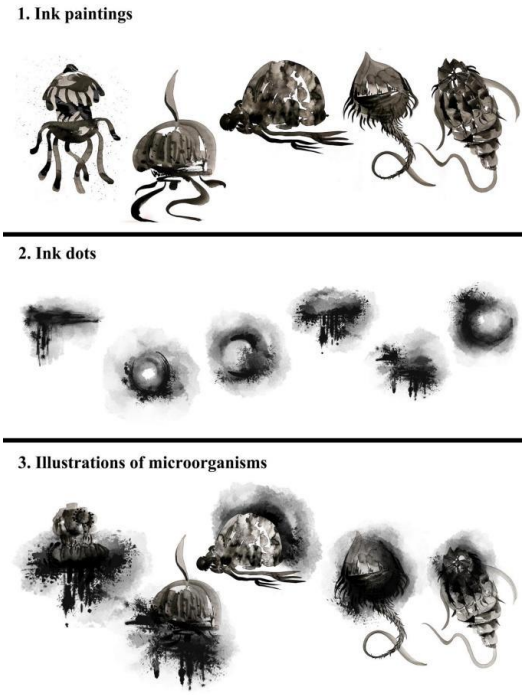

Figure 16 Jingying Zhen, The process of illustrating microorganisms, 2020.

3D Models

I created a series of 3D models as an extension of the ink illustrations, transforming my 2D visions into 3D forms. Then I used Rhino 6 to model and render the forms, adding details to make the microbes clearer (see Figure 17).

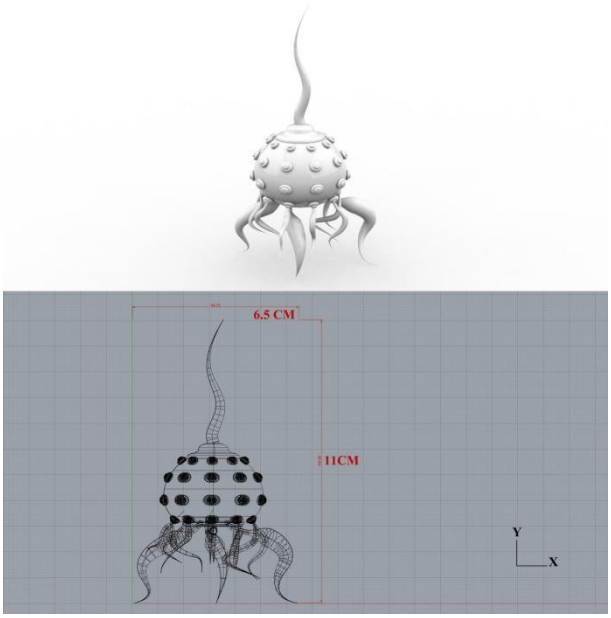

Figure 17 Jingying Zhen, One example from ten 3D models, 2020.

Integration

After drawing, painting, and modeling, I began to combine the individual illustrations to make them a complete creation. As for color, the ink illustrations was rendered in two-dimensional black. Based on the representation of life, I chose red to render each 3D model. Because the microbes live in water, I used the element “water” as a connection to combine the different individuals. Using a digital airbrush tool to create the effect of diffused water ripples, I made the edge of the ink illustrations to echo the flow of water. In order to simulate the texture of rice paper, I scanned rice paper into Adobe Photoshop as the background of the pictures, making the ink effect feel more realistic (see Figure 18). Microorganisms integrated all of the individual microbes with a simulation of their natural environment, and the various media provided a range of effects from clarity to vagueness. After determining the shapes of the microbes, I edited two videos using these “organisms.” By imitating the movement of microorganisms under the microscope, the microorganisms in two and three dimensions are represented respectively. Meanwhile, I also designed the website to showcase my artworks. A companion website helps to expand visual learning and instruction with the

use of art enhanced by computer graphics and digital media technologies (Ursyn, 2012).

