A Journey to Shora:

Expressing the Architectural Environment Behind
A Door into Ocean

by
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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

This thesis seeks to express the architectural environment behind Joan Slonczewski's 1986 science-fiction novel, *A Door into Ocean.* The novel describes a water-covered planet called Shora; its inhabitants, Sharers; and their alternative way of life on living rafts. Building on Slonczewski's writing, I present a series of digital paintings and a narrative to express what living on Shora's rafts might feel like for its residents. Using case studies of existing projects and research into the world of living architecture and biodesign, I situate this project within contemporary architecture, attempting to envision how it might feel to occupy a world of living things.

Life is characterized by the ability to evolve, metabolize, and reproduce. Throughout history, human attempts to provide a safe living environment have led us to a separation between the built environment and nature. With today's environmental concerns, it is imperative for us to consider visionary approaches to imagine a living, instead of a non-living, architecture. Inspiration from and use of the living world in design is encompassed within a large body of work by designers and researchers. Biomimicry (mimicking features or behaviours of living things), biodesign (synthesizing new hybrid typologies by using living organisms as the main elements of the built environment), living and soft-living architecture (using living organisms or lively matters in design), and ecological design (minimizing design's environmentally destructive impacts through integration with living processes) overlap and inform the efforts of many working in the field. These attempts at living architecture, however, remain mostly at a small scale in laboratories or at the scale of installations or concept designs. As the field grows, it is important to envision how the techniques being developed in smaller scales can affect a new way of life in the future. I am particularly interested in representing how architecture might go beyond biomimicry and use living organisms as the main elements of the built environment as described in Shora.

A Door into Ocean is a compelling critique of human life, achieved through "rejecting the terrestrial"[1] and refusing totalitarianism and dictatorship, all seen in Sharers' way of life harmonized with their aquatic environment. Acting as a robust ecosystem for many different marine species without threatening their lives, Shora might represent the future biodesigners dream about. The Sharers use genetic engineering to enable the coexistence of different living materials and their hastened evolution as needed. They use scaffolding and weaving techniques to create semi-permanent structures covered with living organisms. Finally, they modify their own bodies to further adapt to their environment. Through all these techniques, the world in *A Door into Ocean* combines biodesign and living architecture to arrive at a balanced ecological approach to life with the natural world.

Shora is a work of science fiction, set on a fictional planet. Arriving at Shora's architecture today requiring systematic changes not just to our architectural systems, but also to sociopolitical issues. Shora can, however, act as a window to a possible alternative vision. In this way, my role as the architect is to express this world through drawings and narratives. Through this exercise of expressing the imagined, we might get closer to answering larger questions about living architecture: What is the quality of an architecture merged with nature? What are the characteristics of this kind of architecture? How does it feel to live in such a world?

1 Katie Lloyd Thomas, 2017. "Feminist Hydro-Logics in Joan Slonczewski's *A Door into Ocean*" In Landscript 5: Material Culture, ed. Jane Hutton (Berlin: Jovis Verlag, 2017), 196.

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I am grateful to the entire UW faculty who gave us a chance to follow our interests. Studying at this school, with its open-minded atmosphere, was an honour for me. Seeing the opportunity afforded to each and every student to work on entirely different interests, is something that I can always talk about with pride. This school is the first place that I can call home in Canada. I hope that it will be a lovely home for many new students to come, especially for those who leave their homes as they seek a better place to live and learn.

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DEDICATION

To Joan Slonczewski

TABLE OF CONTENT

iii AUTHOR'S DECLARATION

iv ABSTRACT

vi ACKNOWLEDGMENT

xi DEDICATION

xii TABLE OF CONTENT

xvi LIST OF FIGURES

xxiv PROLOGUE

1 PART ONE: INTRODUCTION

4 **Overall Outline of the Thesis**

5 Overview of Part Two

6 Overview of Part Three

10 Conclusion

13 PART TWO: THE DOOR OF LIFE, THE SUN

19 **Scene 1: The Home and the Membrane**

37 **Scene 2: The Ground**

47 **Scene 3. The Raft**

65 **Scene 4. Inverted Forest**

75 PART THREE: CONTEXTUALIZING *A DOOR INTO OCEAN* IN LITERATURE & ARCHITECTURE

77 **3.1. From Non-living to Living Architecture**

79 3.1.1. Concerns: Overusing Natural Resources

82 3.1.2. Concept & Question: Toward Living Architecture

82 3.1.2.1. Relation of Architecture and Nature Diagram

86 3.1.2.2. Metamorphosis Diagram

92 3.1.3. Literature Review

92 3.1.3.1. Literature to Understand ***A Door into Ocean***

94 3.1.1.2. Literature to Understand Biodesign and Living Architecture

99 **3.2. Understanding *A Door into Ocean***

101 3.2.1. The Philosophy

104 3.2.2. Architecture and the Role of the Architect on Shora

106 Living vs. Non-Living

107 Definition of Life and Living Organisms

110 Living Cell

114 3.2.3. The Rhizomatic Relationship

116 Raft Growth

124 3.2.4. The Concept of the Doors

127 3.3. Case Studies in Architecture & Nature

128 3.3.1. Return to Ocean

128 Future Venice Project

132 3.3.2. Living Structures

132 3.3.2.1. Meghalaya Bridges

134 3.3.2.2. Fab Tree Hab

136 3.3.2.3. Baubotanik Tower

138 3.3.3. Living Materials and Lively Matters

138 3.3.3.1. Mushroom – Mycelium

145 3.3.3.2. Biodigital Barcelona Chair

145 3.3.3.3. Biocouture

149 PART FOUR: CONCLUSION

158 LETTERS OF COPYRIGHT PERMISSION

164 BIBLIOGRAPHY

170 APPENDICES

170 7.1. Scene 1: Story of the Root of Life

180 7.2. Scene 2: Polyp Shape Dwellings

188 7.3. Crochet Coral Reef

196 7.4. Initial Inspirations from A Door into Ocean

202 GLOSSARY

FIGURES

xxiv *Figure 1 Chasing the butterfly.*
Digital painting by author.

xxvi *Figure 2 Jellyfish.*
Anna Fox, "At the Monterey Bay Aquarium," June 21, 2014, https://www.flickr.com/photos/harshlight/16080683557/. Modified by author under Creative Commons Attribution 2.0 Generic license (https://creativecommons.org/licenses/by/2.0/).

5 *Figure 3 Meditating in the silkhouse.*
Digital painting by author.

6 *Figure 6 The ground.*
Digital painting by author.

6 *Figure 4 The newly settled raft of Leni-el section.*
Drawing and digital painting by author.

6 *Figure 5 Inverted forest.*
Digital painting by author, with screenshot from Alfredo Barroso, "MANGROVE FOREST, UNDERWATER IMAGES," YouTube video, 2:03, July 9, 2011, https://www.youtube.com/watch?v=syuvFvjv8eo, 0:17. Used with permission.

7 *Figure 7 Concept diagram summary.*
By author.

17 *Figure 8 The sun with turbulence.*
Digital painting by author. Image used as reference: Shutterstock / Dariush M, accessed March 19, 2019, https://focusonbelgium.be/en/science/belgian-scientists-discover-new-form-turbulence.

20 *Figure 9 The membrane.*
Digital painting by author. Image used: Derek Parker, "Green Elfcup," November 4, 2017, https://www.flickr.com/photos/derek_p/38189670341/. Used with permission.

22 *Figure 10 Fruiting body.*
Digital painting by author. Image used: Derek Parker, "Green Elfcup," November 4, 2017, https://www.flickr.com/photos/derek_p/38189670341/. Used with permission.

22 *Figure 11 Meditating in the Silkhouse.*
Drawing and digital painting by author.

28 *Figure 12 Silkhouse plan.*
Drawing and digital painting by author.

29 *Figure 13 Silkhouse section.*
Drawing and digital painting by author.

30 *Figure 14 Silkhouse scaffold.*
Drawing by author.

32 *Figure 15 Silkhouse tectonic.*
Drawing by author.

34 *Figure 16 Silkhouse connection to the ground.*
Drawing by author.

40 *Figure 17 Walking on the ground.*
Digital painting by author.

40 *Figure 18 Roots and blossoms.*
Digital painting by author.

42 *Figure 19 Genetically engineered flowers.*
Digital painting by author.

44 *Figure 20 Signal blossom.*
Digital painting by author.

49 *Figure 21 The Shora.*
Digital painting by author.

53 *Figure 22 Newly settled raft of Leni-el section.*
Drawing and digital painting by author.

53 *Figure 23 Newly settled raft of Leni- el homes level plan.*
Drawing and digital painting by author.

53 *Figure 24 Newly settled raft of Leni- el roots & chambers level plan.*
Drawing and digital painting by author.

60 *Figure 25 Raft formation and tectonic.*
Drawing and digital painting by author.

63 *Figure 26 Leni- el topography lines and density analysis.*
Drawing and digital painting by author.

68 *Figure 27 Inverted forest.*
Digital painting by author, with screenshot from Alfredo Barroso, "MANGROVE FOREST, UNDERWATER IMAGES," YouTube video, 2:03, July 9, 2011, https://www.youtube.com/watch?v=syuvFvjv8eo, 0:17. Used with permission.

68 *Figure 28 Symbiosis.*
Digital painting by author.

70 *Figure 29 Coral polyps.*
Digital painting by author.

83 *Figure 30 Concept.*
By author

86 *Figure 31 Metamorphosis I.*
Drawing by author. Images used as references: Silosarg, "Cave Hohlenstein-Stadel, Lonetal valley, southern Germany (48º32' 58.00"N, 10º 10'22.00"E)," June 21, 2008, https://www.donsmaps.com/lonevalleysites.html; "Old Rome and the Colosseum walking tour," accessed October 29, 2018, http://www.romesightseeing.net/excursion-old-rome-and-the-colosseum/; Sarah Stanfield, "Morning at Duomo di Milano," accessed October 29, 2018, https://www.thetastesf.com/tips-for-visiting-the-milan-cathedral/; Marshall Gerometta, "Empire State Building," accessed October 29, 2018, http://www.skyscrapercenter.com/building/empire-state-building/261; ICD/ITKE, University of Stuttgart, August 18, 2014, https://www.designboom.com/architecture/icd-itke-research-pavilion-2013-14-interview-08-18-2014/; Philip Beesley (Living Architecture Systems Group), "Chung Long Tiao 'Spring Dragon Tail': Shangdu Li, Interactive Watertown Exhibition, Shanghai – China 2015" (Toronto: Riverside Architectural Press, 2016), 3, figure 2, https://doi.org/10.21312/978-1-926724-98-0.

86 *Figure 32 Metamorphosis II.*
Drawing by author. Image used as reference: Philip Beesley (Living Architecture Systems Group), "Chung Long Tiao 'Spring Dragon Tail': Shangdu Li, Interactive Watertown Exhibition, Shanghai – China 2015" (Toronto: Riverside Architectural Press, 2016), 3, figure 2, https://doi.org/10.21312/978-1-926724-98-0.

100 *Figure 33 Evolving from catfish.*
Digital painting by author.

103 *Figure 34 Breathmicrobes.*
Digital painting by author.

109 *Figure 35 Metabolism.*
By author.

109 *Figure 36 Evolution.*
Reproduced by permission of Dr. Advo, "A formalized scheme for a genetic takeover," Figure 4.1 in A. G. Cairns Smith, Genetic Takeover and the Mineral Origins of Life (Cambridge: Cambridge University Press, 1982), 120.

110 *Figure 37 Living cell and phospholipid membrane.*
By author. (Data from William K. Purves, David Sadava, Gordon H. Orians, and H. Craig Heller, Life: The Science of Biology, 7th edition (Sunderland: Sinauer Associates and W. H. Freeman, 2003), 52.)

119 *Figure 38 Initial seed.*
By author.

120 *Figure 39 Growth process I.*
By author.

122 *Figure 40 Growth process II.*
By author.

122 *Figure 41 Rhizomatic growth, plan.*
Drawing and digital painting by author.

122 *Figure 42 Rhizomatic growth, isometric.*
Drawing and digital painting by author.

130 *Figure 43 Future Venice Project.*
Visualization by Christian Kerrigan, accessed March 19, 2019, https://www.dezeen.com/2014/05/30/movie-rachel-armstrong-future-venice-growing-giant-artificial-reef/.

130 *Figure 44 Mutualism.*
By author. (Data from Rachel Armstrong, Soft Living Architecture: An Alternative View of Bio-Informed Practice (New York, London: Bloomsbury Visual Arts, 2018), 154.) Images used: Marie Van den Broeck, "crumbs," accessed May 16, 2019, https://thenounproject.com/search/?q=crumbs&i=382009; Stan Diers, "heat," accessed May 16, 2019, https://thenounproject.com/search/?q=heat&i=860995.

130 *Figure 45 Future Venice Project self-organizing mixture diagram.*
By author. (Data from Rachel Armstrong, Soft Living Architecture: An Alternative View of Bio-Informed Practice (New York, London: Bloomsbury Visual Arts, 2018), 156.) Images used: Jordan Satow, "salt," accessed May 16, 2019, https://thenounproject.com/search/?q=salt&i=1673033; Nauraicon, "oil," accessed May 16, 2019, https://thenounproject.com/search/?q=oil&i=1681784; Eragon, "water," accessed May 16, 2019, https://thenounproject.com/search/?q=water&i=1603864; Bakunetsu Kaito, "pollution," May 16, 2019, https://thenounproject.com/search/?q=pollution&i=901399; Marie Van den Broeck, "soda;" May 16, 2019, https://thenounproject.com/search/?q=soda&i=168126; Yu luck, "organic waste," May 16, 2019, https://thenounproject.com/search/?q=organic%20waste&i=478832; Cono Studio Milano, "powder," May 16, 2019, https://the-

nounproject.com/search/?q=powder&i=922017.

135 Figure 46 Meghalaya living root bridge.
Amit Rawat, "Double decker living roots," October 7, 2017, https://www.flickr.com/photos/arawatclicks/37408038750/. Used under Attribution-Non-Commercial-ShareAlike 2.0 Generic license (https://creativecommons.org/licenses/by-nc-sa/2.0/).

135 Figure 47 Fab Tree Hab.
Terreform ONE, "Fab Tree Hab Village," accessed February 26, 2019, http://www.archinode.com/Arch9fab.html.

135 Figure 48 Baubotanik Tower.
Left: Ferdinand Ludwig, "Baubotanik tower after completion"; middle: Ferdinand Ludwig, "In the second growth period"; right: Boris Miklatusch, "Model of the self-supporting future structure." All images from "BAUBOTANIK: Designing Growth Processes," Form-Rule | Rule-Form 2014 symposium, University of Innsbruck (Conference Paper), accessed February 26, 2019, https://www.researchgate.net/publication/319987765. Used with permission.

141 Figure 49 Mycelium.
Alison Harrington, "Mycelium," June 11, 2014, https://www.flickr.com/photos/125349922@N05/14555906541/. Used under Attribution-ShareAlike 2.0 Generic license (https://creativecommons.org/licenses/by-sa/2.0/).

142 Figure 50 Big Bolshoi simulation vs. Living raft simulation.
Top: Rich Murray, Dark matter stimulation. #19. astroMSgalseq_D_063, June 8, 2005, https://www.flickr.com/photos/rmforall/18135102. Modified by author under Creative Commons Attribution 2.0 Generic license (https://creativecommons.org/licenses/by/2.0/.) Bottom: Drawing by author.

144 Figure 51 Mycelium project.
"Mycelium Project 1.0 – Myceliumchair," accessed March 24, 2019, http://www.ericklarenbeek.com/.

146 Figure 52 Biodigital Barcelona Chair.
Alberto T. Estévez - GenArqOffice, Biodigital Barcelona Chair, Barcelona, 2010 (Photos: Alberto T. Estévez) picture used with permission. Modified by author.

146 Figure 53 BioCouture material.
"BioCouture material," accessed March 30, 2019, https://www.dezeen.com/2014/02/12/movie-biocouture-microbes-clothing-wearable-futures/.

150 Figure 54 Living architecture diagram.
By author.

152 Figure 55 Future Venice Project.
Visualization by Christian Kerrigan, accessed March 19, 2019, https://www.dezeen.com/2014/05/30/movie-rachel-armstrong-future-venice-growing-giant-artificial-reef/.

152 Figure 56 Mycelium project.
"Mycelium Project 1.0 – Myceliumchair," accessed March 24, 2019, http://www.ericklarenbeek.com/.

152 Figure 57 Biodigital Barcelona Chair.
Alberto T. Estévez - GenArqOffice, Biodigital Barcelona Chair, Barcelona, 2010 (Photos: Alberto T. Estévez) picture used with permission.

152 Figure 58 BioCouture material.
"BioCouture material," accessed March 30, 2019, https://www.dezeen.com/2014/02/12/movie-biocouture-microbes-clothing-wearable-futures/.

153 Figure 59 Meghalaya living root bridge.
Amit Rawat, "Double decker living roots," October 7, 2017, https://www.flickr.com/photos/arawatclicks/37408038750/. Used under Attribution-Non-Commercial-ShareAlike 2.0 Generic license (https://creativecommons.org/licenses/by-nc-sa/2.0/).

153 Figure 60 Fab Tree Hab.
Terreform ONE, "Fab Tree Hab Village," accessed February 26, 2019, http://www.archinode.com/Arch9fab.html.

153 Figure 61 Baubotanik Tower.
Left: Ferdinand Ludwig, "Baubotanik tower after completion"; middle: Ferdinand Ludwig, "In the second growth period"; right: Boris Miklatusch, "Model of the self-supporting future structure." All images from "BAUBOTANIK: Designing Growth Processes," Form-Rule | Rule-Form 2014 symposium, University of Innsbruck (Conference Paper), accessed February 26, 2019, https://www.researchgate.net/publication/319987765. Used with permission.

170 Figure 62 The cracker root.
Photograph and digital painting by author.

170 Figure 63 The underground gate.
Digital painting by author. Photograph by Maria Legault, "A cul-de-sac of rock," February 13, 2014, https://mariaklegault.com/2014/02/13/rockwood-conservation-area-rockwood-ontario/. Used with permission.

170 Figure 64 The Maze.
Digital painting by author.

170 Figure 65 The Castle.
Digital painting by author. Image used: accessed Nov 19, 2017, http://www.rockwoodheaven.com/old-mill-2014.html. Used with permission.

180 *Figure 66 Polyp form dwellings.*
Drawing by author. Images used: Daniel Stoupin, Pete West, BioQuest Studios, "Discosoma sp," 2018, https://www.microworldsphotography.com/Galleries/Macro-of-corals/i-rxDQ8bm, http://bioqueststudios.com.au. Used with permission; Iris Van Herpen, "AERIFORM," accessed April 4, 2019, https://www.irisvanherpen.com/haute-couture/aeriform. Used with permission from Philip Beesley.

180 *Figure 67 Inside polyp.*
Drawing by author. Images used: Daniel Stoupin, Pete West, BioQuest Studios, "Discosoma sp," 2018, https://www.microworldsphotography.com/Galleries/Macro-of-corals/i-rxDQ8bm, http://bioqueststudios.com.au. Used with permission; Iris Van Herpen, "AERIFORM," accessed April 4, 2019, https://www.irisvanherpen.com/haute-couture/aeriform. Used with permission from Philip Beesley.

180 *Figure 68 Polyp shape dwellings site plan.*
By author. Aerial from Eramosa River on Google Earth.

189 *Figure 69 Wire Crochet.*
Crochet experiment and photograph by author.

189 *Figure 70 Crochet polyp.*
Crochet experiment and photograph by author.

189 *Figure 71 Crochet coral reef.*
Crochet experiment and photograph by author.

189 *Figure 72 Inside crochet corals.*
Crochet experiment and photograph by author.

196 *Figure 73 Live dwellings.*
Digital painting by author.

196 *Figure 74 Swimming in a floating island.*
Digital painting by author.

203 *Figure 75 Living raft*
By author.

PROLOGUE

Ever since I can remember, I was interested in the world of fantasy, mystery, imagination, and magic. These interests originated in my childhood when my father used to make up fictional and magical stories for me offhand, while we enjoyed nature in our backyard. Those stories were mostly about the generosity of nature, its allure, and the power and hope embedded in this generosity. During summer, we lay under the shadow of the trees and watched the sky and the sun while he made mysterious dream worlds for me. Sometimes I would chase the butterflies, catch and release them, and watch how they danced freely in the sky. Playing in nature and listening to those stories are some of the most memorable moments of my childhood and my life. The most exciting part of these memories was that my father could only create these stories for me, not for anybody else, even my siblings. When I grew up, and he told me that, it surprised me. I felt as though those happy and special moments were just for me, and I wanted to pursue that feeling. So, when I started my thesis at Waterloo, I thought it would be the right time to use my experiences in recapturing my dreams about nature and the natural world. (Figure 1)

Figure 1 *Chasing the butterfly.*

Figure 2 *Jellyfish.*

"We humans have built a world of rectilinearity; the homes we live in, the skyscrapers we work in, the grid-like arrangements of our streets speak to us in straight lines, yet outside our boxes, the natural world teems with swooping and crenelated forms."[1] *(Figure 2)*

1 Margaret Wertheim and Christie Wertheim, *Crochet Coral Reef* (Los Angles: Institute of figuring, 2015), 42.

PART ONE: INTRODUCTION

This thesis seeks to express the architectural environment behind the science-fiction novel, *A Door into Ocean*, by Joan Slonczewski. It presents a series of drawings in the medium of digital painting that express my reading of the book, accompanied by a narrative to describe the features of the drawings in more detail. The novel describes a water-covered planet called Shora; its female inhabitants, the Sharers; and their alternative way of life on living rafts. The thesis drawings represent a Sharer's experience of different spaces, starting from her home, to the ground of the raft, and, at the end, the world of water beneath the raft. Through the drawings and the narrative, one can begin to envision new possibilities and approaches to the future of architecture. The focus of this thesis is neither to find an accurate scientific solution to construct this fictional world, nor is it to recommend this architecture as a futuristic model for building. Rather, it can appear as a new fantasy in people's minds, sticking to our "collective unconscious," and representing a world not so far in the future.

From the beginning of my thesis, I was interested in the world of living things and imagining an architecture integrated with nature and grown by living organisms. My initial ideas brought me into contact with Katie Lloyd Thomas's essay, "Feminist Hydro-logics in Joan Slonczewski's *A Door Into Ocean*," which encouraged me to read the novel. I found in it a compelling picture of the ideas I had been exploring since the beginning, and it made me consider *A Door into Ocean* as the basis for my thesis. Written by the American microbiologist Joan Slonczewski in 1986, *A Door into Ocean* won the John W. Campbell Memorial Award for best science fiction novel the following year.[1] Although the author's intention to foreground a feminist approach was minor, it is considered a feminist science-fiction text by many sources.[2] The story is about a fictional water-covered planet called Shora. Its inhabitants grow their living raft with interwoven trees and other living organisms, dwelling upon this raft in their "Silkhouses." Shora is a world of living things, lifelike materials, and water. The residents are Shar-

1 Katie Lloyd Thomas, 2017. "Feminist Hydro-logics in Joan Slonczewski's *A Door into Ocean*" In Landscript 5: Material Culture, ed. Jane Hutton (Berlin: Jovis Verlag, 2017), 194.
2 Ibid.

ers, a group of women who use genetic engineering and the "science of lifeshaping"[3] to modify the planet and their bodies. They profoundly believe in sharing everything rather than making rigid boundaries and separations.[4] *A Door into Ocean* is a compelling critique of humans' approach to life and how we have decided to live on the earth. The book proposes an alternative way of living and architecture that is worth exploring. As Lloyd Thomas suggests, it shares similarities with the ideas and research of Living Architecture Groups and living system researchers: "*A Door into Ocean*'s holistic vision reminds us to ask what kinds of social and conceptual environments beyond the lab or studio are implied by these new living architectures?"[5] It represents a optimistic view of what biodesigners hope for the future of the earth. These ideas and my initial love of nature led me to become interested in visually expressing the world of Shora, and to investigate the characteristics of this world.