Figure 18 Jingying Zhen, Microorganism, 2019.

4. RESULTS

I used different types of digitization to express biology-based art, including 2D illustrations, 3D printing, and videos. My works are all interrelated and define each other. For example, the 3D prints are an expansion of the representative drawing. Furthermore, they share a common theme: Small Universe. The color of artwork drawn in black and red shows imagination and reality.

The two-dimensional illustrations (see Figure 19) were created from my understanding of microbes from an artist's perspective. Imagine a drop of ink as a "tiny life" blossoming as it is dropped in a jar of water. Since the expression of painting is more artistic, I used black to convey that this is an imaginary world. All of the individual microbes were rendered with a simulation of their natural environment, and the various media provided a range of effects from clarity to vagueness.

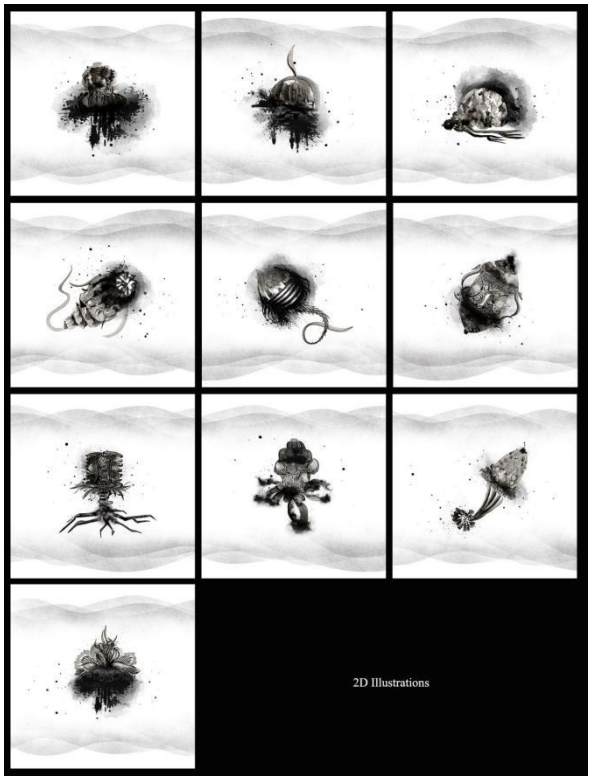

Figure 19 Jingying Zhen, 2D Illustrations, Small Universe, 2020.

The three-dimensional models were painted in a deep blood red color. They reflect the connection between "unseen life" and the 'real world,' allowing the viewer to conjure up thoughts of little wriggling "lives," truly existing in this world (see Figure 20). They were created using a special resin and a technique called 'Stereolithography' (SLA) 3D printing.

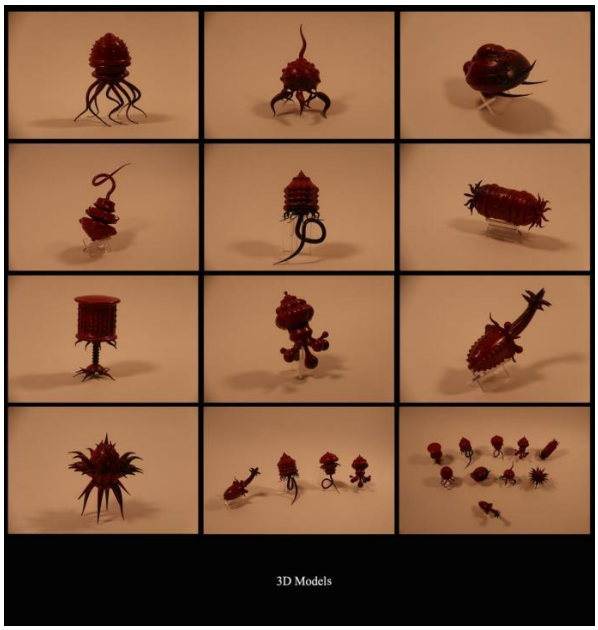

Figure 20 Jingying Zhen, 3D Models, Small Universe, 2020.