Overall Outline of the Thesis

This thesis is composed of four parts. Part One is an introductory essay. The main body of the thesis is composed of parts two and three. Part Two, a synthesis of drawings and a narrative based on *A Door into Ocean,* expresses the architectural environment behind the book from a personal perspective. Part Three encompasses the research, analysis, and precedents that provide the basis for the initial synthesis. The first essay in Part Three explains the concept behind the thesis and investigates the concerns that animate my interests in a living, as opposed to a non-living, architecture. The second essay of this section explores other aspects of *A Door into Ocean* including its philosophy, feminist basis, rhizomatic relationships, architectural breakdown, and concept of the doors in Shora. Finally, the last essay in Part Three presents different analogies in nature, architecture, and specifically, in the field of living architecture, that resonate with the planet Shora depicted in the novel. Finally, Part Four includes concluding remarks and a speculative projection on future possibilities in living architecture and biodesign.

3 Ibid, 193.
4 Ibid.
5 Ibid, 201.

In the following pages, I will summarize the ideas discussed in parts two and three before delving into them more deeply.

Overview of Part Two

This chapter is the main part of this thesis, showing the synthetic result of all the research presented in the chapters that follow it. In this part, I express the world of Shora with a series of drawings, accompanied by a narrative. The name of Part two: The Door of Life, The Sun is inspired by the concept of the doors in the book, which considers the sun a symbol of life and the first of the three doors of Shora. The sun, here, is the agent that creates all living things. The drawings and narrative describe the spatial experience of a Sharer on Shora. It contains four scenes:

Figure 3 *Meditating in the silkhouse.*

The Home and the Membrane

This scene demonstrates the spatial experience of the Sharers' homes, known as Silkhouses. According to Slonczewski, silkhouses are spire-form structures made with concave panels of woven silk. She describes the interior walls and ceilings as covered with a furry paste decorated with fungi. I built upon this description in my illustrated narrative by employing a few materials that share the same furry paste qualities described in the book. These include lichen (an association of fungi and algae), bacterial cellulose biofilm (which acts like a flexible water barrier), and moss. I also speculated that silkhouses might be stitched to the ground with living roots passing through their membranes and weft-knitted panels. (Figure 3)

The Ground
This scene expresses the quality of the soil and the feeling of walking upon the raft. A layer of fertile soil-like substance covers the main scaffold of the raft, providing a flexible surface. Mycelium, grass, and algae solidify the soil and make an ever-green matting to walk on. (Figure 4)

The Living Raft
These annotated vignettes demonstrate a comprehensive view of one raft using plans, a section, and diagrams that describe its formation and architectonics. The rafts' scaffolds consist of arborescent living structures, which connect with a rhizomatic network of roots floating on the ocean. They provide thick and durable surfaces to build upon with layers of organic waste, ever-green matting, and raft blossoms. (Figure 5)

Inverted Forest
This scene is about the space beneath the raft, representing the raft under water. The rafts' living trunks and branches grow vertically into the depth of the ocean. The living branches are covered by algae, corals, sponges and other marine organisms. (Figure 6)

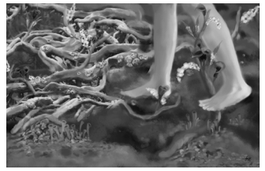


Figure 6 *The ground.*

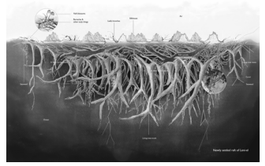


Figure 4 *The newly settled raft of Leni-el section.*

Figure 5 *Inverted forest.*

Overview of Part Three

Overview of "From Non-Living to Living Architecture"
The beginning of this chapter points out a few critical concerns caused by inconsiderate environmental interventions in modern times. Humans' relationship with nature has changed significantly throughout time. The early humans of the prehistoric era had little understanding of the causes behind natural phenomena. This lack of knowledge often resulted in them fearing their surrounding environments. As knowledge about nature was gained and passed down through generations by different means, the human relationship with nature also changed. In the West, modernization caused a separation between nature and the built environment. By the time of the current

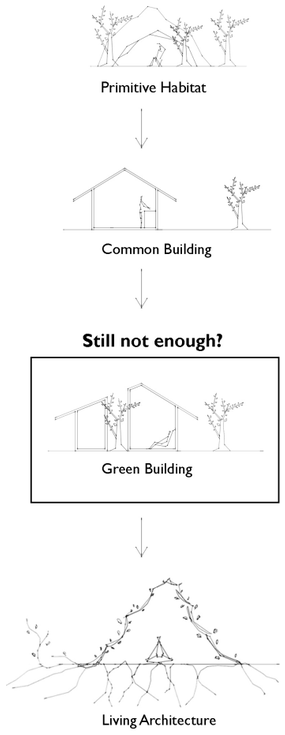


Figure 7 *Concept diagram summary.*

information revolution, the side effects of this divide (now exported to most places around the globe) have become progressively more vivid. By employing environmental strategies in building, the relation of nature and built environment has become closer, but the gap is still tangible. In fact, as the population increases, we extract more from nature, and it seems that green buildings just present a better appearance to cover human neglect.

These crises inspired me to consider a visionary approach to architecture and imagine a living architecture, instead of a non-living one, that harmonizes with nature rather than destroying it. This architecture is a part of nature; it is self-growing, self-repairing, intelligent, and it has fascinating forms. It is built by living cells, and evolution, reproduction, and metabolism are some of its attributes. (Figure 7)

The main question that arises here is, how can we imagine an architectural environment that is integrated with nature and grows with the symbiosis of living organisms? And what are the significant characteristics of such a living environment? The concept resonates with the world of Shora as it has been totally grown by living organisms, from the core to the surface. Here, Shora is an example of a visionary approach to this kind of shift in architecture.

Overview of "Understanding *A Door into Ocean*"
The philosophy behind *A Door into Ocean* is deeply rooted in the hypothesis that humans evolved in water and the process of human evolution from fish.[6] It emphasizes water as a site of human inhabitation over terrestrial life. Besides that, it indicates the relation of this aquatic architectural environment to feminist theory. Therefore, the book is often considered a work of feminist science fiction.

Shora's architects are co-designers with the planet's ecology. Furthermore, they are not just designers, but biologists who have comprehensive knowledge about nature. The hypercomplex materials that make up Shora, such as living trees, fungi, seaweed, corals, moss, algae, and fur have similarities to the characteristics of "experimental architecture," which bring

6 Ibid.

risks and uncertainty and make hybrids.[7]

The absence of hierarchy or a totalitarian system in Shora's social relations translates into the Sharers' practice of architecture. Each person has equal rights in using spaces, and all resources are shared. As nature, with its ever-changing features, grows and constructs the architectural environment, it is never monotonous to live in. In the terrestrial life that we have manufactured on earth, inert materials with lifeless qualities in a living environment do not fulfill our wide-ranging and diverse desires. In the world of Shora, harmonizing with nature is a creative approach. The inhabitants experience genuine inner peace in which fear has no meaning anymore. This fearless morale is the result of integration with nature.

One of the main questions here is, what are the differences between a living architecture and a non-living one? Evolution, procreation, and harmonization with human instincts are the main characteristics of a living architectural environment. Here, the definitions of life, living organism, and living cell are described to better communicate the characteristics of this world.

Shora is formed like plateaus, growing "in the middle, not at the beginning or in the end."[8] It is rhizomatic as it makes connections with everything. Interconnection can be seen at all scales, from the macro to the micro. Living cells make separate, but not isolated, compartments. Overall, the whole living environment is made up of living cells – the smallest architectural elements – that replicate from the bottom up. In case of rupture, Shora's rafts can revitalize and regrow since all the Sharers' knowledge and skills have been recorded in every cell. The living raft structure is rhizomatic as the hydroponic tree roots grow and create new trees on their path to make a multiplicity. All interconnected and interwoven living branches are ever changing, making a new entity every single moment.

7 Rachel Armstrong, *Soft Living Architecture -an Alternative View of Bio-Informed Practice* (New York, London: Bloomsbury visual arts, 2018), 23.

8 Gilles Deleuze and Felix Guattari,"Introduction: Rhizome," in A Thousand Plateaus: Capitalism and Schizophrenia [Mille plateaux, of Capitalisme et schizophrenie], translated by Brian Massumi (Minneapolis: University of Minnesota, 1987), 21.

Shora has just three doors: the door of the sun, which is a representation of life; the door of death, which is inevitable in each person's life and for all living things; and the door of the self that the Sharers do not share with anyone. This thesis focuses on the door of the sun as a metaphor for life. The architecture discussed in this thesis is a living architecture. Life and living organisms have significant roles to play in the design and sustainability of this architecture. This is why the door of the sun resonates with the main concepts under discussion in this work. The three doors of Shora provide a contrast to how humans make countless doors, borders, and seperations on earth to consolidate power. The concept of the doors in *A Door into Ocean* is a compelling critique regarding how we live on our planet. It is a symbol of the walls and borders that separate people and deprive them of their rights.

Overview of Case Studies in Architecture and Nature

The world of Shora depicts a fictional, speculative approach to architecture. There are, however, case studies in architectural practices of recent decades – from biodesign, ecological architecture, and living and soft-living architecture – that resonate with this world. These practices are still in the initial stages of development, and they overlap in many ways. Many of them propose advantages that may be considered effective environmental solutions one day, but their future is unknown and full of unanswered questions. There is no guarantee that any of the prototypical concepts in development will aid the emergence of a better future.

Examples of these practices can be seen in Rachel Armstrong's projects where she proposes an experimental architecture for this century. In her "Future Venice" project, she suggests a self-organizing mixture of artificial cells that reinforce the foundations of Venice. They grow over time, creating a living scaffold not dissimilar to Shora's rafts.

Using living trees as the main structural elements – often using "pleaching"[9] techniques – is another method where living organisms are used in architectural projects. Meghalaya bridges are an old and significant example of a living structure formed by rubber fig aerial roots. Fab Tree Hab

9 Check the glossary.

by Terreform One is a proposal for future homes which use trees as their main scaffold. The main goal of the project is congruence with ecology. Similarly, Baubotanik Tower employs living trees as the structural element and the envelope of the building.

Shora's rafts and architectural environment are grown by living materials. A niche in contemporary design encompasses interests in using living things and lively matters. Use of moss, algae, mycelium, grass, and cellulose biofilm indicates the emergence of a new materialism in design practice. Living materials are rarely seen in architectural spaces used today. Instead, these techniques and materials are mostly used in installations or appear as experiments in labs. Constructing a new world with these kinds of materials brings up many different questions and uncertainties which require further investigation.

Conclusion

Living architecture represents a sustainable approach through life and living on the earth that we have never experienced before. To realize it, we must increase our knowledge about nature. This viewpoint is not just about architecture, but about a holistic approach to life in which architecture has an important role to play. Although the architecture of *A Door into Ocean* presents many fascinating features, it is not possible to guarantee that this is a proper, or applicable, way to construct the future.

In "The Alpha and the Omega," the architecture critic Aaron Betsky claims that building rules, economic issues, and construction methods make it difficult to create great architecture.[10] He believes that "some of the most powerful pieces of architecture do not exist in buildings. We inhabit them

10 Aaron Betsky, "The Alpha and the Omega," *Beyond No. 1: Scenarios and Speculation*, ed. Pedro Gadanho; trans. Paul Hammond (Amsterdam: SUN Architecture, 2009), 126.

through stories, whether they are myths, fiction or poetry."[11] Overall, fiction is not only fiction, but also builds up our reality from social movements to architectural environments. It builds up individuals' unconscious, impacts our consciousness, and eventually, our existence is defined by our imagination. Stories can open new windows toward other possibilities and new approaches to the future of architecture. Today is the time to think about new, alternative ways of living, and one of the architect's main responsibilities is to write the stories of tomorrow. This novel represents a new approach to life and architecture that is worth expressing as a speculative, visionary architecture. This future may or may not be possible, but it is nonetheless captivating to dream and express.

11 Ibid.

PART TWO: THE DOOR OF LIFE, THE SUN

Note: The following illustrated narrative is by the author, inspired by descriptions from *A Door into Ocean*. I have built upon the concepts described in the book through additional research on current and potential techniques in the design of living architecture and biodesign, which are further discussed in Part Three. The aim of the following narrative is to speculate how the ideas described in the book might work on a tectonic and quotidian way for the Sharers.

"- Name the first Door of Shora.

- The Sun, which shares all life."[1]

The journey starts with the sun. It distributes energy and life on the planet using convection to exchange heat and cause turbulence. (Figure 8)

1 Joan Slonczewski, *A Door into Ocean* (New York: A Tom Doherty Associates Book, 1986), 81.

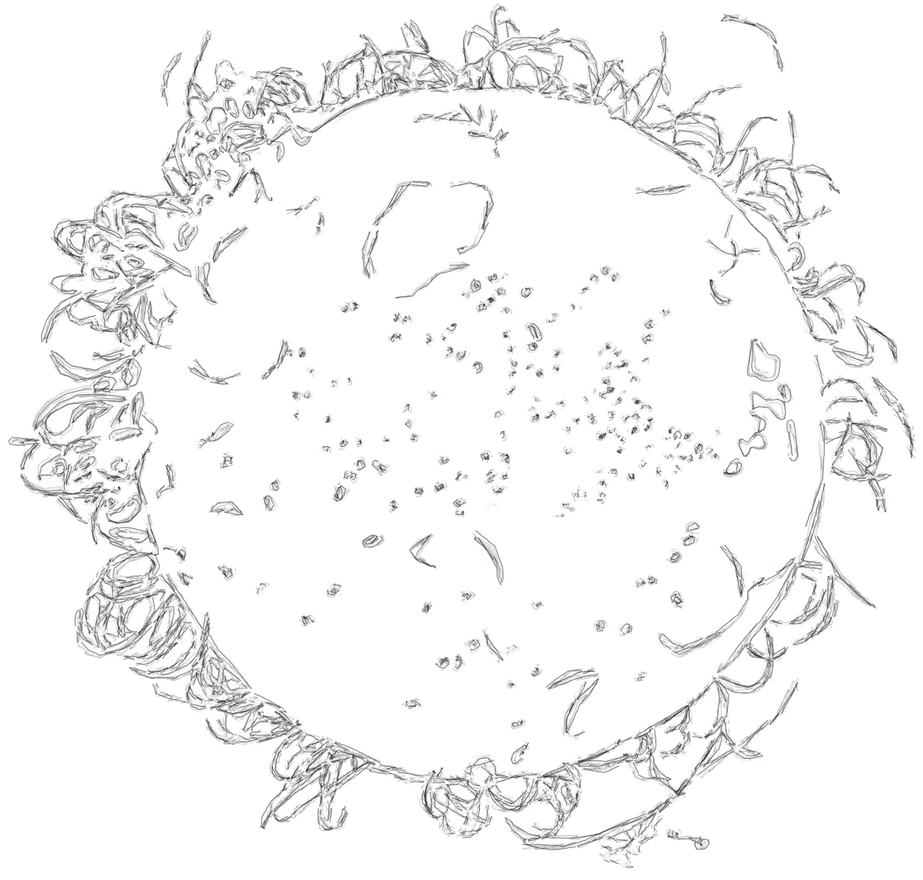


Figure 8 *The sun with turbulence.*

Scene 1: The Home and the Membrane

The starworms were singing. She touched the wall with her long-webbed fingers. The material was soft, viscous, mucous, and life-like. She could feel how the layers breathed. She wanted to examine the membrane's health using her genetic-engineering knowledge. Water droplets shone on the surface and the fruiting body of the fungi. The whole wall was a dense and flexible layer. The mycelium beneath the surface made a vast network, connecting the whole environment like an "information-sharing membrane."[2] The surface was made not just of fungi, but a symbiosis of different species like moss, mushrooms, algae, microorganisms, and bacteria that formed a thick, water-resistant layer of cellulose biofilm with woven silks on the exterior. At the microscopic scale, it was constructed by cytoplasm and living cells that made separated, but not isolated, compartments. (Figure 9)

2 Paul Stamets, *Mycelium Running: How Mushrooms Can Help Save the World* (New York: Ten Speed Press, 2005), 2.

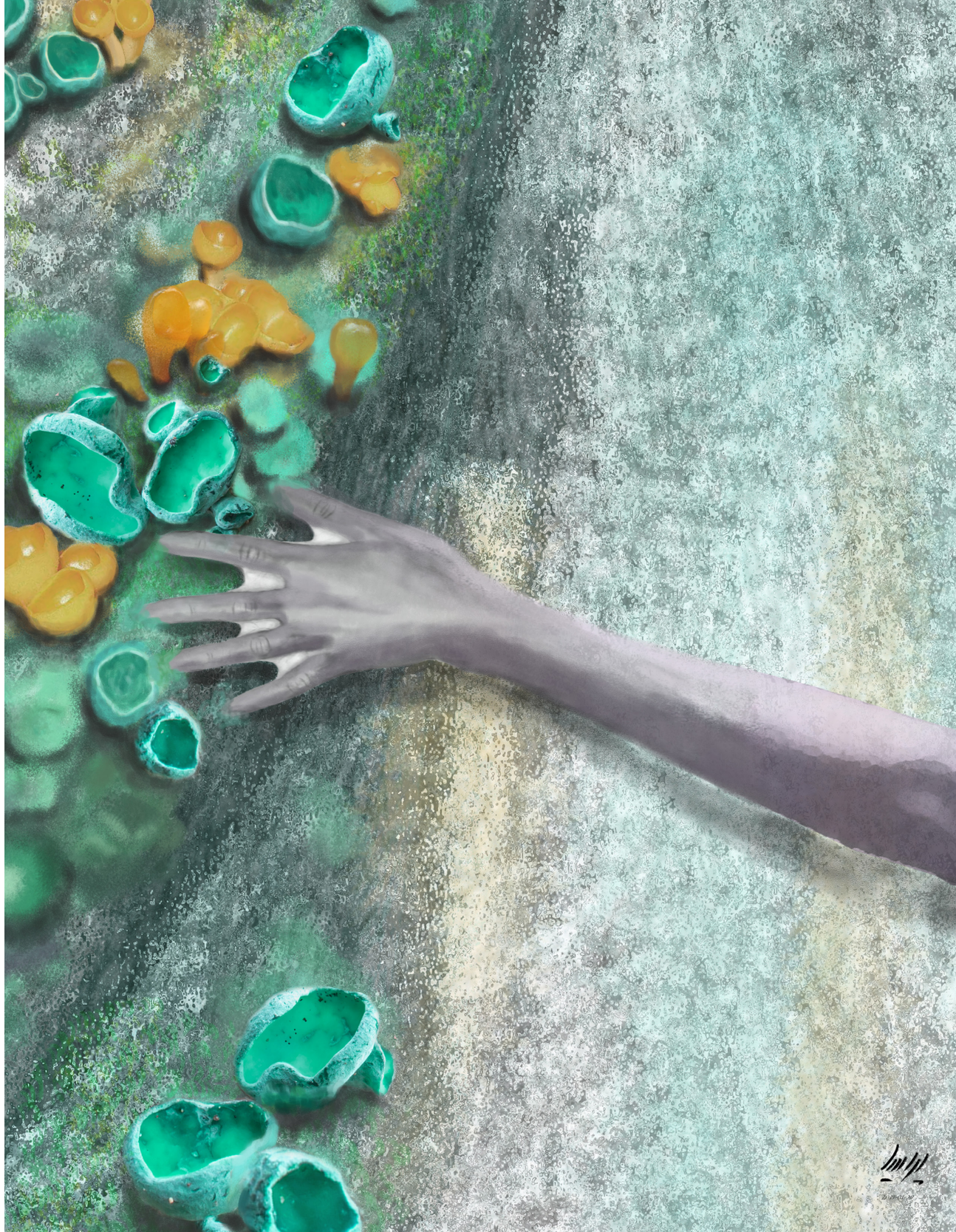


Figure 9 *The membrane.*

The interconnection of living materials could be seen at all scales, from the micro to the macro. The harmony of cyan and amber colours furnished a unique and well-designed environment to sit on cross-legged, meditate, and discover the world of mind and self. The whole space matched her feminine body, and you could tell she was unified with the environment. She and her sisters were in the world of the in-between, a liminal existence with interconnections between all strata. They made a rhizome with the whole environment as they modified their own bodies and the entire world to create harmony and connections. They were "aided, inspired, multiplied"[3] by the living trees, breathmicrobes, mycelium, corals, and many other species. (Figures 10-11)

Figure 10 *Fruiting body.*

Figure 11 *Meditating in the Silkhouse.*

3 Gilles Deleuze and Felix Guattari,"Introduction: Rhizome," in *A Thousand Plateaus: Capitalism and Schizophrenia* [Mille plateaux, of Capitalisme et schizophrenie], translated by Brian Massumi (Minneapolis: University of Minnesota, 1987), 3.

The interior odour was pleasant, unique, and rejuvenating. The ground was covered with a thick, evergreen layer of moss – soft and flexible – that acted like a living mattress suitable for sitting or sleeping on. In some areas, it was decorated with the fruiting body of the fungi. The mushrooms were not just decorative. Besides solidifying the membrane and their information-sharing ability, they provided a decent source of nutrition for the inhabitants. There were no windows, but the transparency of the algae layer and cellulose biofilm brought enough light inside the home.

The home was a tent-like spire, made of concave panels in different sizes and forms attached together. The foundation of the home was stitched to the ground of the raft with tangled living roots. From the outside, it was covered with woven sea silks on which moss, weeds, and other living organisms partially grew. She started to fix a few broken panels with her sisters. They had broken in last week's hurricane. It was common for them to gather, consult, and share responsibilities. The home had access to the outside, as well as to the ocean through under-raft tunnels. The tunnels were made of interwoven roots lit with phosphorescent substances. (Figures 12-16)

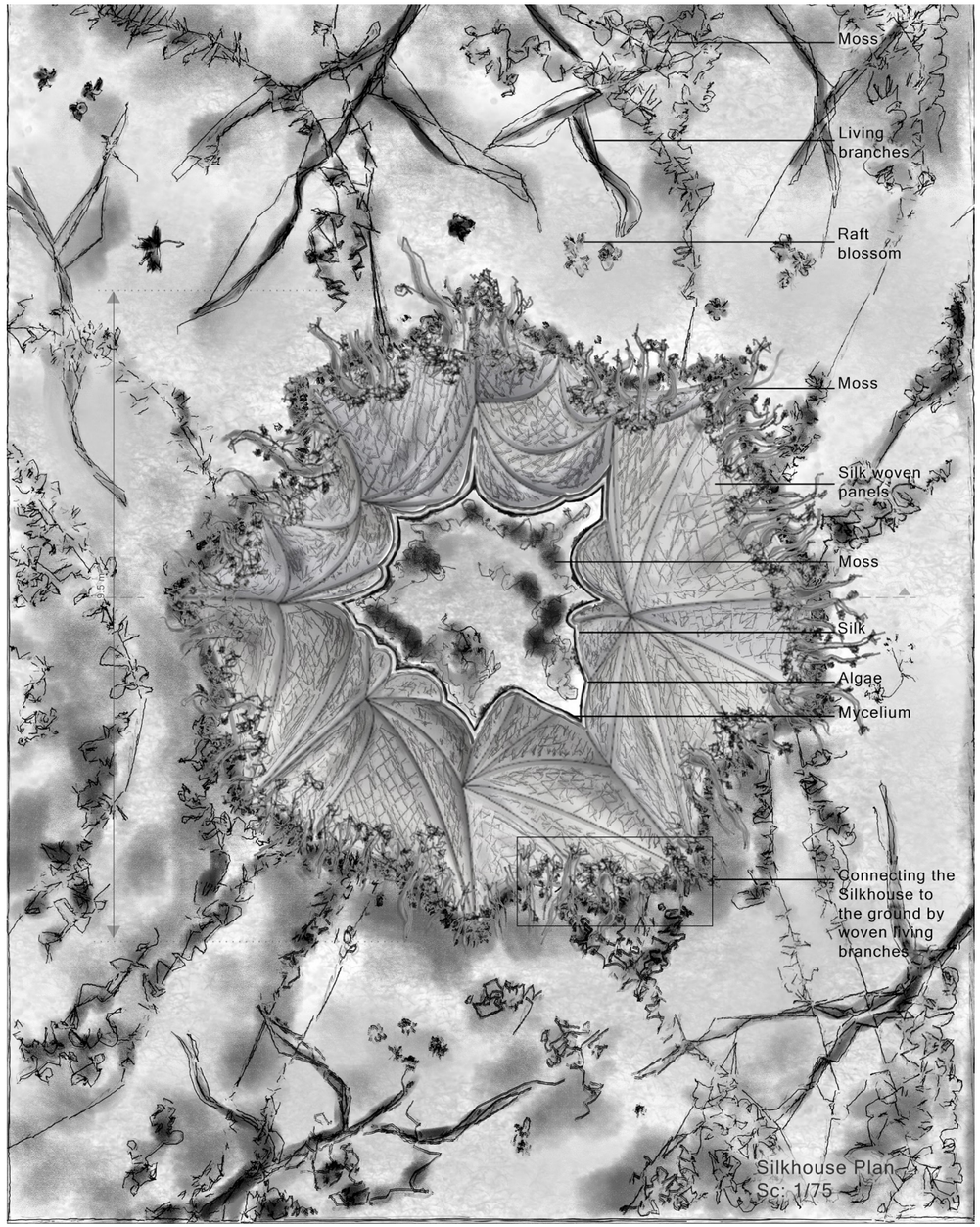


Figure 12 *Silkhouse plan.*

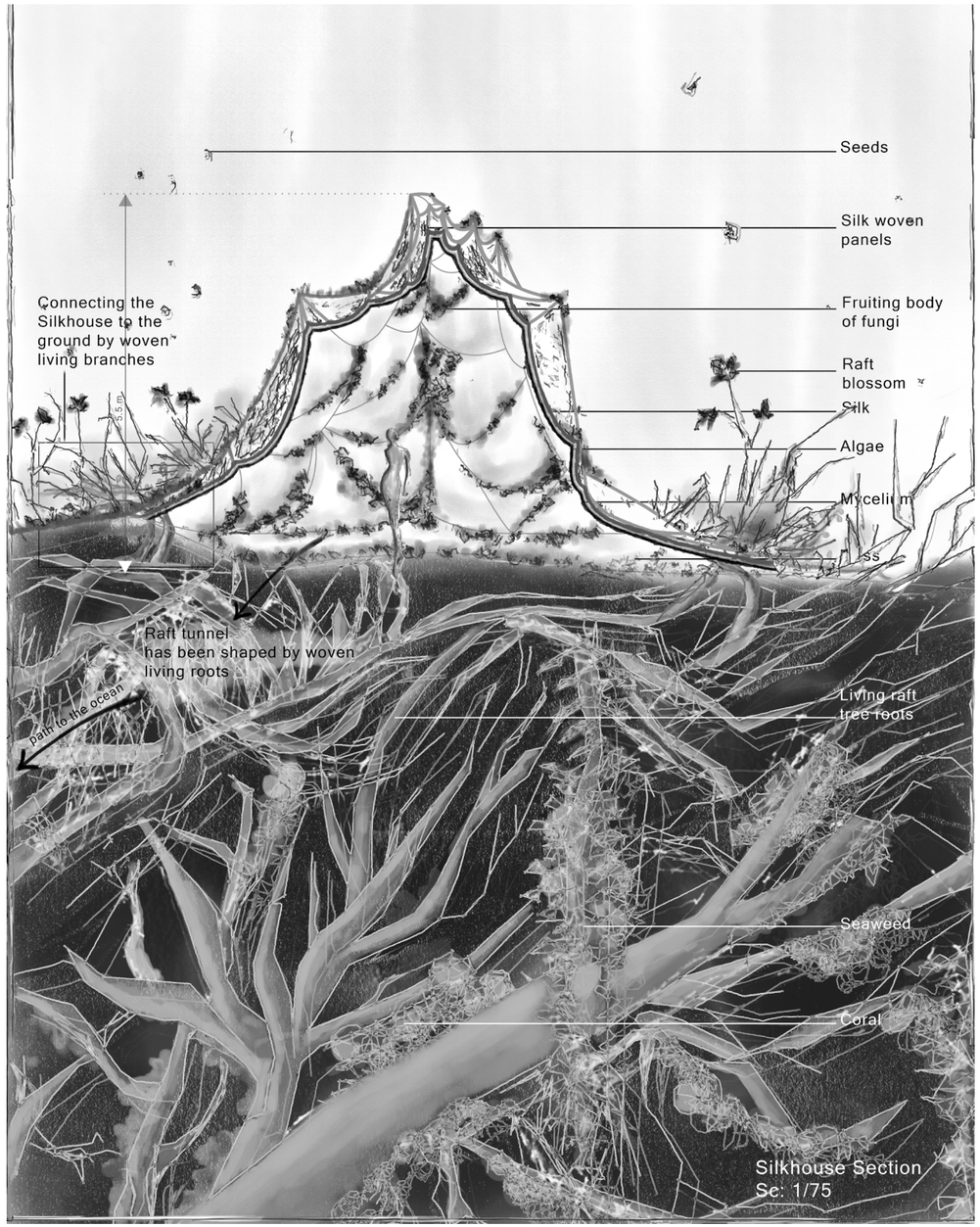
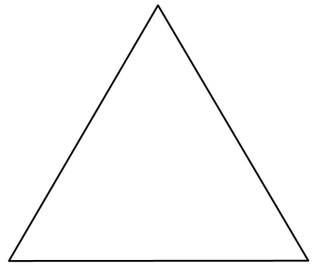
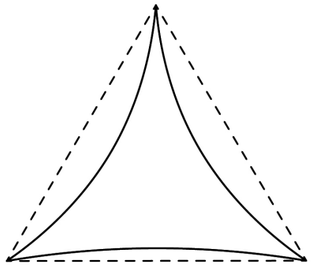


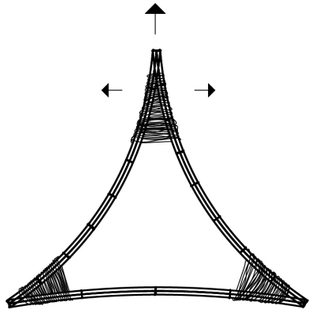
Figure 13 *Silkhouse section.*



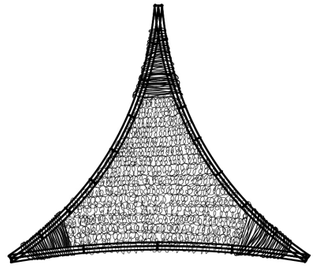
Most stable geometry



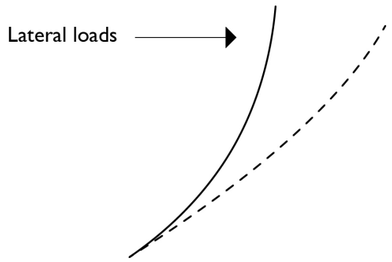
Concave panel with pre-tensioned segments (provide more flexibility)



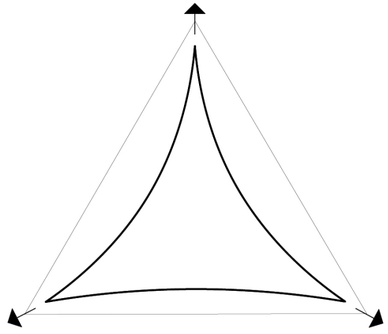
Silk threads are strong in tension



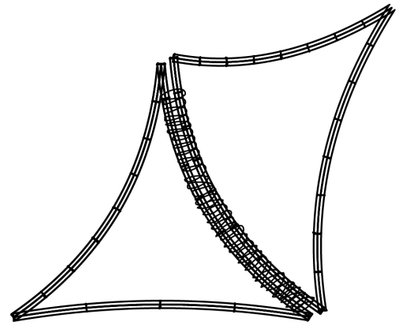
Woven panel



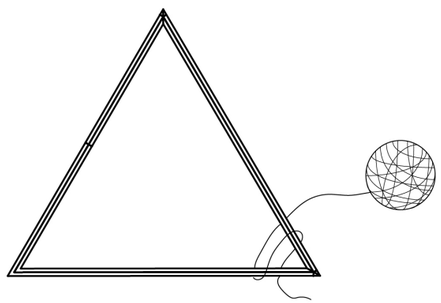
Concave element reaction in lateral load



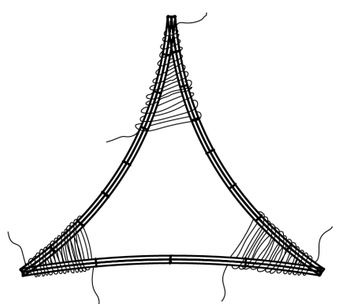
Lateral loads convert to tensional forces



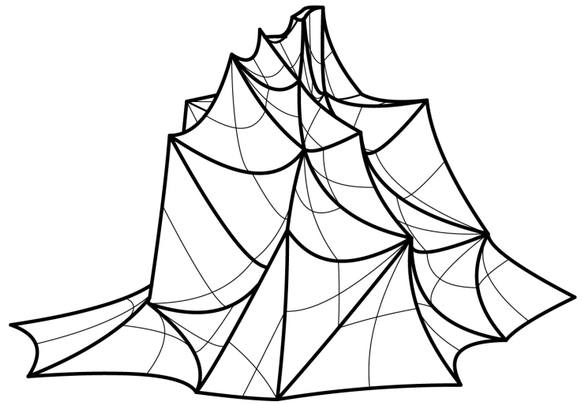
Attaching the concave panels with sea-silk and natural glue



Pre-tensioning the panels by tying sea-silk



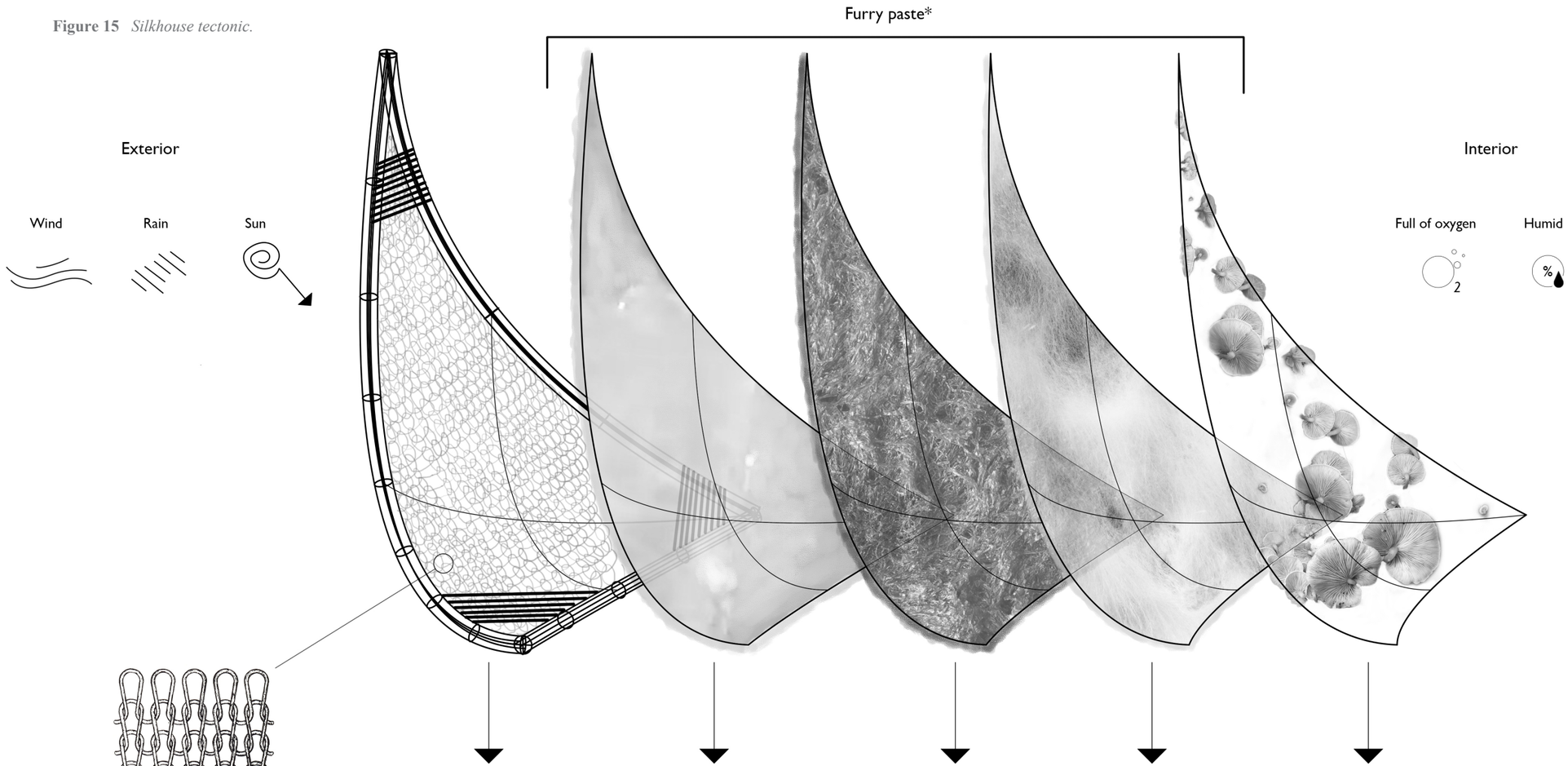
Sea-silk threads tolerate the tension



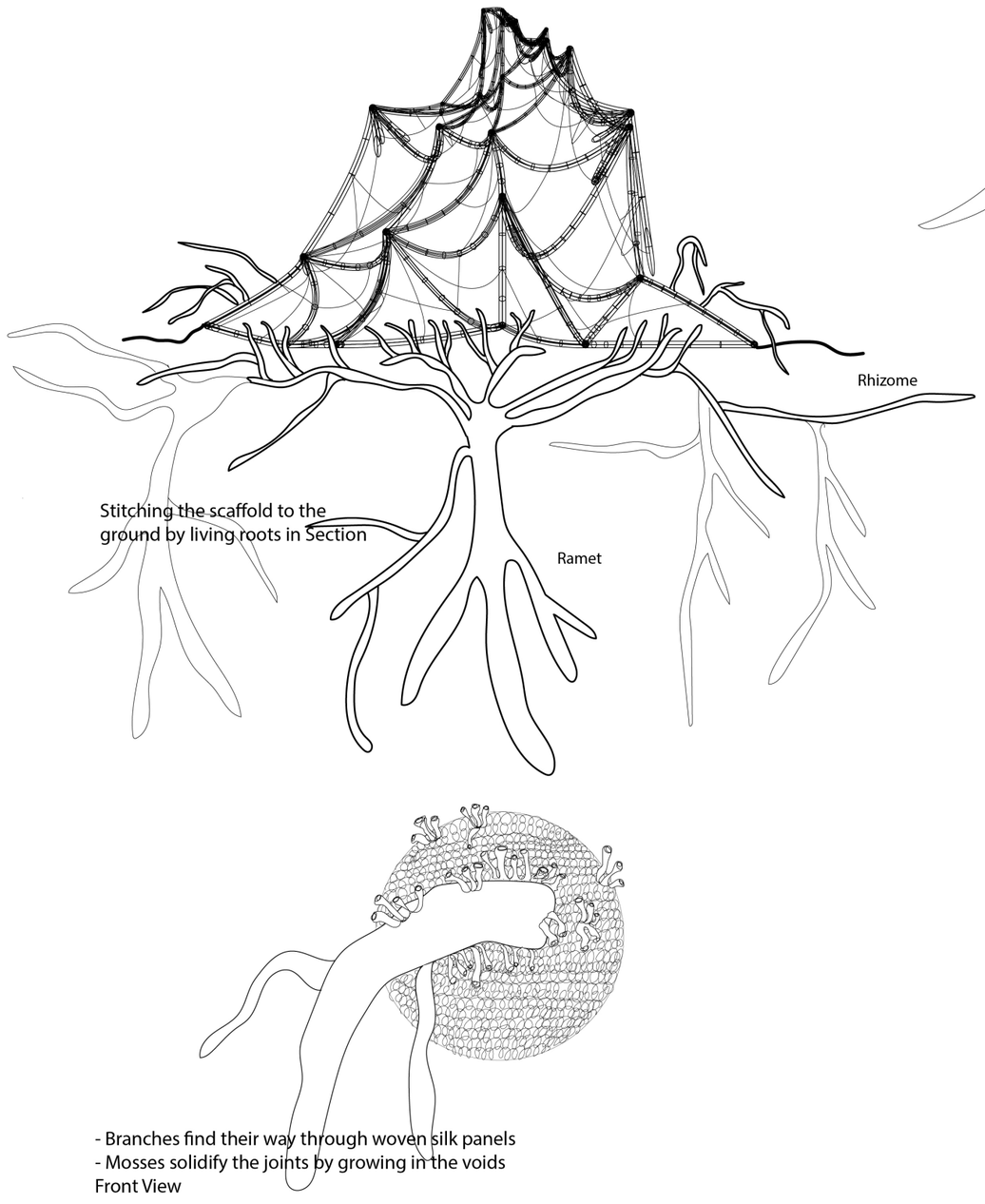
Silkhouse scaffold

Figure 14 *Silkhouse scaffold.*

Figure 15 *Silkhouse tectonic.*



* Joan Slonczewski, A Door into Ocean (New York: A Tom Doherty Associates Book, 1986), 54.
** Ibid.
*** Ibid., 116.



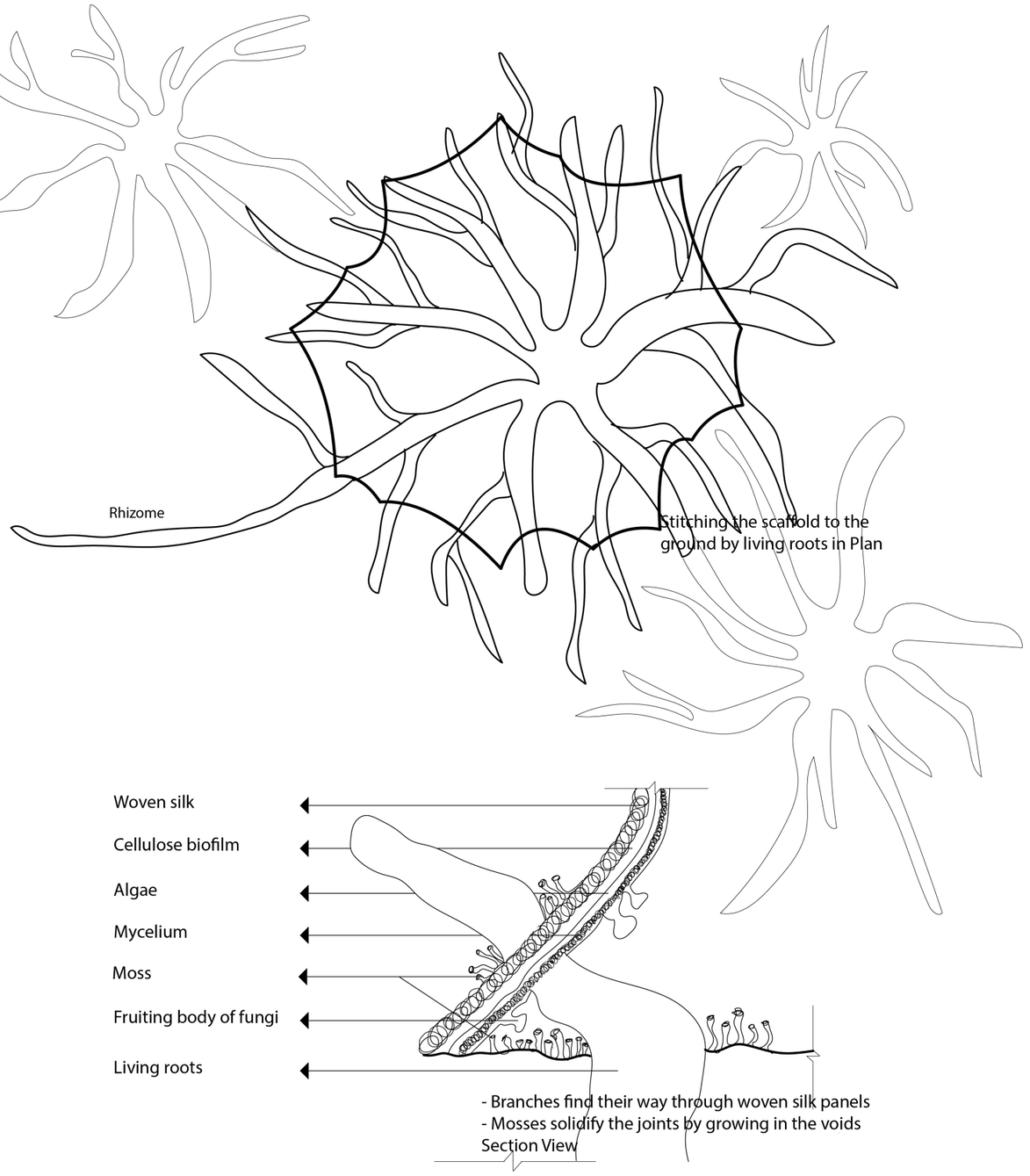


Figure 16 *Silkhouse connection to the ground.*

Scene 2:The Ground

She went outside the silkhouse, and the sunlight embraced her purplish skin. Although apparently everything was fine, she had a feeling that something was out of order as the starworms were singing. Her naked feet touched the ground. They sank into the moss and algae layers that spread on the ground. The raft was covered with a thick layer of fertile, soil-like material, made with the organic waste of hydroponic trees, living branches, and the debris of other living organisms. Beneath the evergreen layer, a mycelium network spread throughout the soil and solidified the ground by weaving in and out. As a connecting component between life and death, the fungi were decomposing dead materials to enable new organisms to flourish. One of the main tasks of the inhabitants was to examine the symbiosis of living organisms in the ecosystem to track their efficiency. With a few sisters, she checked how adequately the mycelium filaments were preventing the ecosystem from collapse. A few small ponds formed where the living branches were less dense. At the edge of the ponds, the soil was eroded by the movement of water, so the interwoven roots of the raft trees were visible. The roots were covered with barnacles and sporadically decorated with flowers. (Figures 17-18)