As an explanation and definition, the videos conveyed that microorganisms I created lived in the two- or three-dimensional world. When I used a microscope in the biological laboratory, I observed that we would need to put a drop of water or oil on the lens of the microscope in order to see the microorganisms more clearly; this inspired me. I thought I would also use my illustrations to simulate the activity of microorganisms under the microscope. When I designed the video 1 (see Figure 21), I focused all the elements in a circle, the way people observe the wonderful small life through the lens of a microscope.

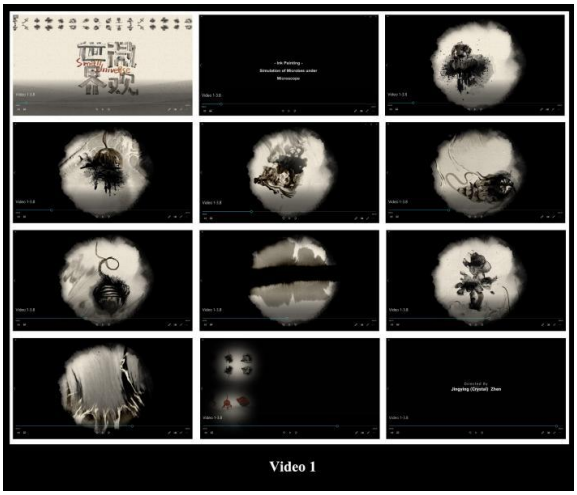

Figure 21 Jingying Zhen, Video 1, Small Universe, 2020.

Video 2 (see Figure 22) compared 3D models of microorganisms with real microorganisms under the microscope. It shows the viewers the beauty of biology, because the 3d models have transformed the data of 2D illustration into real objects. Thus I shown the models together with the real microorganisms that I got in the biology lab to produce a contrasting effect. And the color of the background used different shades of red to create a fantasy vision.

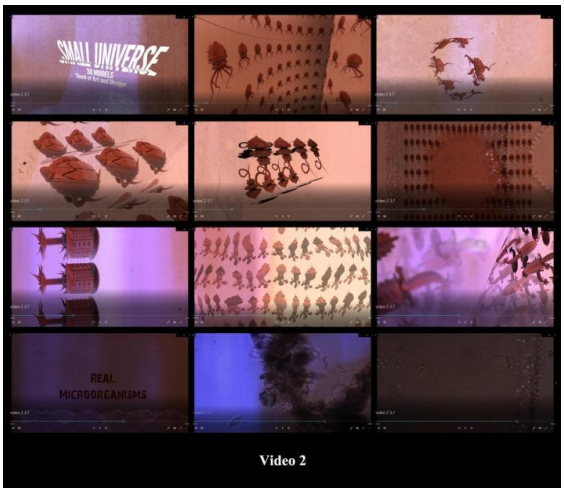

Figure 22 Jingying Zhen, Video 2, Small Universe, 2020.

The website design was my final resource; I edited my artworks on the Internet. That helps more people were able to learn this new knowledge. Here is the URL: https://dart2020.wixsite.com/d-art-2020/crystalzhen (see Figure 23).

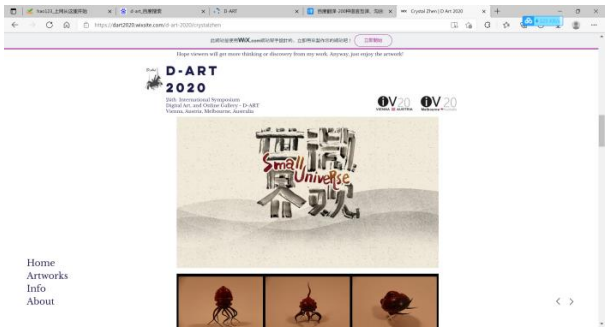

Figure 23 Jingying Zhen, Web design, Small Universe, 2020.