Figure 17 *Walking on the ground.*

Figure 18 *Rootsandblossoms.*

The flowers were genetically engineered so various species of flora grew on one stem.[4] The combinations of the different blossoms added to the area's beauty. The wind spread the flowers' spores through the air for further procreation. She watched a hanging flower seed that had been dropped in the water. Floating on the surface of the ocean, it would grow into a new raft. The air was fresh, and the odour was sweet and pleasant with a combination of rose-orange[5] and ginger scent spreading out by the genetically engineered flowers. (Figure 19)

Figure 19 *Genetically engineered flowers.*

4 Inspired by a scene from the film *Annihilation*. *Scene from 'Annihilation' | Anatomy of a Scene. film. Directed by Alex Garland. The New York Times, 2018, https://www.youtube.com/watch?v=R9RAdaP8cu0.*

5 Slonczewski, *A Door into Ocean*, 53.

The starworms were singing. This was not a good sign. It meant there was a threat nearby. She was not able to hear the song. The frequency was lower than her hearing threshold. However, the raftweed blossoms were opening and closing, showing that something was going to happen, their hairy surface absorbing subsonic vibrations of the starworms' song.[6] There was an unknown threat to Shora, to her and her sisters, and all living things. (Figure 20)

6 Ibid., 117-8.

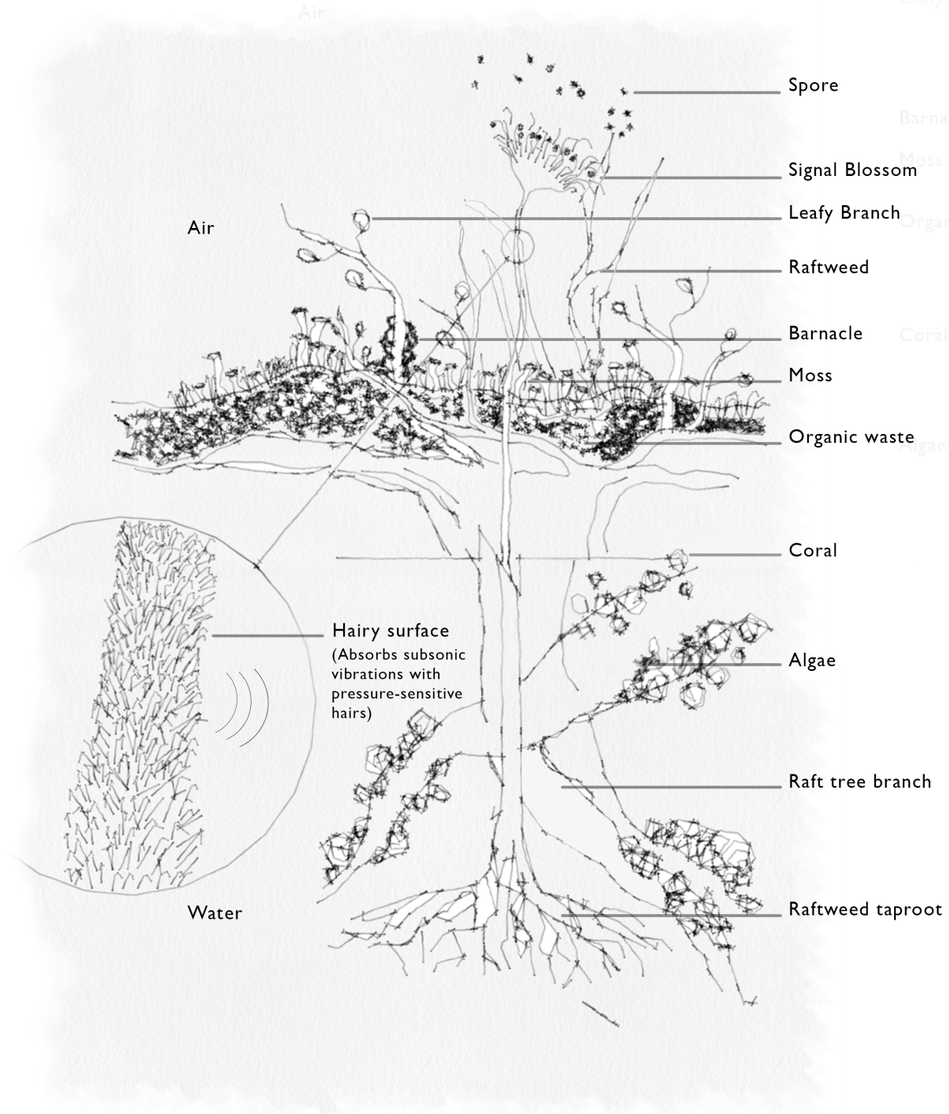


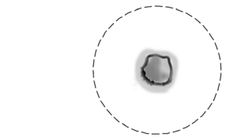
Figure 20 *Signal blossom.* ▶

Scene 3. The Raft

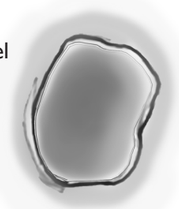
Shora, the water covered planet, had many living rafts floating on its surface. They were grown by interwoven, living trees, and were of various ages, sizes, and densities. As the trees multiplied over time, the rafts got wider, expanding horizontally on the ocean. The rafts did not have specific boundaries. They grew and made new entities at every moment. Their archetype was similar to the architecture of dark matter, mycelium networks, and neurons in the human brain, formed with voids, filaments, and particles.[7] Their floating pace depended on the motion and oscillation of the water. The form of the rafts created turbulence around and beneath the water's surface, dissolving more oxygen in the water. (Figure 21)

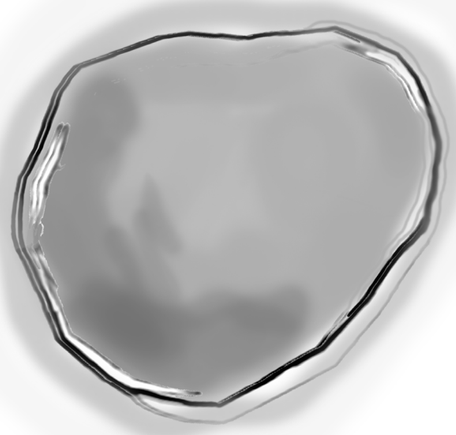
Figure 21 *The Shora.*

7 For more information check section 3.3, Mycelium Architecture.

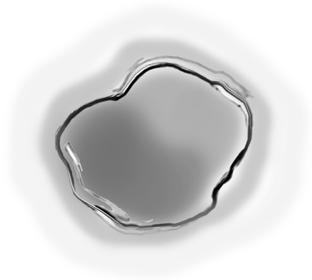


Newly setteled raft of leni-el



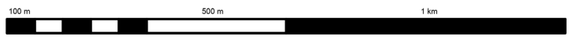


Kiri-el raft



Reai-el raft

Ocean



She lived on Leni-el, a newly settled raft, about thirty years old. It was at the beginning of its growth process, about eighty metres wide by one-hundred-and-twenty metres long, and it was already dense enough to provide a surface for new inhabitants. About twenty silkhouses could settle on this size, with their numbers increasing as the raft grew over time. The homes were built and grown by the inhabitants, connected by under-raft tunnels. The tunnels were like a vast maze, providing access to the chamber-like laboratories and the ocean. The raft also created shelter for many different marine species, like seaweed, corals, algae, sponges, fish, and jellyfish. Living organisms could be seen in all strata, from the surface to the core and underneath the raft. (Figures 22-5)

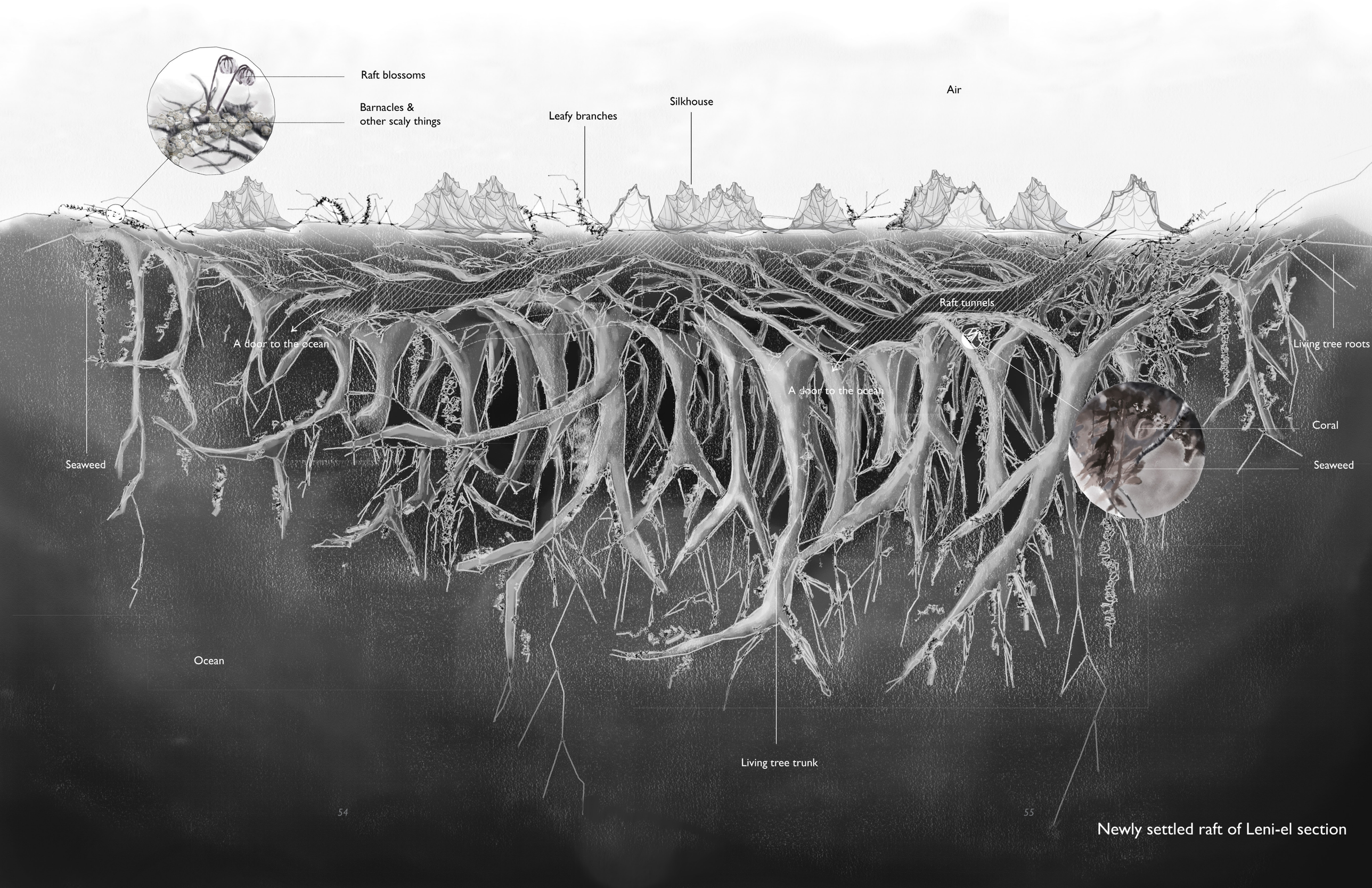
The floating seeds of the raft blossoms initiated the living rafts. They sprouted a few branches, each of which was capable of growing new trees, whose stems, again, brought out new ramets[8] as they grew. In this sense, the rafts grew rhizomatically, with multiple interwoven trees attached together like an inverted forest. In case of rupture, the raft could revitalize and renew itself. The density and height of the rafts varied from its edge to its centre. As the trees started to grow around the initial seed, the core remained denser than other parts. This meant that the height of the core was greater than its surroundings, creating a suitable place for gathering that could be seen and shared by everyone. This gathering place had a decent view and access to the other parts of the raft, especially to the homes, and was surrounded by a few small ponds and decorated with flowers. (Figure 26)

8 Check the glossary.

Figure 22 *Newly settled raft of Leni-el section.*

Figure 23 *Newly settled raft of Leni- el homes level plan.*

Figure 24 *Newly settled raft of Leni- el roots & chambers level plan.*



Newly settled raft of Leni-el section

Place of gathering

Ever-green matting
(Moss- Grass-
Mycelium- Algae)

Silkhouse

Ocean

Newly Settled Raft of Leni-el
Level of Silkhouses Plan

Chamber 2

Chamber 1

Central Chamber

Chamber 3

Interlinking living branches

Chamber 4

Ocean

Newly Settled Raft of Leni-el
wwLevel of Chambers Plan

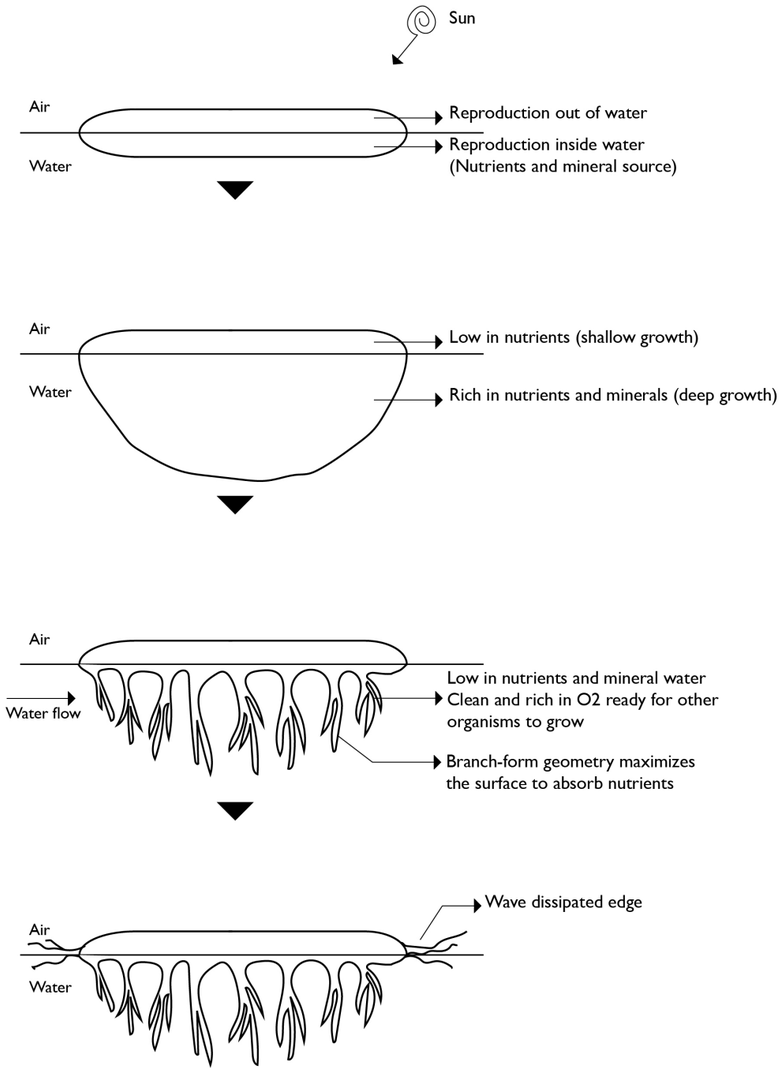
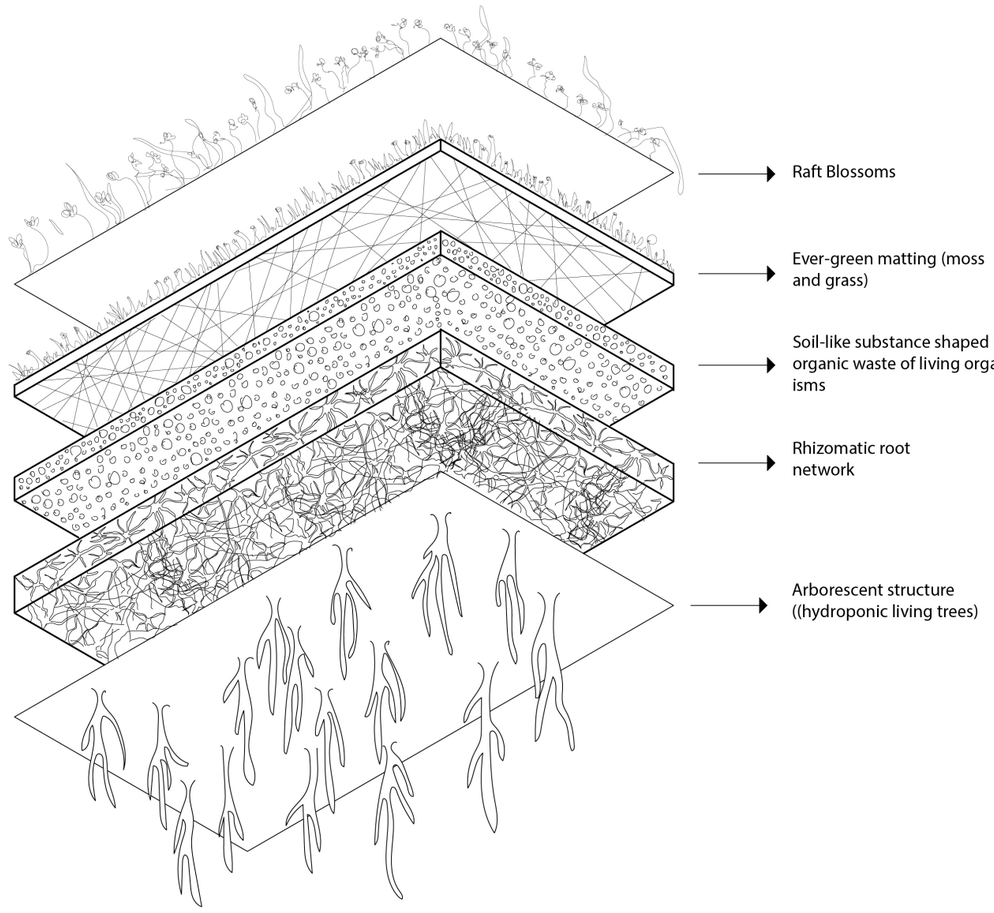
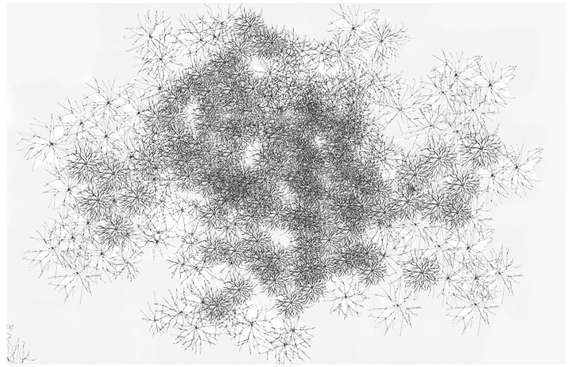


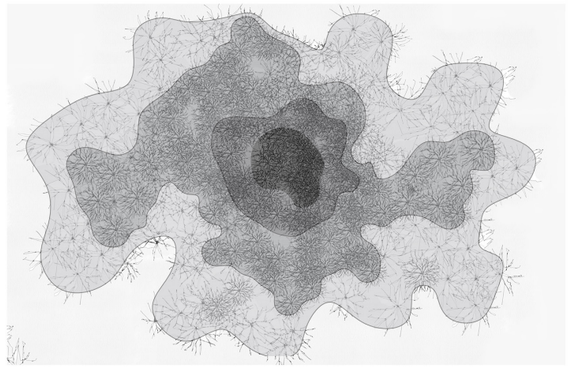
Figure 25 *Raft formation and tectonic.*



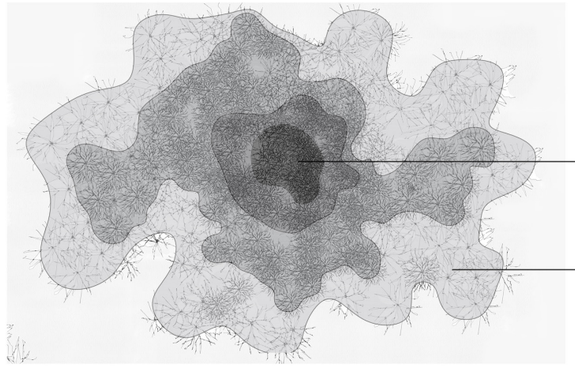
Living raft tectonic

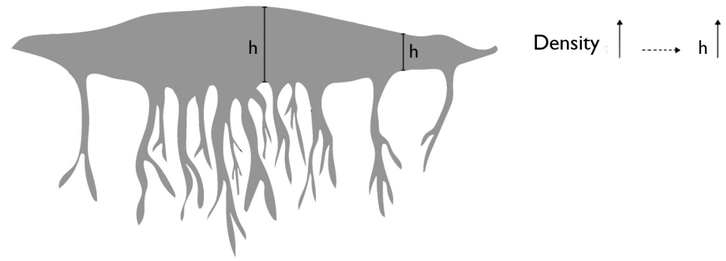


Raft Topology



Topography Lines





Topography Logic

Figure 26 *Leni- el topography lines and density analysis.*

Scene 4. Inverted Forest

She dove into the ocean and swam beneath the raft to the coral and seaweed forest, where fish danced freely around her body. The purplish breathmicrobes growing on her skin enabled her to stay underwater longer. The porous raft brought light underneath and made it possible to observe the beauty of the underwater layer. Seaweed hung from branches, improving the quality of the water by decreasing the ocean's acidity. (Figure 27)

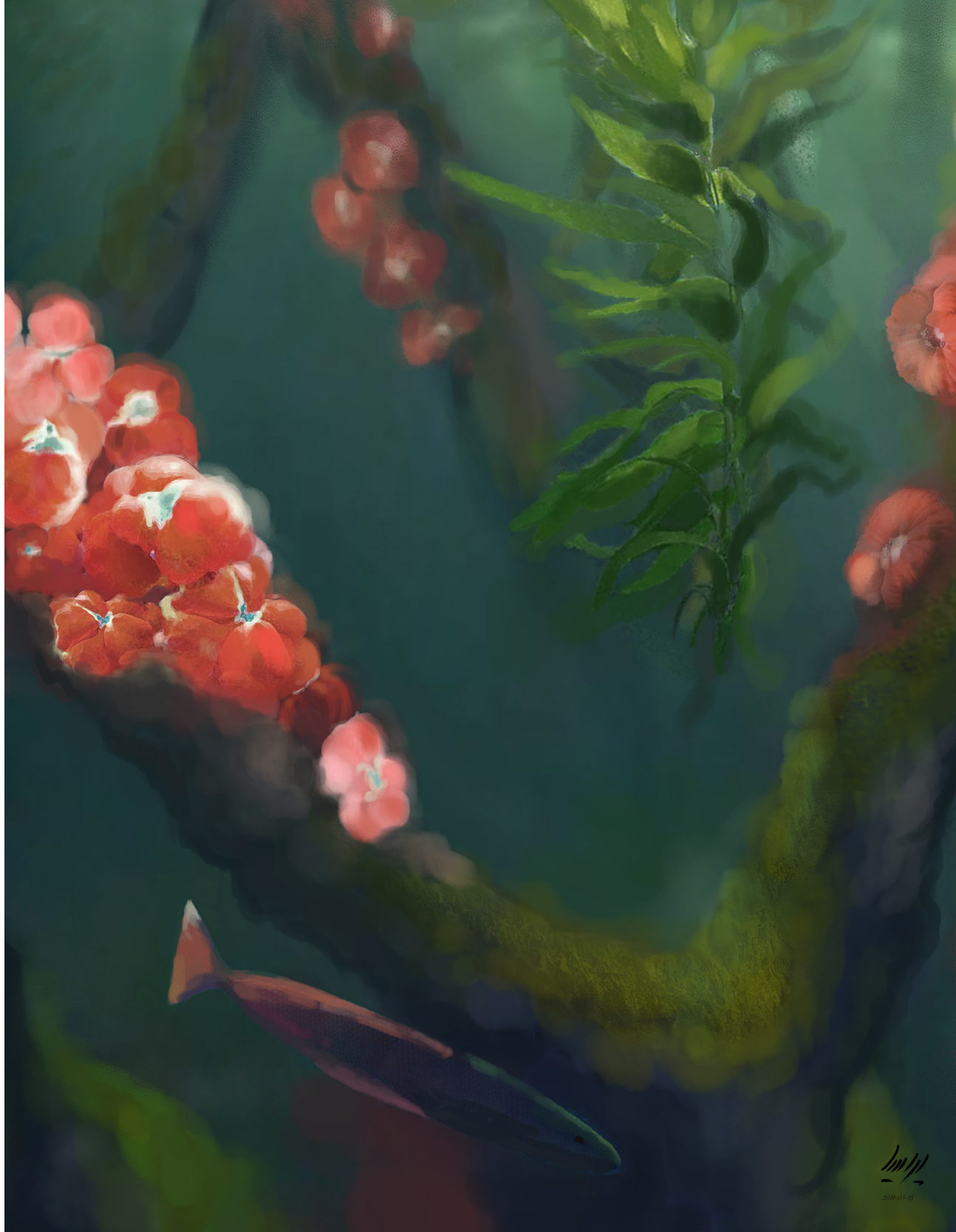


Figure 27 *Inverted forest.* ▲

Figure 28 *Symbiosis.* ▶

The inverted tree branches were covered with algae and decorated with corals. With a combination of red, rose, scarlet, and blush colours, the corals shone against the blue background of the ocean. The pigments came from zooxanthellae, tiny algae that live in symbiosis with the corals. Zooxanthellae were also responsible for producing enough energy for the corals' metabolism and growth. She checked the corals' health by measuring the water temperature and the concentration of zooxanthellae in polyp tissues to prevent bleaching. She realized that the water temperature was unexpectedly high. (Figures 28-9)

Figure 29 *Coral polyps.*

Shora was a world of parallel cities that gradually evolved to align with one another. It was a world of corals, seaweeds, and many marine species like fungi and algae – in short, cities of different living things. She swam among these parallel worlds with her sisters, made connections with them; she became them, and they became her. Swimming in the ocean and living in this dynamic environment reminded her of human evolution from fish and her birth from the water of the womb. There was a tendency in her to return to the water, to swim towards the darkness and the world of the unknown.

The threat announced by the signal blossoms and starworm songs was a destructive fire that affected all of Shora. It burned all the living things to death, from the rafts to the water and the sky. It was the fire of violence, the fire of the fear, of death that hastens others' death[9] and the fire of fear of other living things. All things became extinct, all the living cells, except one. That one was enough to perhaps flourish into life again, as it contained all the knowledge and memories of the former whole.

9 Slonczewski, *A Door into Ocean*, 333.

PART THREE: CONTEXTUALIZING *A DOOR INTO OCEAN* IN LITERATURE & ARCHITECTURE

3.1. From Non-living to Living Architecture

Current concerns regarding the human footprint on the earth and its effects on natural resources and living organisms, which are increasing day by day, made me interested in thinking about a visionary approach to architecture. This approach talks about a shift through which architecture is grown rather than constructed. It talks about a living architecture rather than a non-living one.

3.1.1. Concerns: Overusing Natural Resources

> "I wonder what would happen if there were a United Organization of Organisms (UOO, pronounced "uh-oh"), where each species gets one vote. Would we be voted off the planet? The answer is pretty clear."[1]

I have always been critical about the way that we have decided to live on this planet, and I was curious about dreaming of another world and other ways of living. Although the world maintains its beauty, the political walls and borders and power-seeking approach will lead us to catastrophe. My critiques are about the whole approach to human life, in which architecture has a crucial role. In my opinion, we have made a world of violence and fear, a world of injustice and fire, by killing innocent people and children, by making borders and separation and by producing weapons to deprive some people of life. We destroy our home, the mother of nature, and all living things, more and more every single minute. We extract valuable resources from the heart of the earth and through our garbage, chemicals, and pollution to the sea, air, and soil may cause nature's annihilation.

These are just a few statistics about these disasters: climate change due to human activities is revealing its consequences. The global temperature is increasing, and the Intergovernmental Panel on Climate Change

1 Paul Stamets, Mycelium Running: How Mushrooms Can Help Save the World (New York: Ten Speed Press, 2005), 1.

(IPCC) predicts a 2.5 to 10° Fahrenheit increase over the next century.[2] This will cause the extinction of over 90 percent of the world's coral reefs by mid-century.[3] Polar glaciers are melting[4], and in less than one hundred years, sea level will rise up to four feet.[5] If the rate of rain forest destruction remains the same, there will be none left in the next hundred years.[6]

If we continue this attitude, we may not be able to live on this planet for much longer. By continuing this trend, we will reach a sad ending, a tragedy of our own making, a polluted desert-like world we have shaped for ourselves and for posterity. Traces of this failure can be seen in all aspects of life, and architecture is not an exception. Our buildings are made with valuable resources extracted from the heart of the earth. Although a comprehensive range of knowledge is needed to build these solid, cubic, and tall structures, preserving nature seems to lack priority in this sequence, while the forms and functions are not matched to the human spirit. The more we figure out nature, the more we understand the value of what we are missing. As an architecture student, I cannot make significant changes to humanity's approach to life and ways of living, but at least I can dream of these changes, of an alternative way of living.

Vitruvius believes that imitating nature is a must for architects. This imitation can be found in different characteristics of a building like proportion, materiality, and form. Today's machinery is inspired by nature, as Vitruvius said: "All machinery is derived from nature and is founded on the teaching and instruction of the revolution of the firmament."[7] Although imitating nature has been a human lighthouse throughout history and signif-

2 "How climate is changing," accessed March 6, 2019, https://climate.nasa.gov/effects/?Print=Yes.
3 "More than 90 percent of world's coral reefs will die by 2050," accessed March 6, 2019 https://www.independent.co.uk/environment/environment-90-percent-coral-reefs-die-2050-climate-change-bleaching-pollution-a7626911.html.
4 "How climate is changing,".
5 Ibid.
6 John Vidal, "We are destroying rainforests so quickly they may be gone in 100 years," accessed March 6, 2019 https://www.theguardian.com/global-development-professionals-network/2017/jan/23/destroying-rainforests-quickly-gone-100-years-deforestation.
7 Vitruvius,"Book X," in VITRUVIUS (the Ten Books on Architecture), trans. Morris Hicky Morgan (New York: Dover Publications, INC., 1960), 284.

icant achievements have been made, our attitude towards nature prevents the earth from remaining a suitable place for many creatures. In my opinion, the human approach towards nature has failed. This failure is evident in different aspects like human relations, politics, economy, and architecture. But how can humans survive and preserve the planet? The answer could be found in a return to nature, although there is no single answer to this broad and complicated question.

3.1.2. Concept & Question: Toward Living Architecture

The concept of this thesis and Shora's position are about a time when human knowledge regarding nature has increased to the point that architecture is integrated with, not separated from, nature. The concept aims to show different positions regarding nature throughout history. Shora is a representation of this world and a compelling source in the literature that creates a living architecture.

3.1.2.1. Relation of Architecture and Nature Diagram

> *"Currently, tar and concrete deserts form the ground of modern cities and are inherently hostile to the living system. These deserts could be replaced by vibrant communities of soil-like bodies. Transplanting or seeding extensive metabolic networks into urban environments could increase planetary fertility, inviting the natural realm to inhabit even the most extreme environments."*[8]

Humans have made a long journey to reach our current situation. In prehistoric times, in general, nature was unknown to humans, and it caused fear with its foreign environment. Nature was dominant, and humans intervened minimally in their surroundings. Humans were trying to survive on a wild, virgin planet. Caves were a dwelling for prehistoric people, and also provided a context to draw the unknown. At that time, human knowledge about their surroundings increased, and their interventions changed ways of living. The journey went on and, by increasing awareness regarding nature, the human position relative to nature changed. Valuable resources have been extracted without interruption, and humans considered themselves governors of the world. Initially, resources were considered to be unlimited; not only were they limited, but their consumption caused considerable side effects. Modernization caused a separation between nature and the built environment. By the time of the current information revolution, the side effects of this process are becoming progressively vivid. Many efforts are being made by scientists and researchers to achieve a method to save the earth and other living creatures. Biomimicry is one of the methods that considers nature as a model, measure, and mentor[9] to make a better and more sustainable world. By employing environmental building, the relationship between nature and the built environment has become closer, but the gap is still tangible. In fact, as the population increases, we extract more from nature, and it seems that green buildings just present a better appearance to cover human neglect. In his animation, MAN[10], Steve Cuts shows the process of human life since the beginning of history. Although the future that he illustrates is tragic, it shows the reality of human impact.

The fictional future that is the focus of this thesis seeks to imagine a living architecture. It shows a hopeful process that human knowledge can reach a level where it can merge with nature instead of imitating it. The meaning of architecture has undoubtedly changed from what we have experienced in the past. Architecture is a part of nature, and it harmonizes with the natural world. It is self-growing, self-repairing, intelligent, and it has fascinating forms. This architecture is built by living cells, and evolution, reproduction, and metabolism are its attributes. By eliminating unnecessary parts, it can create an equilibrium between different components. By looking to the dwellings of various creatures, like termite mounds, their advanced technology can be seen. The reason is that they maintain a balance with nature as their homes remain part of nature. This thesis proposes that by reaching a significant level of knowledge regarding nature, we can keep this harmony, like other creatures. The concept diagram on the next page shows the relation of architecture and nature through history. (Figure 30)

Based on all these ideas, the questions posed by this thesis are:
What is the quality of an architecture which is merged with nature? What are the characteristics of this kind of architecture? How does it feel to live in such a world, for example, in the world of Shora?

Figure 30 *Concept.* ▼

8 Rachel Armstrong, *Soft Living Architecture -an Alternative View of Bio-Informed Practice* (New York, London: Bloomsbury visual arts, 2018), 55.

9 Janine M. Benyus, *Biomimicry: Innovation Inspired by Nature* (New York: HarperCollins publisher Inc, 1997).

10 Steve Cutts, "Man," 2012, 3:36, https://vimeo.com/56093731.

Past

TIME

Future

Primitive habitats

Archetype

Common Building

Environmental concern:
-"Natural land loss and irreversible destruction of biodiversity
-Exploitation of raw material
-Extensive use of energy
-Production of waste
-Emissions into soil, water and air" (Gruber, Biomimetics in architecture, 8)

Learning from our mistakes

Archetype

Still not enough?

Green Building

+ Knowledge & Science

+ Features:
-adoptive
-responsive
-selective
-cognitive
-etc.

Form transformation

Archetype

Living Architecture

KNOWLEDGE REGARDING NATURE

Features	Relationship with nature	Strategies
<u>Primitive habitats</u> -Nature dominates the human -Unknown nature causes fear -The human lives in bare nature with minimum modifications -Hazardous natural phenomena and creatures create a harsh living environment	Unknown Nature Cause Fear	?
<u>Common building</u> -The human separates himself from nature by constructing walls around himself -Nature tends to be more known and the fear caused by nature is reduced -Increasing population creates a wider gap between human and nature -Knowledge about nature increases -Less harsh living environment and longer life span -Using up natural resources destroys nature	Extract from Nature	
<u>Green building</u> -Attempt to bring nature back to the living environment -Human dominates nature in many aspects -Knowledge level has increased significantly -Despite all attempts, using up natural resources continues	Learn from Nature	
<u>Living dwellings</u> -Living environment and nature have merged -Knowledge level is at the highest point in history -Living environment and nature become harmonious -The living environment or living nature present fascinating forms -The intelligent living environment can self-repair and grow. -There is an equilibrium between different components.	Well Known Nature Nature Living Environment	

3.1.2.2. Metamorphosis Diagram

The following diagrams show the metamorphosis of architecture during history with a few significant buildings. Here, the transition between buildings is important, rather than each building individually. It would require an entire thesis to fully understand the whole scenario, but touching on the characteristics of this process can help to better situate this thesis and this kind of architecture. Here, buildings are a representation of the dominant approach and show the human ability to use their surroundings to construct the built environment. At the end of the journey is the world of Shora. This architecture takes life out of capsules and is grown by living things.

At the beginning of this path is Hohlenstein Stadel as a representation of early dwellings. It is a shelter whose limestone has been shaped over many years by natural forces and shows the origins of the first figurative art. Different factors like the agricultural revolution and increases in brain capacity led us to the next era, thousands of years later, when we see buildings like the Colosseum as a symbol of civilization. Gathering finds a significant role in human life, enabling people to share desires like killing and power-seeking. By increasing proficiency in using nature and in terms of craftsmanship, we see the emergence of buildings like the Milan Cathedral (Duomo di Milano). Here, the power of the Catholic Church plays a dominant role, shown by mastery in ornament. Valuable resources have been extracted from nature to show the glory of God and, mainly, the power of the leader.

Due to an increasing population and the industrial revolution, the pace of life and architectural construction increased. The Empire State Building is a symbol of this era, symbolizing "the image America hoped to project to the rest of the world"[11] by reaching the sky. The audacity of the US in construction took nature and sunlight from modern cities. The human approach created a greater division between humans and nature by using "vast material resources."[12] Here, understanding the rules of nature

11 Melissa Harrison, "Everything You Need to Know About Art Deco Architecture in 10 Buildings," accessed October 11, 2018, https://www.highsnobiety.com/2017/03/21/art-deco-architecture-examples/.

12 Luke Fiederer, "AD Classics: Empire State Building / Shreve, Lamb and Harmon," accessed October 11, 2018, https://www.archdaily.com/797767/ad-classics-empire-state-building-shreve-lamb-harmon.

Figure 31 *Metamorphosis I.* ▼

Figure 32 *Metamorphosis II.* ▼

enables mastery over natural forces to construct this iconic structure. The comfort-seeking manner of modern humans, in reality, pushed them further from nature. Humans try to reduce this gap as they understood what they were missing.

By investigating natural design strategies to mimic nature and with the help of technology, projects like ICD-ITKE and Dragon Tail by Philip Beesley emerge. In both cases, nature acts as a model for investigating new design strategies. The role of technology here is to help optimize material consumption and structural performance, besides many other features, and to broaden our abilities to construct complicated forms. In the diagram, buildings are inert objects built with Victorian technologies, as Rachel Armstrong suggests,[13] until the Dragon Tail emerges as an example of architecture that reacts to users like the natural world. Signs of life can be seen in the protocells by producing biological and bottom-up architecture. Although the protocells do not have DNA, they have the quality of living things as they grow and react to their environment. These metabolic materials[14] are encapsulated in plastic containers, but the living architecture proposed by this thesis looks forward to a time when living architecture is not encased in capsules anymore. This fictional architecture goes a step further: it is made by living cells, grown from the bottom up. The whole environment is grown by living organisms, living cells, cytoplasm, seeds, spores, fungi, moist and fertile soil, living branches, etc. Symbiosis is one of the main factors here between living things and living architecture. The whole architecture acts as an ecosystem and provides suitable shelter for many different species. There is no carbon footprint, and it harmonizes with the natural world. (Figures 31-32)

13 Rachel Armstrong, "Self–Repairing Architecture," accessed March 7, 2019, https://www.nextnature.net/2010/06/self–repairing-architecture/.

14 Ibid.

Empire State

Duomo di Milano

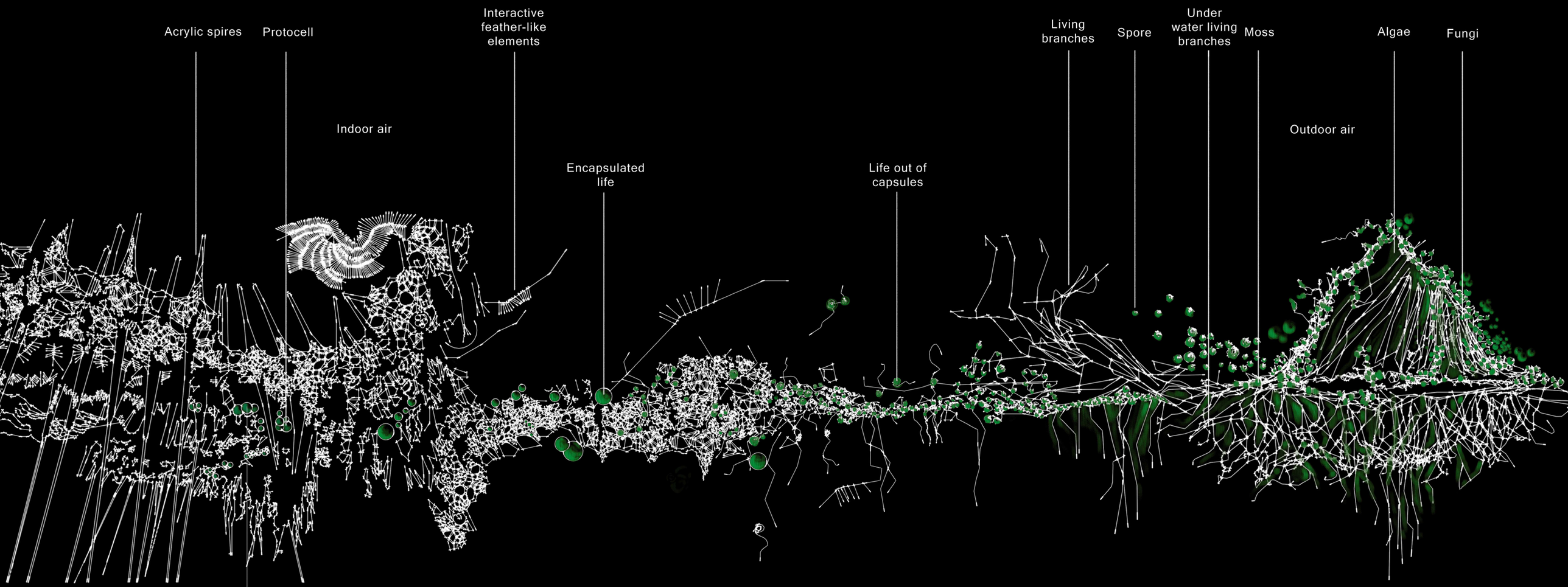
Colloseum

Hohlenstein Stadel

ICD ITKE

Spring Dragon Tail

Futuristic Living Architecture



Spring Dragon Tail- Philip Beesley- Shanghai, China

Bottom-up live living future environment

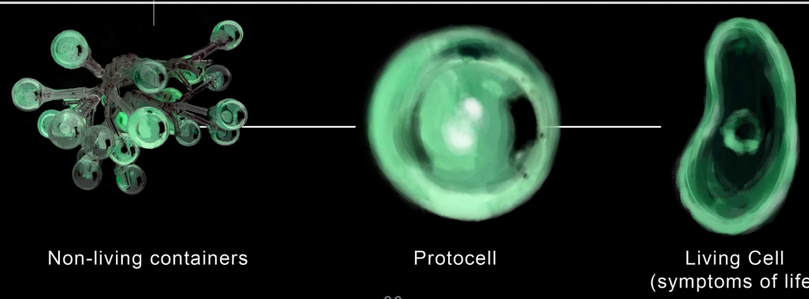
Land

Water

Life is surrounded by boundaries and capsules.

More complexity in components forms and features

Boundary-less life freely expanding.



Non-living containers

Protocell

Living Cell
(symptoms of life)

Life can be seen in all different scales. The whole living environment and architecture have been made by living cells that replicate from the bottom-up.

3.1.3. Literature Review

3.1.3.1. Literature to Understand *A Door into Ocean*

To understand the architecture behind *A Door into Ocean*, an initial reference, besides the novel, is a compelling essay by Katie Lloyd Thomas entitled "Feminist Hydro-logics in Joan Slonczewski's *A Door Into Ocean*." The essay opened my eyes to the potentials of the novel, and specifically, the architectural environment it proposes by describing the similarities between Shora and the projects of designers and researchers who work with living systems.[15]

Thomas argues that today is the right time to consult the concepts discussed in *A Door into Ocean*. She attributes this urgency to three main reasons: the rise of a new materialism, what Peg Rawes calls "relational ecology,"[16] and feminist theory and its relation to water. First, the Sharers' life on Shora depicts a new holistic way of life, both in their relational approach to material culture, as well as social life. Second, life on Shora represents a non-hierarchical "relational ecology": the Sharers live as equals to their living environment, and the fellow creatures that share this environment with them. Finally, the book depicts ideas rooted in a feminist new materialism: an all-female occupied aquatic planet draws parallels with the hypothesis that human evolution started from water, and emphasizes water's life-giving characteristics. Additionally, Lloyd Thomas draws parallels between Shora and the works of designers, philosophers, theorists, and researchers. These examples include Luce Irigiray's work on figuration of fluidity, Rachel Armstrong's "Future Venice," and Philip Steinberg's empirical and speculative work on ocean space.

A study guide to *A Door into Ocean* by Joan Slonczewski presents complementary information regarding the ideas behind the novel.[17] She describes the initial thoughts and the reasons for writing the book, like trading national forests, nuclear winter, women's rights, and other issues emerging in the early eighties.[18] She also provides explanations for the range of new vocabularies she employs in the novel. Slonczewski's intention in writing *A Door into Ocean* was to open a hopeful view toward the future while emphasizing continuing efforts to preserve the planet.

15 Katie Lloyd Thomas, 2017. "Feminist Hydro-Logics in Joan Slonczewski's *A Door into Ocean*" In Landscript 5: Material Culture, ed. Jane Hutton (Berlin: Jovis Verlag, 2017), 195.
16 Ibid., 194.
17 Joan Slonczewski, "A Door into Ocean," last modified January 4, 2001, http://biology.kenyon.edu/slonc/books/adoor_art/adoor_study.htm.

Life and Living Organisms in Literature

Investigating definitions of life, living organisms, and living cells is necessary since Shora's rafts are made by living things. The architectural environment evolves over time to optimize itself and to provide a suitable ecosystem for other species. There are many compelling references about biology, the origins of life, and genesis that provide comprehensive knowledge regarding these fundamental issues. Attaining an in-depth knowledge of these fields requires a generous amount of time and insight regarding biology, which is outside the scope of this thesis. To familiarize myself with these concepts, I read parts of went through *Life: The Science of Biology*, 7th[19] edition, by William K. Purves, David E. Sadava, and Gordon H. Orians. The first four chapters describe the definition of life and living cells as the fundamental units of life. Life is defined by three characteristics, which are evolution, reproduction, and metabolism. The study of cells, in some sense, is equivalent to the study of life.

Another compelling reference is *Genetic Takeover and the Mineral Origins of Life* by A. G. Cairns Smith, which is about the origins of life from inorganic crystals and the process of evolution of these non-living matters. In addition, Smith believes that the origins of organic molecules are a "primordial soup" shaped in a non-biological way.[20] He also describes the process of evolution from simple to complex mechanisms and the way a complex mechanism carries information from simpler ones, even though it is a new entity.