5. CONCLUSION

In conclusion, I want to express human thinking about life forms that cannot be seen with the naked eye, like the world I am investigating. This thinking, whether it is human perception of life and the world, or not, is trying to understand the emotions that other unknown lives convey. The work I portrayed only began to explore biology-based art; I would like to further explore that tiny world in order to show the unseen area for everyone who is interested.

I believe the artwork I did is valuable. For further development, I hope to study more biological directions whereby my artwork can be more reasonably integrated with science. For example, if I increase the magnification of the microscope, will I see more invisible life forms? In my two- or three-dimensional works, how would smaller life forms interact with those I have already studied? What would happen if I used other materials to draw the "Small Universe?" For example, what if I were to use cotton to replace rice paper? Would the texture make the paintings even more random than the rice paper did? How about different fabrics?

Taking an interdisciplinary approach has led me to new experiences and perspectives. My hope was that this art was only the beginning of a more thorough exploration of microbiology displayed in art.

ACKNOWLEDGMENTS

This thesis was written in University of Northern Colorado. My sincerest heart thanks goes to Anna Ursyn and Andrew Svedlow whose help and support have inspired me to become a better artist and writer. Especially My committee chair, Dr. Ursyn, has helped me when I became confused in my studies and in life.

I would like to give special thanks to professor Yuyan Han, and instrumentation specialist Chad Wangeline in the Biological Science Department at UNC. These kind and generous people gave up their free time to help me observe microbes under the microscope, enabling the adding of scientific data to my paper.

To conclude, I owe thanks to every teacher whose teaching helped me clear the fuzzy haze around my art and plans for the future.

REFERENCES

[1]Brown R. (2014). Paper sculptures. Retrieved from http://roganbrown.com/home.html

[2]Bailey, R. (2019). Bacteria shapes. Retrieved from https://www.thoughtco.com/bacteria-shapes-373278

[3]Breedlove, B. (2015). Delicacy and durability: The microbiological sublime. Emerging Infectious Diseases, 21(1), 190-191. doi:10.3201/eid2101.AC2101

[4]Boyd, K. (2019). These massive, uncanny artworks will give you the chills. Retrieved from. https://hyperallerqic.com/4g1103/these-massive-uncanny-artworks-will-give-you-the chills.

[5]Donovan, T., Baume, N., Mergel, J., Weschler, L., & Institute of Contemporary Art. Boston, Mass. (2008). Tara Donovan (1st ed.). New York, Boston: Monacelli Press.

[6]Hane, E. (2019). Micro magic. American Craft, 79(2), 28-29.

[7]Molesworth, C. (2009). The sculptures of Tara Donovan: Fields and figures. Salmagundi, (164/165), 51-58.

[8]Nuraisah, A. (2015). Science notes year 5 chap 1(a) microorganisms. Retrieved from https://www.slideshare.net/NuraisahAisa/science-notes-year-5-chap-1a-microorganisms-51248364

[9]Tucker, R. (2015). Viruses in drinking water supplies and human health risks. Retrieved from https://www.watertechonline.com/directory/article/15549515/viruses-in-drinking-water-supplies-and-human-health-risks

[10]Smigiel, A. (2018). The unreal world of Yayoi Kusama. Medea, 4(1). doi:10.13125/medea-3238.

[11]Suzuki, S. J. S., & Weinstein, E. (2017). Yayoi Kusama: From here to infinity. New York: Museum of Modern Art.

[12]Ursyn, A. (2012). Biologically-inspired computing for the arts: Scientific data through graphics. Hershey, PA: IGI Global.

[13]Yoshitake, M., Chiu, M., Dumbadze, A. B., Jones, A., Sutton, G., Tezuka, M., & Cleveland Museum of Art. (2017). Yayoi Kusama: Infinity mirrors. London, Munich, New York, Washington, DC: Hirshhorn Museum and Sculpture Garden.