18 Ibid.
19 William K. Purves, David E. Sadava, Gordon H. Orians, and H. Craig Heller, *Life: The Science of Biology*. 7th ed. (USA: Sinauer Associates and W. H. Freeman, 2003).
20 A. G. Cairns Smith, *Genetic Takeover and the Mineral Origins of Life* (Cambridge: Cambridge University Press, 1982), vii.

Rhizomatic Aspects in Literature

Shora and Sharers make rhizomatic relationships with one another and with other species. In *A Thousand Plateaus: Capitalism and Schizophrenia*, French philosopher Gilles Deleuze and psychoanalyst Félix Guattari propose rhizome theory in contrast to arborescent, or tree-like organizations. Thus, the rhizome is a botanical structure that enters into the world of philosophy. The rhizome theory stands in contradiction to hierarchical or binary systems. The rhizome's features, like its ability to be connected to other things, has relevance to Shora, where Sharers make connections by modifying and genetically engineering their own bodies and other living things. Another feature is a multiplicity that has no subject or object,[21] which can be seen in Shora's language and the idea of sharing and spreading information to every cell of the living rafts. A rhizome can revitalize through rupture, similar to how even a single cell of Shora's raft can replicate, make multiplicity, and grow from the bottom up.

3.1.1.2. Literature to Understand Biodesign and Living Architecture

Looking at the correspondence between the world of Shora and current architectural practices, I found a few terms like biomimicry, living architecture, soft-living architecture, synthetic biology, and biodesign. Among these practices, I found the greatest correlation to *A Door into Ocean* in biodesign, as both employ living organisms to grow the architectural environment, rather than emulation or using lively matters.[22] Biodesign is design with biology, a new trend that goes further than biomimicry. William Myers's *Bio Design: Nature Science Creativity* is a collection of relevant case studies at different scales, from macro to micro.[23] Biodesign is a paradigm shift that talks about integration with, rather than emulation of, nature. Its primary goals are to achieve cleaner technologies and reduce the impacts of the Industrial

21 Gilles Deleuze and Felix Guattari, "Introduction: Rhizome." in A Thousand Plateaus: Capitalism and Schizophrenia [Mille plateaux, of Capitalisme et schizophrenie]. trans. Brian Massumi (Minneapolis: University of Minnesota, 1987), 8.

22 Check the glossary.

23 William Myers, *Bio Design: Nature- Science- Creativity* (New York: The Museum of Modern Art, 2012).

Revolution. This book is a compelling source in terms of understanding the position of Shora's visionary architectural environment in our current time.

Living Structures in Literature

Bio Design describes several case studies with living structures, like the Meghalaya living bridges, Baubotanik, and Fab Tree Hab. These precedents have resonance with the growing rafts of Shora, whose main elements are hydroponic living trees. The rafts resonate with these new practices in architecture in that they aim to use the benefits and the "constructive intelligence"[24] of the trees. All of these examples use living trees as the main structure. The Meghalaya bridges are living structures constructed by local people in India. In *Living Root Bridges: State of Knowledge, Fundamental Research, and Future Application,*[25] Sanjeev Shankar describes these bridges and their benefits to society and ecology. Shankar is a researcher interested in combining traditional knowledge in new ways. In his paper, "Revitalizing Traditional Knowledge: Living Root Bridge as a Biome," he emphasizes the importance of revitalizing these strategies, and proposes a design to do so.[26]

Other researchers interested in this type of architecture who are also inspired by the Meghalaya bridge include Ferdinand Ludwig and his team. In the "Growing Bridges"[27] chapter in *Hortitecture: The Power of Architecture and Plants*, Ludwig and Wilfrid Middleton explain the construction methodology of these bridges and their aim to make the knowledge behind them accessible for our current time. The Baubotanik tower is a project by Ferdinand Ludwig and his team at the University of Stuttgart. The project engineers living plants as the load-bearing components of the building. In

24 Ibid., 37.

25 Sanjeev Shankar, "Living Root Bridges: State of Knowledge, Fundamental Research and Future Application." IABSE Conference, September 23-□25 2015).

26 Sanjeev Shankar, "Revitalizing Traditional Knowledge: Living Root Bridge as a Biome," unpublished manuscript for 5th Annual international Conference on Sustainability at Indian Institute of Management Shillong, last modified 2016. Adobe pdf.

27 Ferdinand Ludwig and Wilfrid Middleton, 2019. "Growing Bridges," in *Hortitecture: The Power of Architecture and Plants*, ed. Almut Grüntuch-Ernst (Berlin: Jovis, 2019).

"BAUBOTANIK - Designing Growth Processes,"[28] Ludwig describes the importance of these projects as an intersection between biology and technology, introduces other case studies in traditional architecture, and other designers interested in biodesign. He also describes the project and the methodology behind its construction and monitoring the trees during their growth. Fab Tree Hab is another project by Terraform ONE that proposes dwellings made with 100% living nutrients. They proposed "pleaching"[29] as a methodology to reform living trees to make the scaffold. Beside *Bio Design* by Myers, *New Directions in Ecological Design* is another source, by Mitchell Joachim and Mike Silver, which describes this project and other examples related to ecological design. Terraform ONE's website also represents comprehensive knowledge regarding the project.[30]

Soft-Living Architecture in Literature

Another compelling case study in *Bio Design* is the Future Venice project by Rachel Armstrong, which proposes a self-repairing architecture that grows with lively matter to reinforce the foundation of Venice. In *Soft Living Architecture: An Alternative View of Bio-informed Practice*, Rachel Armstrong considers the project as a Soft Living Architecture. The book introduces this new practice in architecture and describes it as "the starting point for biodesign as vivogenesis – the spectrum of events that made possible the transition between inert to lively matter."[31] The book provides a comprehensive overview regarding this practice and explains a few case studies like Future Venice and Persephone. Future Venice is located in an aquatic context that grows gradually, in which "architects are co-designers within an ecology of actants,"[32] like on Shora. Both cases create parallel cities suitable for many different species, not just humans.

28 Ferdinand Ludwig, "BAUBOTANIK - Designing Growth Processes." (Conference: Symposium "Form-Rule/Rule-Form, University of Innsbruck, Jan 01, 2014).
29 Check the glossary.
30 "FAB TREE HAB- Local Biota Living Graft Structure," accessed March 24, 2019, http://www.archinode.com/bienal.html.
31 Armstrong, *Soft Living Architecture,* xiii.
32 Ibid., 88.

Living Materials in Literature

This section looks at the use of living organisms or living matter in the field of design. *Bio Design* mentions precedents that leverage these materials, like the Algae lab and Mycelium project, Biodigital chair, and Biocouture. These are just a few examples among many other projects that work with living materials, and what follows is intended to create a familiarity with current research that has a correspondence with the materiality of Shora. Fungi footprint is seen in many types of living material projects and research and is therefore investigated further.

Fungi and their underground network, called mycelium, have an important role on earth. In *Mycelium Running: How Mushrooms Can Help Save the World*, Paul Stamets describes the importance of mushrooms for the planet as grand recyclers and as a junction between living and dead things. Additionally, he proposes "mycorestoration" as a way to heal the planet with mycelium. He also explains the archetype of mycelium and its similarities to the model of dark matter and brain cells. Interestingly, mycelium's architecture has similarities with the living rafts of Shora, with voids, filaments, and particles in their formations. In "Biodigital Barcelona Chair," Alberto T. Estévez explains the idea of manufacturing a chair that is covered in living grass. He also shows the relation of this kind of project to Salvador Dali's famous quote that the future "will be soft and hairy."[33] This project and the idea behind it is similar to the interior of the silkhouse, which Slonczewski describes as a "furry paste."[34] Biocouture is a project by Suzanne Lee that involves growing a leather-like cloth with microorganisms. A combination of green tea, sugar, yeast, grown microbial-cellulose, and natural dyes form a dense and flexible layer.[35]

33 Myers, *Bio Design*, 120.
34 Slonczewski, *A Door into Ocean*, 54.
35 Myers, *Bio Design*, 109.

3.2. Understanding *A Door into Ocean*

Figure 33 *Evolving from catfish.*

3.2.1. The Philosophy

The philosophy behind *A Door into Ocean* is based on the evolution of humans from water, and the idea that we evolved from fish.[1] Sharers are the descendants of catfish.[2] They chose water as a site of inhabitation, instead of terrestrial life. Water's fluidity, mobility, and oscillation creates a dynamic lifestyle that is ever changing. "The ocean is a site or 'object' to be analyzed and understood, and an alternative figure to think with."[3] (Figure 33)

Slonczewski creates a feminist society in which all inhabitants of the planet are women. Lifeshapers[4] help to manage the "fusion of ova"[5] for reproduction between two lovemakers. Although the author's intention to foreground a feminist approach was minor, it is considered a feminist science-fiction text by many sources.[6] Living in water and a return to the ocean is a reminder of the waters of the womb. "Water is traditionally associated with the feminine: excessive, threatening, disruptive, as well as life-giving."[7] Through the science of lifeshaping, Sharers adapt their bodies to the ocean, indicated by their long-webbed fingers, hairless scalp, and coexistance with "breathmicrobes."[8] Breathmicrobes have a purplish color, store oxygen, and give Sharers their ability to stay underwater for a long time. Sharers' knowledge and technologies regarding nature increase in a way that allows them to integrate with nature and the ocean, rather than remaining separated. The philosophy behind Shora proposes an alternative architectural environment and a non-violent, feminist society that is worth discovering. (Figure 34)

1 Katie Lloyd Thomas, 2017. "Feminist Hydro-Logics in Joan Slonczewski's *A Door into Ocean*" In Landscript 5: Material Culture, ed. Jane Hutton (Berlin: Jovis Verlag, 2017), 201.
2 Joan Slonczewski, *A Door into Ocean* (New York: A Tom Doherty Associates Book, 1986), 5.
3 Ibid.
4 Check the glossary.
5 Joan Slonczewski, "A Door into Ocean," last modified January 4, 2001, http://biology.kenyon.edu/slonc/books/adoor_art/adoor_study.htm.
6 Katie Lloyd Thomas, 2017. "Feminist Hydro-Logics in Joan Slonczewski's *A Door into Ocean*" In Landscript 5: Material Culture, ed. Jane Hutton (Berlin: Jovis Verlag, 2017), 194.
7 Ibid., 203.
8 Ibid., 204.

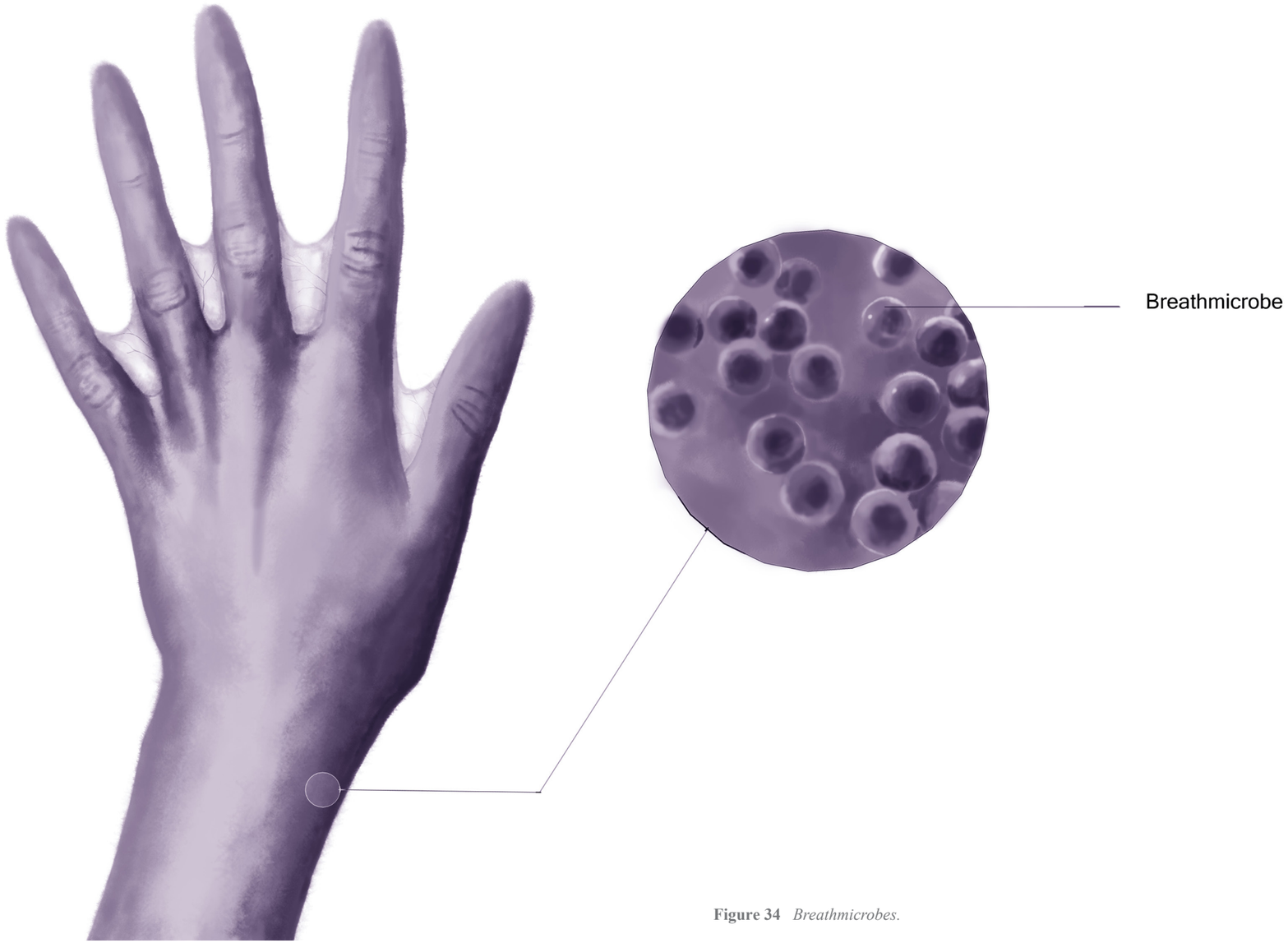


Figure 34 *Breathmicrobes.*

3.2.2. Architecture and the Role of the Architect on Shora

This part of the thesis examines the relation of Shora's architecture to the "experimental architecture" that Rachel Armstrong promotes for this century. Then, the role of the architect is discussed as co-designer with the natural world, with broad knowledge in different disciplines. It describes the non-hierarchical architecture of Shora and the sharing of equal rights among Sharers in their architectural environment. In addition, it discusses the features of a living architecture, in contrast to a non-living one, accompanied by definitions of a few significant terms like life, living organism, and living cell.

The architecture represented in *A Door into Ocean* has similarities to the "experimental architecture"[9] that Rachel Armstrong promotes for this century. It goes back and forth between rational investigations of techniques and explores new environments by expanding limits.[10] Sharers employ their rationality, and always extend the boundaries of the environment's capabilities by investigating within the field of genetics to evolve their living environment. Transformative, intricate materialities, such as fur, soil, and felt, which bring risks, uncertainty, change, and make hybrids are some of the characteristics of an "experimental architecture" practice.[11] The hypercomplex materials that make up Shora, such as living trees, fungi, seaweed, corals, moss, algae, fur, and many others, enable similarly variable conditions. Sharers' science of "life-shaping"[12] and their broad and comprehensive knowledge in genetic engineering are combined with their nature-loving artistic sense to build the architecture. The role of architects in the world of Shora differs from ours, but is akin to how Armstrong describes it for Soft Living Architecture, in which architects "are co-designers within an ecology of actants that orchestrate soft control systems based on mutual participation, interconnection, trust and shared values. They create the conditions for inhabitation, vibrancy, fertility, wonder, and enchantment between people,

9 Rachel Armstrong, *Soft Living Architecture -an Alternative View of Bio-Informed Practice* (New York, London: Bloomsbury visual arts, 2018), 22.
10 Ibid.
11 Ibid., 23.
12 Check the glossary.

their habitats and the wider world."[13] Shora's architects should necessarily have broad information of different disciplines, and their roles are to act as the brain of a complex system which prepares the context by knowing the science behind nature, instead of the design and construction of single projects. On Shora, similar to how Myers describes biodesign, "designers are turning to biologists for their expertise and guidance"[14] to "achieve enhanced ecological performance through integration with natural systems."[15]

Sharers' homes and architecture have a similar methodology of construction. No hierarchical constructions appear in the story, and a similar quality of life is provided to each person and family. People treat each other equally; therefore, architecture offers similar qualities to each person.

> Silkhouse form: *"Upon the raft rose a stalk of blue spires with concave sides that fit together like curved diamond shapes, broadening at the base. It might have been rock crystal, but the tips looked utterly fragile."*[16]

In such a living environment, with no differentiation and no variety in architectural methodology, the architectural space might have turned out monotonous. The answer to this issue lies in nature, which is dynamic and ever changing, and thus never repetitive and boring. Since nature changes every single moment, it is not monotonous to observe and experience. Sharers decorate their homes with fungi in different tones and colours. The interior walls and ceilings have no specific demarcation[17] and the ever-changing fungi paintings cover the interior surfaces.

> *"And the "painted" surfaces, a wall carpet of gold and green with intricate red lines that tantalized him to name their forms, were ever-changing as the fungi grew."*[18]

13 Armstrong, *Soft Living Architecture*, 88.
14 William Myers, *Bio Design: Nature Science Creativity* (New York: The Museum of Modern Art, 2012), 10.
15 Ibid.
16 Slonczewski, *A Door into Ocean*, 54.
17 Ibid., 92.
18 Ibid., 116.

In the terrestrial life that we have manufactured on earth, inert materials with lifeless qualities in a living environment do not fulfill our wide-ranging and diverse desires. In the world of Shora, harmonizing with nature is a creative approach. The inhabitants experience genuine inner peace in which fear has no meaning anymore. This fearless morale is the result of integration with nature.

Living vs. Non-Living

This section explains the reasons for a living architecture over a non-living architecture. It considers evolution, reproduction, and correspondence with human nature as three features of this architecture.

The ocean, as a site for the Sharers' inhabitations, harmonizes with their characteristics and ethics as opposed to a terrestrial environment. Water's fluidity, mobility, oscillation, and dynamic nature synchronize with Sharers' flexible and practical approaches throughout life. They live on "porous living rafts"[19] that grow and change gradually over time while providing decent shelter for a variety of marine species. Here is a question worth asking: Why is their raft and their architectural environment living instead of non-living? What are the advantages of a living, as opposed to an inorganic, architecture?

I have three different approaches to this question:

1. The essence of nature is that is has changing characteristics. Therefore, all living organisms, including humans, need to evolve over time to survive for the future. A living raft, instead of a non-living one, can optimize itself within these developments and can be a part of the evolution. This feature provides an equilibrium between the living environment and nature, and maintains sustainability.
2. Procreation is another fundamental feature of living things, and thus the living raft. To address a threat or based on needs, the raft can

19 Thomas, "Feminist Hydro-logics," 195.

reproduce to provide enough living space and to maintain itself.
3. A living environment, as opposed to inert, cubic dwellings, is in harmony with human nature. Living in the middle of living materials nurtures and purifies the mind while it reminds its inhabitants of the meaning of life and creation.

Definition of Life and Living Organisms

This part provides a concise definition of life with its features: evolution, metabolism, and reproduction. Then, it describes the process of evolving from "zero technology" designs to "high technology" designs over time. These descriptions demonstrate the basic characteristics of a living thing and a living architecture like that of Shora. In the process of evolution, naked genes transform into complicated ones, while preserving information from previous metamorphoses. This feature shares a similarity with Shora, as every cell carries the Sharers's whole knowledge and new information is added constantly over time.

> *"Sharers… envision a life force, a sort of living ether, that pervades every atom of their universe. Each drop of water, each breath of air, holds a thousand bits of life in it, growing and struggling."*[20]

One of the main characteristics of Shora's architectural environment is integration with nature. It is grown by living organisms; it is alive and contains living cells. Therefore, there are a few important definitions here: What is life? What is the definition of living organisms and living cells? "One concise definition of life is: an organized genetic unit capable of metabolism, reproduction, and evolution."[21] "Metabolism involves conversions of matter and energy"[22] (Figure 35), "Reproduction continues life and provides

20 Slonczewski, *A Door into Ocean*, 102.
21 William K. Purves, David E. Sadava, Gordon H. Orians, and H. Craig Heller, *Life: The Science of Biology*. 7th ed. (USA: Sinauer Associates and W. H. Freeman, 2003), 2.
22 Ibid.

the basis for evolution,"[23] and evolution is about "changes over billions of years."[24]

One significant question about evolution is how mechanisms evolve from simple to complex over time. A. G. Cairns-Smith, in *Genetic Takeover*, explains this process in a simple way (Figure 36). The diagram shows the process of evolving "zero technology" designs to "high technology'" designs.[25] It indicates that G1, as "naked genes" at stage A, elaborates its phenotype at stage B while the process becomes more complex over time.[26] In the next stage, G2 – another class of genes – appears within G1. G1 provides a sophisticated box for its growth.[27] Over time, G2 gradually grows into a complex substrate and eliminates G1 from the system while maintaining heritable information from G1.[28]

This process of evolution has significant features. First, a simple series of genes can be replaced with a more complex one over time. Secondly, the second series carries all the information from the previous one. With this ability, the system has the potential to develop itself over time. As a result, a living environment, as opposed to a non-living environment, can optimize itself by retaining information throughout an evolutionary process.

23 Ibid., 3.
24 Ibid.
25 A. G. Cairns Smith, *Genetic Takeover and the Mineral Origins of Life* (Cambridge: Cambridge University Press, 1982), 121.
26 Ibid.
27 Ibid., 120.
28 "The Origin of Life: Genetic Takeover," accessed Nov 17, 2018, http://originoflife.net/takeover/.

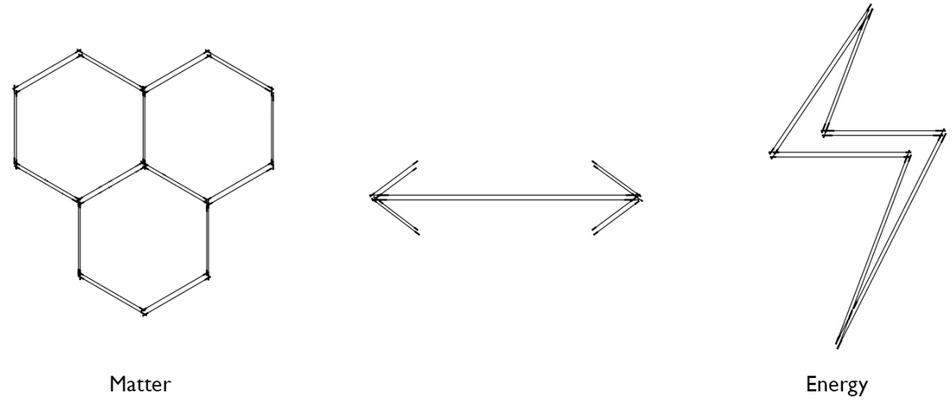


Figure 35 *Metabolism.*

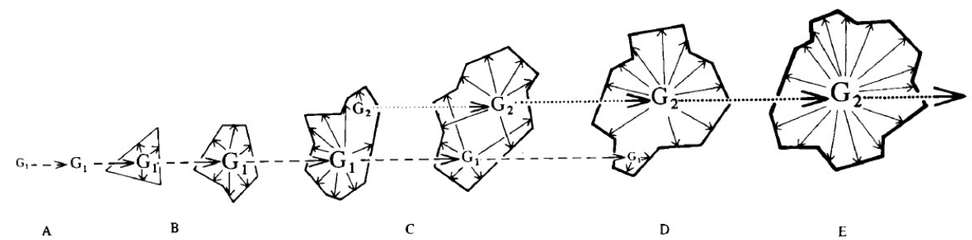


Figure 36 *Evolution.*

Living Cell

This part explains the role of the living cell as the "basic building block" of life.[29] It then describes the interconnection between the cell's interior and the extracellular matrix (ECM) and how the cell constitutes a separated, but not isolated, compartment. As Shora is grown by living cells, interconnection at the micro scale is one of its significant features.

To study life, it is worth starting with the cell as it is the "basic building block"[30] of all living things and, in some sense, they are equivalent.[31] The cell is a "living compartment."[32] According to Purves, Sadava, and Orians, "Three statements constitute the cell theory:

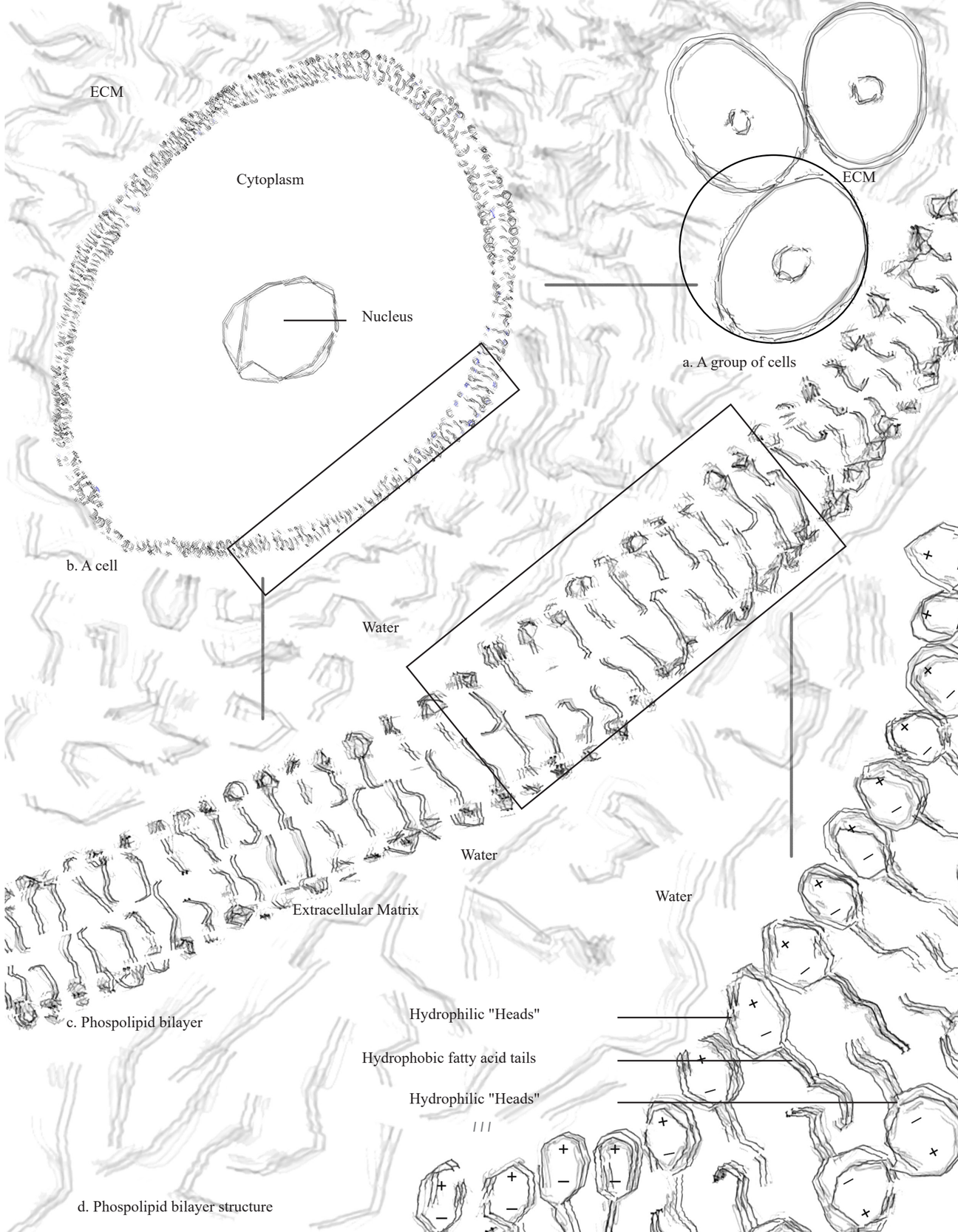
- Cells are the fundamental units of life.
- All organisms are composed of cells.
- All cells come from preexisting cells."[33]

The plasma membrane, which encompasses the cell as "the water-insoluble phospholipid structure,"[34] defines the cell.[35] Figure 37 shows how phospholipids create a bilayer membrane that keeps water inside the cell and preserves the penetration of ECM water inside the cell. Although the phospholipid membrane controls the penetration of water, it doesn't create an isolated compartment.[36] Proteins in the lipids can cross the threshold of the membrane and enter the cytoplasm and into the ECM.[37] In this sense, proteins interchange between the inside and the outside of the cell. These movements of matter indicate interconnection in the basic building blocks of living organisms. They also show how nature intelligently makes a separate compartment while keeping the cell interconnected.

The phospholipid membrane keeps the cytoplasm within itself: "The cytoplasm is composed of two parts: the liquid cytosol, and insoluble

29 Purves, Sadava, Orians and Heller, *Life: The Science of Biology*, 61.
30 Ibid.
31 Ibid., 62.
32 Ibid., 61.
33 Ibid., 62.
34 Ibid., 61.
35 Ibid.
36 Ibid., 65.
37 Ibid.

Figure 37 *Living cell and phospholipid membrane.*



suspended particles, including ribosomes."[38] Most of the cytosol is allocated to water, making an aqueous environment with constant motion rather than a static one.[39] As a result, motion, movement, and interconnection are the basic characteristics of all living things, visible at different scales.

The cell's significance in a living architecture is that it is the main element of the architectural environment. The cell shows how nature creates a separated compartment that can maintain a connection with its surroundings in a selective way. It represents interconnection as a significant feature of all living things, from the microscopic to the macroscopic scale.

38 Ibid.
39 Ibid.

3.2.3. The Rhizomatic Relationship

This section begins by explaining the etymology of Shora's name from Arabic and Persian, and how its meaning has relevance to Slonczewski's key idea of sharing. Then, the rhizomatic aspects of Shora, from architecture to social relationships, language, and their way of life are discussed. Furthermore, a rhizomatic growth for the living rafts is proposed by author.

Before explaining the rhizomatic aspect of *A Door into Ocean*, it is significant to understand the reasons for choosing the names of Shora and the Sharers. Looking up the meaning of Shora in the dictionary, I didn't find anything in English. But it reminds me of the word شورا in Arabic and Persian, pronounced in English as "Shora." In Arabic, شورا is the name of one of the surahs of the Quran. It means a kind of group activity that is admirable. It is also a synonym for "parliament," as a place where people gather and consult. These kinds of consultations are not just related to social issues, but can cover a range of different subjects. In Persian, it means "consultation" and, again, a group of people who gather to consult.[40] In addition, there is a planet that was named "Shura" in 1977 to honor Aleksandr Kosmodemyansky, a hero of the Soviet Union. Shura was the name of Kosmodemyansky's pet.[41] The idea of sharing and consulting is one of the key features of Sharers, the people who share. In this sense, Shora is an intelligent word choice both because of its meaning and its similar rhythmic tone to the name Sharer.

Shora's rafts are formed like plateaus, "growing in the middle, not at the beginning or the end."[42] They don't have specific borders, as they grow, change, and make new boundaries at every moment. Shora is rhizomatic as it makes connections with everything. Although there is an apparent contradiction in that the raft is composed of trees, which are arborescent structures,

40 "شورا," accessed March 26, 2019, https://dictionary.abadis.ir/fatofa/اروش/.
41 "1977 Shura," accessed March 26, 2019, https://www.revolvy.com/page/1977-Shura.
42 Gilles Deleuze and Felix Guattari, "Introduction: Rhizome." in A Thousand Plateaus: Capitalism and Schizophrenia [Mille plateaux, of Capitalisme et schizophrenie]. trans. Brian Massumi (Minneapolis: University of Minnesota, 1987), 21.

considering each tree as a single entity is meaningless because they are multiple, interwoven trees that make a new entity that grows larger each year. The rafts' growth is more horizontal than vertical, like a rhizome. Sharers are not just themselves, since they have been "aided, inspired, multiplied"[43] by the living trees, breathmicrobes, mycelium, corals, and many other species. Their language has no object and subject. If you hit someone, it means that you have been hit as well by that person. Some words have no equivalent in the Sharers' language, like "order" and "obey." They share everything; they make connections with other living organisms. They don't make points; they form lines by creating a vast network. Rhizomatic features exist not only in their language or social relations, but also in their architectural environment, as they don't make hierarchical structures. They allocate the highest value to the place of gathering, placing it on a higher level and decorating it to be shared by everyone.

Place of gathering: *"Up the raft, beyond the silkhouse, grew rows of buoyant airblossoms, kept aloft by reservoirs of secreted hydrogen gas. Beyond the airblossoms, the raft sloped upward gently, until it dipped to a hollow at the center. Selfnamers were converging here, over a hundred so far."*[44]

The Sharers' homes are also connected with a mycelium rhizome and the under-raft laboratory in the form of chambers and tunnels with "multiple entryways."[45] They share knowledge and modify their bodies and other living things to make new connections and to be renewed again. When a rupture occurs, Shora revitalizes itself. It cannot be destroyed, as every single cell carries the whole knowledge of the Sharers.

43 Ibid., 3.
44 Slonczewski, *A Door into Ocean*, 75.
45 Deleuze and Guattari, "Introduction: Rhizome," 12.

"- As it is, every cell of every living raft contains a whole library of all the basic knowledge and skills Sharers possess.
- A library, in a cell?
- A chromosome library. Trillions of bits of data on molecular chains, coiled up so small you can't even see it. In every cell of raft-wood. Billions of cells in every raft seedling, each the seed of an entire Sharer life and culture."[46]

Shora, Sharers, and other species instantly deterritorialize and reterritorialize again. They become each other in this process. It is an aligned evolution of different beings.[47] They extend their territory by forming a rhizome with other things like the sun, winds, seaweeds, corals, clickflies,[48] mycelium, and other species. Shora and Sharers create a rhizome, similar to a wasp and an orchid. The orchid and the wasp imitate each other: "The orchid deterritorializes by forming an image, a tracing of a wasp; but the wasp reterritorializes on that image."[49] Eventually, wasp and orchid together create a rhizomatic system, merging in the formation of a new entity called a rhizome. Similarly, Shora's architectural environment is integrated with nature. This integration indicates the becoming-nature of the architecture and the becoming-architecture of nature.

Raft Growth

In this part, the primary source of inspiration for the living rafts, the mangrove forest, and imagining the forest as inverted, are explained. The mangrove forest's process of reproduction, and its similarities and differences with the living rafts of Shora, are examined. Based on these analyses, a rhizomatic growth process is suggested as an alternative to the process of reproduction by seeds. A simple simulation of this growth gives a sense of the raft's growth over time.

Joan Slonczewski, on her webpage at Kenyon College, explains the

46 Slonczewski, *A Door into Ocean*, 284.
47 Deleuze and Guattari, "Introduction: Rhizome," 10.
48 Check the glossary
49 Deleuze and Guattari, "Introduction: Rhizome," 10.

living raft idea in *A Door into Ocean* thus: "The raft trees are 'hydroponic;' they grow by extending buoyant roots deep into the water, then putting out leafy branches above." [50] She had two sources of inspiration. The first one went back to her childhood, when she used to lay down in the forest and watch the sky. She saw the forest as inverted, and imagined the sky as water. The second source is the mangrove forest, which supports a very fertile ecosystem.[51] Mangrove forests are one of the most diverse and productive ecosystems on the earth. Additionally, they provide resources for the whole ecosystem by photosynthesis. They live between land and water in tropical areas.[52] Also, they offer decent shelter for different marine species, like small fish and coral reef fish. Mangrove roots are home to sponges, corals, and barnacles.[53] They have two methods of reproduction. One is pollination, which is a risky process. The other way is by propagules, a process called vivipary.[54] It differs from reproduction by seed or fruit; trees produce seedlings, growing embryos, which are dependent on them for a few months until they detach.[55]

The mangrove forest as a source of inspiration shares a few similarities with the fictional living raft described in the book. Firstly, it can provide decent shelter for different marine species, and thus many species are dependent on it. Secondly, its tangled underwater roots have similarities to the inverted forest in *A Door into Ocean*. Finally, barnacles, corals, and sponges are also marine species that grow on the living raft's roots.

There are, however, a few differences between the living raft and mangrove forest. The hydroponic raft trees grow while afloat, while mangrove forest roots need to be fed by soil. Therefore, they grow in shallow water, and are attached to the seabed or water's edge. The living raft repro-

50 Slonczewski, "A Door into Ocean."
51 Ibid.
52 Peter J. Hogarth, *The Biology of Mangroves and Seagrasses* (Oxford: Oxford University Press, 2015), v- 1.
53 "Into the Mangrove Forest | UnderH2O | PBS Digital Studios," directed by Craig Musburger, posted by UnderH2Oshow, July 2, 2013, https://www.youtube.com/watch?v=4mSDrAQp4dQ.
54 Check the glossary.
55 Hogarth, *The Biology of Mangroves and Seagrasses*, 32-3.

duces through the seeds of the raft blossoms,[56] while the mangrove forest's process of reproduction is by propagules and pollination.

> *"Raft blossoms were shedding petals like golden confetti; soon their seeds would drop to sprout new raftlings in the sea."*[57]

Another noticeable difference is the formation of the raft in comparison to the mangrove forest, as the main trunks are underwater, providing a relatively flat surface for dwelling upon. The question that arises here is if the raft's only means of reproduction is by seeds, the chance of the trees attaching to one aother to provide a large, cohesive raft is very low, as they will be dispersed from one another by the motion of the water. Therefore, there may be another method of reproduction or another answer to how they attach to one another. One possible answer is that the roots are rhizomatic and, in this way, the raft can grow horizontally over time as tree rafts are attached together. In addition, seeds can still provide a second way of reproducing, especially by producing trees for new rafts. In botany, rhizomes are underground stems that grow horizontally while bringing up new roots and stems from their nodes. They spread out of control, and it is not easy to get rid of them as new plants can emerge from a piece of the rhizome.[58]

Based on these analyses, rhizomatic growth can be the approach for the proposed form for the raft and this is the reason for proposing a rhizomatic growth simulation. The following growth simulation shows that the raft becomes thicker and denser at the centre over time. This density has similarities with how Slonczewski describes the living raft: "our home raft is stronger yet, twice as thick at the center."[59]

Figure 38 illustrates a growth logic that I defined for the raft. The first seed

56 Slonczewski, "A Door into Ocean."
57 Slonczewski, *A Door into Ocean*, 92.
58 David Beaulieu, "Rhizomes: Definition, Examples," last modified November 15, 2018, https://www.thespruce.com/rhizomes-definition-examples-2131103.
59 Slonczewski, *A Door into Ocean*, 51.

acts as an initiator, a single seed that floats on the ocean. To make the simulation simple, the growth starts with selection numbers of random branches (here, a random range between 0 to 6 has been used). Each branch will be positioned with a random angle (between 0 and 360 degrees) and random length (integer numbers between 1 and 6). Each branch ends in a node, which is a new initiator, and so this process continues. (Figures 39-42)

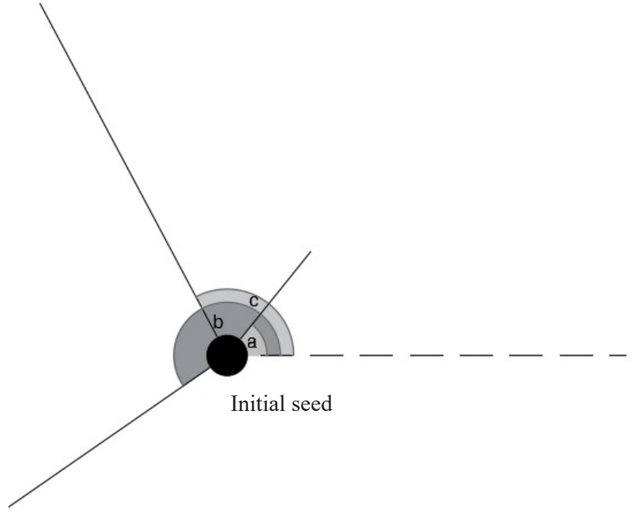


Figure 38 *Initial seed.*

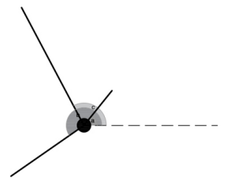
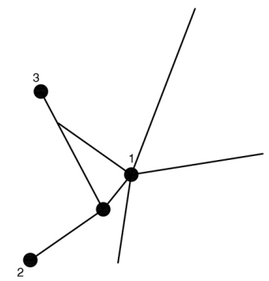
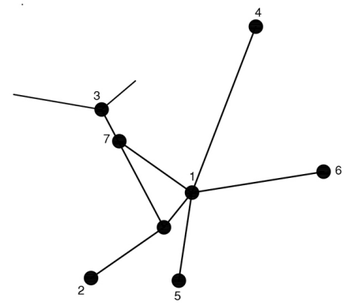
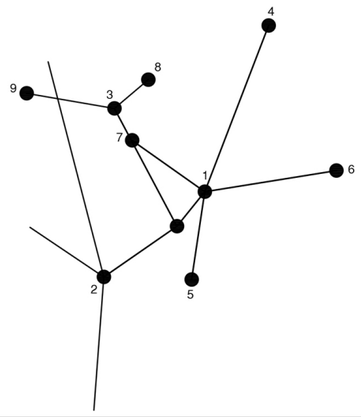
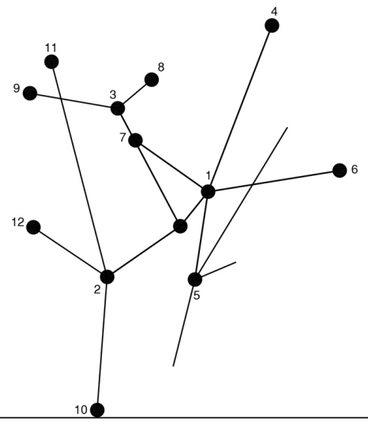
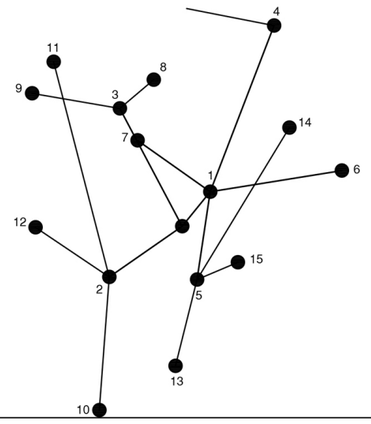
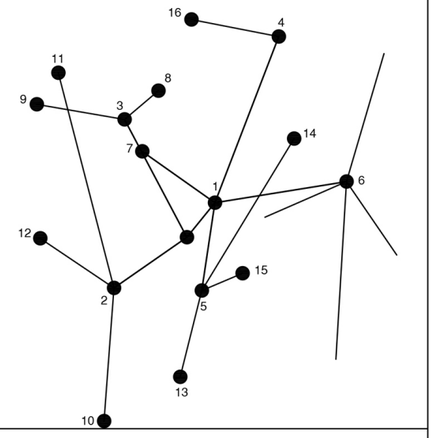
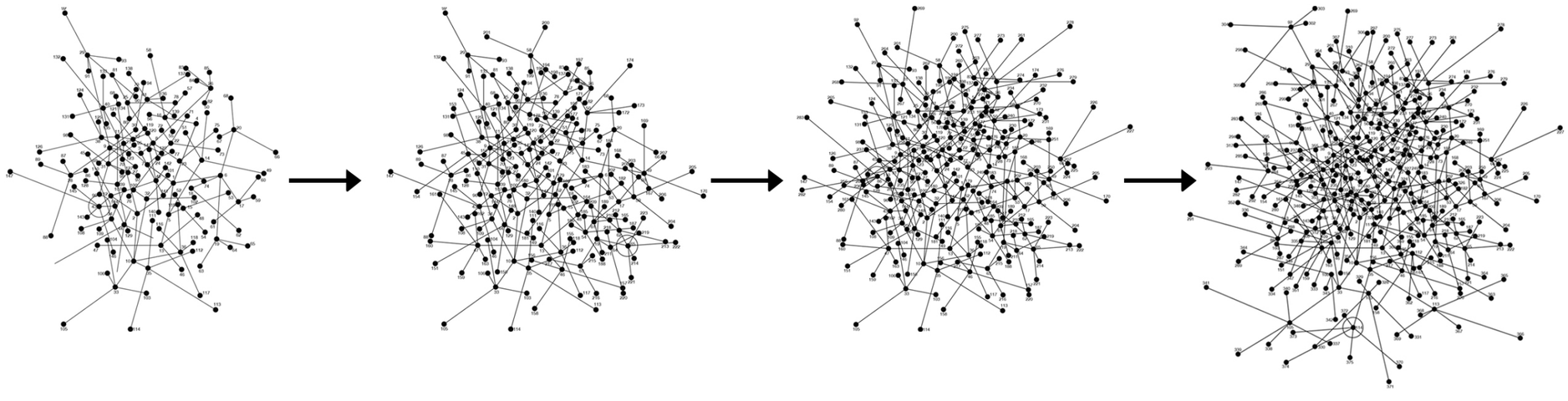
			
1. This is the start point of the rhizome growth. Initial seed which act like an initiator.	2. It starts to specifies growth direction based on random number of branches, lengths and angles.	3. Each branches ends in a node.	4. Each node acts like a new initiator.
			
5. The growth process goes on...	6. The growth process goes on...	7. The growth process goes on...	8. The growth process goes on...

Figure 39 *Growth process I.*



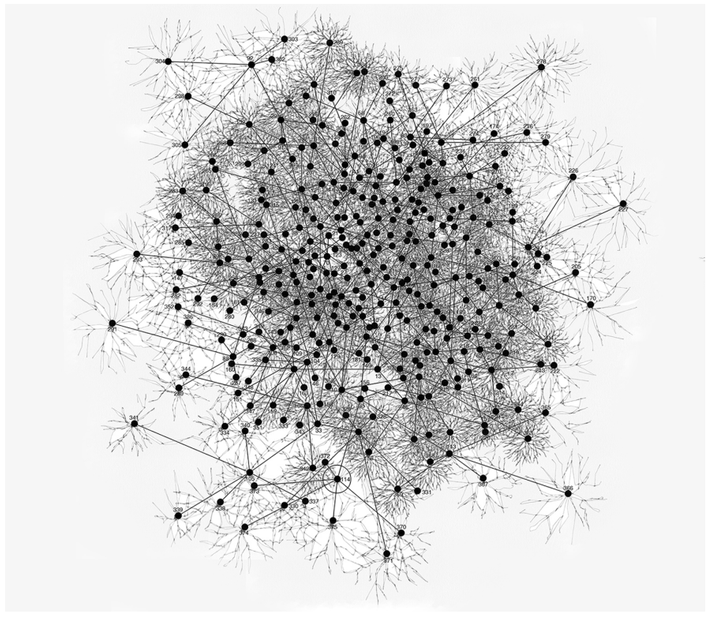
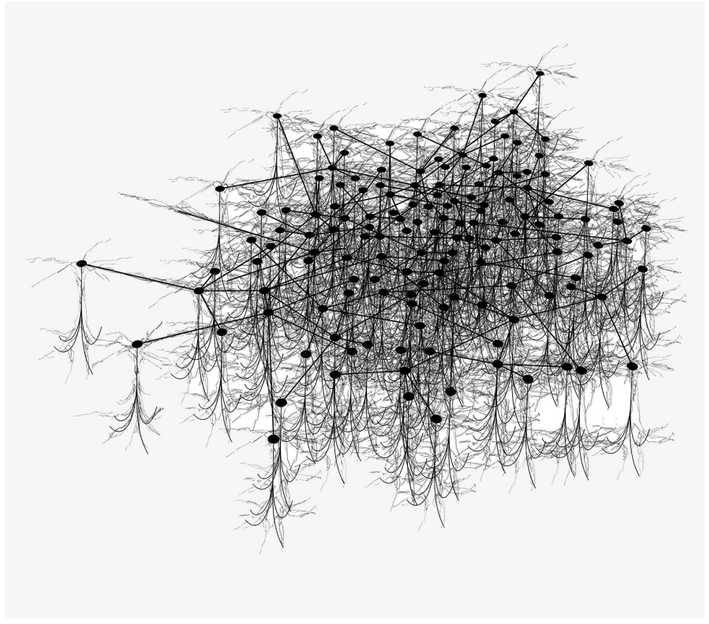


Figure 40 *Growth process II.*

Figure 41 *Rhizomatic growth, plan.*

Figure 42 *Rhizomatic growth, isometric.*



3.2.4. The Concept of the Doors

Shora has just three doors: the sun, Death, and the Self. What follows explains the concept of the doors, which are metaphors for life, death, and the self on Shora. The only means of separation on Shora is these three doors. The Sun, as the metaphor for life, is the main source of energy that creates living things. As the architectural environment that this thesis proposes is living, the focus here is just on the first door of Shora (the Sun), although the other doors are worth exploring. This part also describes how customs differ in our world by making endless doors as symbols of separation, and borders.

> *"The Names of the Doors were the oldest tradition known, older than genetic records, as old as the lips of Shora herself: the First Door of the Sun, the Last Door Unshared, and the Door of the Self. It was said that Shora would live forever, so long as the Names were remembered."*[60]

Shora has just three doors that are inevitable in each person's life. The first one is the Sun, the endless source of life, light, and energy. All living things are descendants of the Sun: "Sea and sky are the twin breasts of Shora, and sun is the heart that beats behind them."[61] The last one is Death, which all living things face sooner or later. By entering that door, we give other living things the ability to live. This is the reason that Sharers have no fear of death. They believe that the main reason behind the desire for killing is fear of death, and when there is no fear, there is no tendency to kill.

> *"You are dying already inside, from the sickness you call 'killing.' If you would only stop trying to share death, which can't be done, then we could help you learn to share life. Then you wouldn't need fear anymore."*[62]

60 Slonczewski, *A Door into Ocean*, 123.
61 Ibid., 85.
62 Ibid., 353.

The third door is the Self, a door to the private place of the mind, the place of solitude and consciousness. In case of pain and discomfort, Sharers sit cross-legged to meditate and discover the world of the mind. This process of healing the mind is called Whitetrance. In this phase, Sharers consume the oxygen of breathmicrobes, gradually losing their purplish colour. This process is reminiscent of corals bleaching as a result of lack of oxygen. The life of corals is dependent on zooxanthellae, a kind of algae that produce oxygen. Global warming is one of the reasons for coral bleaching. With changing climactic conditions, corals expel zooxanthellae, and turn white.[63]

> *"Whitetrance is the most vulnerable state of consciousness. On Shora, with such small rafts to dwell upon, it is hard to find solitude. Whitetrance gives each Sharer one place alone with her soul. And that aloneness is just a whisper away from death."*[64]

In contrast to Shora's three doors is the patriarchal planet, called Torr, which has countless doors. "You see how customs differ. Now Torr is called the planet of a thousand doors, nothing but doors among countless chambers, from the surface to the very core."[65] Torr resembles our planet, and its countless doors remind us of the borders, inert walls, and barriers that separate people. As Rachel Armstrong mentions beautifully, "There is an urgent need to reimagine and repurpose bricks, the units of architectural construction, and find a building technology that does not separate us but enables us to embrace each other."[66]

63 "What is coral bleaching?," National Ocean Service, accessed March 25, 2019, https://oceanservice.noaa.gov/facts/coral_bleach.html.
64 Slonczewski, *A Door into Ocean*, 366.
65 Ibid., 150.
66 Armstrong, *Soft Living Architecture*, 160.

3.3. Case Studies in Architecture & Nature

This part presents several case studies in architecture and nature that resonate with Shora's architectural environment. These precedents are related to new practices in architecture such as biodesign, soft living architecture, and Living Architecture. It begins with the Future Venice project as an example that spreads architecture underwater with lively matter.[1] It resonates with the planet of Shora, which is covered with water and whose architecture is formed in the ocean. Also, the self-organizing mixture of life-like materials in this project has similarities with the use of living materials on Shora. The next part features a few precedents that employ living trees to build living structures. Similarly, interwoven living trees grow the living rafts of Shora, providing a living environment for Sharer life. To conclude, I propose analogies between examples of living materials and lively matters in current practices and the materiality of Shora.

3.3.1. Return to Ocean

Future Venice Project

Rachel Armstrong's Future Venice project deploys lively matters[2] and their features to reinforce the foundation of the city of Venice, Italy. It leverages a bottom-up growth process over time, and for this scenario, it uses a living metabolism instead of a dead one. Also, it is supposed to consume organic waste to grow and create a self-organizing mixture. Both in Future Venice and on Shora, the architecture grows bottom up, over time in the ocean. Both cases use a living metabolism with a low activation threshold; therefore, no pollution is emitted. They create suitable ecosystems for many different species, like parallel cities. (Figure 43)

Future Venice is about growing a bottom-up, self-organizing structure to preserve the city's foundation from erosion. Although it deploys artificial cells with living characteristics, like Shora it grows continuously and

1 Check the glossary.
2 Check the glossary.

constructs a "living reef-like structure."[3] On Shora, the bottom-up growth process gradually provides a thick raft for the Sharers to settle on. In both cases, the architectural and constructed environment is self-formed over time, with humans acting as stimuli and the rest proceeding by itself. Humans can use their knowledge, however, to control and lead the process if needed.

Armstrong writes that "Venice's buildings have 'living' metabolisms, not dead ones."[4] Living metabolisms are different from dead metabolisms: "They have low activation thresholds and combust without igniting,"[5] while for the dead ones the threshold is higher, and when they ignite, a considerable amount of pollution will be released. Although the released energy of a dead metabolism is much higher than a living one, a living metabolism provides many other benefits. For example, the waste of a living metabolism can become the raw material for another reaction.[6] (Figure 44) This cycle in a living architecture, like that of Shora or the Future Venice project, prevents harmful waste in nature. Therefore, construction waste disposal is not an issue anymore. Besides that, it represents a sustainable approach that has never been experienced, as it eliminates negative environmental impacts.

One of the advantages of the Future Venice project is its ability to use the waste substance and convert it into a new useful substance, beneficial for the whole environment. Figure 45 shows the process of a self-organizing mixture in the Future Venice project, which transforms extra substances into an active soil-like material that reinforces the city's foundation.

Shora is the world of living things and Sharers hate non-living ones. They hate things that cause fire, like the "typical fuels for modern technologies."[7] Similarly, the Future Venice project aims not to use typical fuels.

3 Rachel Armstrong, *Soft Living Architecture: An Alternative View of Bio-Informed Practice* (New York, London: Bloomsbury visual arts, 2018), 155.
4 Ibid., 154.
5 Ibid.
6 Ibid.
7 Ibid.

Figure 43 *Future Venice Project.*

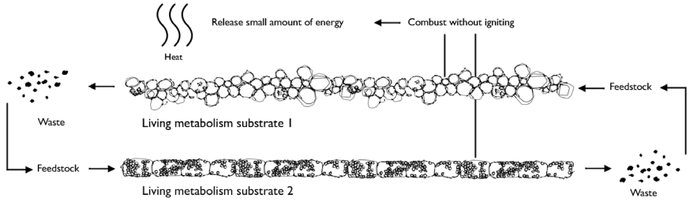


Figure 44 *Mutualism.*

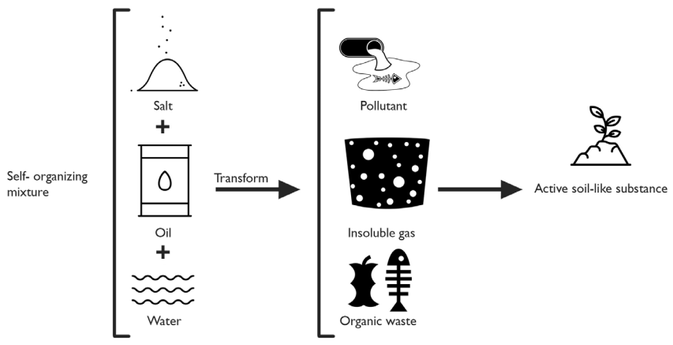


Figure 45 *Future Venice Project self-organizing mixture diagram.*

> *"People fear stone," Usha said, "because it contains never-life."*
> *"Non-life? You mean, death?"*
> *"Nonsense," she repeated vehemently. "What's to fear about death? Death is natural. Stone is never-life."*[8]

Humans make the city and urban landscape for themselves; however, "many parallel cities co-exist alongside our urban environments."[9] In the Future Venice project, a parallel city is constructed on the water's edge and beneath it for protocells to settle.[10] On Shora, the rafts are not only for the Sharers to settle on, but create parallel worlds at different scales for other creatures, altogether unifying a sustainable ecosystem.

8 Joan Slonczewski, *A Door into Ocean* (New York: A Tom Doherty Associates Book, 1986), 101.
9 Armstrong, *Soft Living Architecture*, 156.
10 Ibid., 156-7.

3.3.2. Living Structures

The next three projects engage nature to provide different structures. In these case studies, trees are formed for a certain useful purpose. The history of the living structure shows that this type of architecture has been used for centuries and some current projects seek new applications to reach another level of this type of architecture for the future. These projects have similarities with the living rafts of Shora as they are grown by interwoven living trees. Although the scale of the living rafts is much bigger than these projects, in all cases living trees act as the main structural elements in the architectural environment.

3.3.2.1. Meghalaya Bridges

This part examines Meghalaya living bridges in India and their benefits for the ecosystem, as well as the location of the bridges and how they promote cooperation and resilience among the people, like the rafts do for Sharers. Their construction methodology of formworks is explained. Their strategy is proposed as an explanation for how the chambers and tunnels of Shora's rafts are made. (Figure 46)

Living root bridges are vernacular, plant-based structures located in the tropical rainforests of Meghalaya in northeastern India, in a densely forested environment with wet weather. They are grown by the Khasi people with rubber fig (*Ficus elastica*) aerial roots across rivers and streams, and survive for several centuries. These bridges act as a biome for different species and can be adapted for growing orchids, foods, and medicine.[11] They are captivating examples of a correlation between nature and architecture. Construction costs are minimal, and the whole community participates in the growth process. The bridges are highly durable, remaining for centuries, and support other biota.[12]

11 Sanjeev Shankar, "Revitalizing Traditional Knowledge: Living Root Bridge as a Biome," 5th Annual international Conference on Sustainability at Indian Institute of Management Shillong, 2.
12 Ibid.

The Khasi tribe's "remote location and distinctive environment" nurture them with "self-sufficiency and resilience" while they share and cooperate with each other.[13] They grow the bridges in a participatory practice with different generations involved in the process.[14] In these cases, they are like the Sharers as Shora provides a context to share everything and grow a living environment. Furthermore, Sharers' participatory approach in constructing their homes and sharing different tasks is similar to that of the Khasis.

Living bridges "made by shaped trees"[15] are a sustainable architectural solution, in contrast to the use of steel and concrete with a high carbon footprint. The construction process starts with making a deadwood formwork across a channel. After that, ficus trees planted beside the formwork drop their aerial roots and grow over the initial scaffold until they cover it. By growing daughter roots, the bridge becomes more rigid and makes a complex network of living roots over time.[16] The growth process takes fifteen to thirty years or more to become strong and stable for load-bearing.[17]

On Shora, Sharers make underground tunnels that provide access to the ocean and also to the chambers of life-shaping.[18] Since these chambers are used as laboratories that extend beneath the entire raft, they have a particular importance for the Sharers: "It turned out that nearly all the rafts had some extent of lab warrens," and "In a sense one might say… the whole planet is their laboratory."[19] In the story, Slonczewski describes how Sharers dig the raft tunnels, cutting branches and roots to do so. However, digging may cause destruction to the living raft, thus contradicting the balance that Shora creates between architecture and nature. Therefore, weaving tree roots or branches by using formworks to create the desirable forms, as

13 Shankar, "Revitalizing Traditional Knowledge," 3.
14 Ibid.
15 Ferdinand Ludwig and Wilfrid Middleton, "Growing Bridges," in *Hortitecture: The Power of Architecture and Plants*, ad. Almut Grüntuch-Ernst (Berlin: Jovis, 2019), 178.
16 Ibid., 180.
17 Sanjeev, Shankar, "Living Root Bridges: State of Knowledge, Fundamental Research and Future Application," IABSE Conference, September 23-□25 2015, 3.
18 Check the glossary.
19 Slonczewski, *A Door into Ocean*, 215.

the Khasis do, may be a better approach.

> *"Roots and vines twisted from the walls at odd angles. This was where "life-shaping" took place, although there was no sign of laboratory benches or plumbing, not even a stray petri dish."*[20]

The weaving method that is used in Meghalaya, and could also be used on Shora, can form nature in a desirable way for different uses of space. It provides consolidated, live structures that can last for many years and have fascinating features like self-repair and interactivity.

3.3.2.2. Fab Tree Hab

Fab Tree Hab proposes dwellings whose structures are made of living trees, similar to the rafts of Shora. Other than temporary framing, living and organic materials have been used in this project, which also resonates with Shora's Silkhouses. This section provides a brief overview of Terreform ONE, the designers of the project. It then describes the concept of the project and explains "pleaching"[21] as its construction strategy. Finally, the construction methodology and advantages of the project are described. (Figure 47)
Terreform ONE is a non-profit urban design and architecture group who are multidisciplinary specialists, working within a socio-ecological design framework to design smart cities. It was founded by Mitchell Joachim and Maria Aiolova in 2006.[22]

The structure of Fab Tree Hab is based on slow farming trees while congruence with ecology is its guiding principle.[23] The home is grown with living trees and other living nutrients in about seven years,[24] and shaped

20 Ibid., 210.
21 Check the glossary.
22 "Terreform ONE [Open Network Ecology]," accessed February 26, 2019, http://www.terreform.org/about.html.
23 "Nature's home," accessed February 26, 2019, http://www.archinode.com/Arch9fab.html.
24 William Myers, *Bio Design: Nature- Science- Creativity* (New York: The Museum of Modern Art, 2012), 58.

Figure 46 *Meghalaya living root bridge.*

Figure 47 *Fab Tree Hab.*

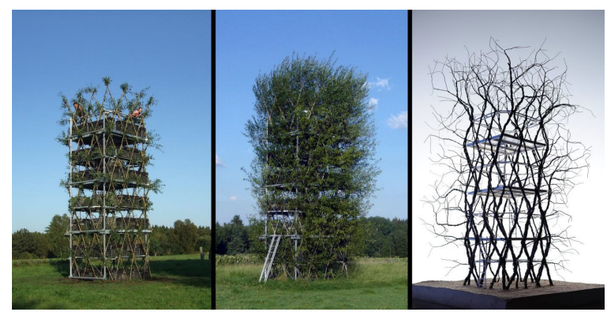


Figure 48 *Baubotanik Tower.*

with a reusable, prefabricated Computer Numerical Controlled (CNC) scaffold.[25] One of the main strategies in construction is "pleaching," which is shaping trees by weaving their branches. Tree trunks act as the load-bearing elements, while the branches make the frames to cover walls and ceilings.[26] For the ideal form, a plywood frame is used, then detached after achieving a stable structure.[27] The walls are covered with "conventional clay and plaster"[28] on the interior. Although the process of growth takes time, some of the advantages of this project are low price, labour, and fabricated materials and, last but not least, its health for the environment and long life-span.[29] These advantages can be considered as belonging to Shora's architecture as well.

3.3.2.3. Baubotanik Tower

The Baubotanik project proposes another captivating example of using living trees to form architectural space. By using technology and geometrical consideration, a strong structure is generated. This can be compared with the Sharers' approach and how they grow their architectural spaces and, especially, the living rafts. (Figure 48)

This project is created by the Baubotanik group, founded at the University of Stuttgart in 2007. Their focus is on theoretical and scientific aspects of living architecture.[30] According to Ferdinand Ludwig, "One major aim of the group is to develop adequate botany-based design tools, planning methods, construction principles and horticultural details that comply with the needs and growth patterns of the used plants."[31] Baubotanik projects are an experience between technology and biology to construct architectural spaces.

25 Mitchell Joachim and Mike Silver, *New Directions in Ecological Design* (New York, Barcelona: Actar publishers, 2016), 73.
26 Myers, *Bio Design*, 58.
27 Ibid.
28 Ibid.
29 Ibid.
30 Ferdinand Ludwig, "BAUBOTANIK - Designing Growth Processes," Symposium "Form-Rule/Rule-Form, University of Innsbruck, January 1, 2014, 1.
31 Ibid.

The Baubotanik tower project is a three-storey building constructed using 400 *white willows* (*Salix alba)* plants. A tubular scaffold is used as an initial framework until the plants get rigid enough to tolerate the loads.[32] The designers take advantage of the "constructive intelligence"[33] of living trees, the ways that they react to stress or load rise.[34] They grow the plants in a rhombic structure form to facilitate the growth process and face similar geomorphic reactions.[35] For the plants to become self-supporting and load-bearing is a process that takes eight to ten years, based on the designer's predictions.[36] In terms of creating strong joints, Ludwig and his team connect the plants with various joining methods. By growing the bark tissue of two plants together, a partial fusion happens and, after a while, they share the same annual ring in successful cases.[37]

32 Ibid., 7.
33 Check the glossary.
34 Myers, *Bio Design*, 37.
35 Ludwig, "Baubotanik- Designing Growth processes," 7.
36 Ibid., 8.
37 Ludwig, Ferdinand, Hannes Schwertfeger, and Oliver Storz. 2012. "Living Systems: Designing Growth in Baubotanik." Architectural Design 82 (2): 82-87. doi:10.1002/ad.1383. https://doi-org.proxy.lib.uwaterloo.ca/10.1002/ad.1383.

3.3.3. Living Materials and Lively Matters[38]

This section focuses on living materials – materials made by living organisms – and lively matters – materials that have some features of living things. Shora's living rafts and Sharers' homes are made with similar materials like fungi, moss, seaweed, coral, barnacles, and living trees. Several precedents for this kind of material use, among many others, are investigated. The fungi and mycelium archetype and features will be discussed at the beginning. They are worth mentioning not only because they can be used as living materials, but also because of their brilliant architecture. The use of mycelium in architecture is investigated with two projects, the Mycelium wall by Petra Gruber and Thibaut Houette, and the Mycelium project by Studio Klarenbeek & Dros. This part is followed with two more examples, the Biodigital Barcelona chair by Alberto T. Estévez, which achieves qualities of "soft" and "hairy" with living grass, and Biocouture by Suzanne Lee, a leather-like material grown by microorganisms.

3.3.3.1. Mushroom – Mycelium

Sharers use different fungi species in diverse colors to decorate their homes. Also, the living rafts of Shora represent a compelling example of an ecosystem, and studies show that ecosystems require a mycelium structure to exsist in order to avoid collapse.[39] Therefore, a quick scientific review of mycelium's features and roles is beneficial. In the following, I discuss the definitions of mushroom and mycelium, some of their features, and their importance to the earth. Then, the architecture of mycelium networks is explained, and its similarities to the model of dark matter, neurons, and the living rafts of Shora are discussed. Two case studies that demonstrate the current use of mycelium in architecture are introduced. (Figure 49)

38 Check the glossary.
39 Paul Stamets. Mycelium Running (How Mushrooms Can Help Save the World) (New York: Ten Speed Press, 2005), 1.

> *"Fungi are keystone species that create ever-thickening layers of soil, which allow future plant and animal generations to flourish. Without fungi, all ecosystems would fail."*[40]

Paul Stamets, the author of *Mycelium Running: How Mushrooms Can Help Save the World* (2005), is an American mycologist who has worked on fungi for over forty years. According to Stamets, "A mushroom is the reproductive structure or fruiting body of mycelium,"[41] while mycelium is "The network of fungal threads in soil that act as interfaces between plant roots and nutrients."[42] He also considers it the "neurological network of nature."[43] Stamets calls mycelium the "information-sharing membrane"[44] of living organisms and, along these lines, it is like "the Earth's natural Internet."[45] In this sense, we might be able to communicate and exchange information by mycelium cellular networks in the future.[46]

Mycelium is one of the most important components of nature. It spreads all over landscapes where life can be found.[47] Stamets writes that "Mycelium, constantly on the move, can travel across landscapes up to several inches a day to weave a living network over the land."[48] Its crucial role is to provide the conditions for plants to grow, while breaking down dead organic materials into nutrients for reuse. Although in the past decades, human development has caused catastrophic results for nature that continue, using mycelium can help us to mitigate this unpleasant footprint and regulate this imbalance: "Living in harmony with our natural environment is key to our health as individuals and as a species."[49]

40 Ibid.
41 Ibid., viii.
42 Ibid.
43 Ibid., 2.
44 Ibid.
45 Ibid., 4.
46 Ibid.
47 Ibid., 7.
48 Ibid., 1.
49 Ibid.

Mycelium Architecture

Natural selection in living and non-living things occurs based on success. This kind of selection is seen in mycelium architecture as well. The mycelial form and archetype is a smart way to organize matter in terms of energy conservation and connectivity. This matter formation can be found in the organization of dark matter in the universe as well. The internet and neurological patterns are other examples of the mycelial archetype. These similarities seem not to be accidental, and mycelium uses the same pattern to optimize regeneration and is, as a result, one of the most successful species on earth.[50] "Biological systems are influenced by the laws of physics"[51] in terms of matter-energy conservation, and mycelium architecture is an example of this phenomenon.

The rafts of Shora also resonate with mycelium architecture in terms of form. The rhizomatic structure[52] of the raft spreads horizontally and resembles the same archetype since it is energy efficient and matter conserving. The density of the branches in some parts of the rafts is higher than in others, which consequently causes a higher density of filament in those parts. In some parts, there are voids to conserve more energy and matter for other parts. This archetype can be found not only in mycelium but also in dark matter and the brain's neurological networks. This shows, in addition, the biological necessity of fungi and mycelium; the archetype and form of these creatures might thus be the most reasonable archetype to create the world of Shora. (Figure 50)

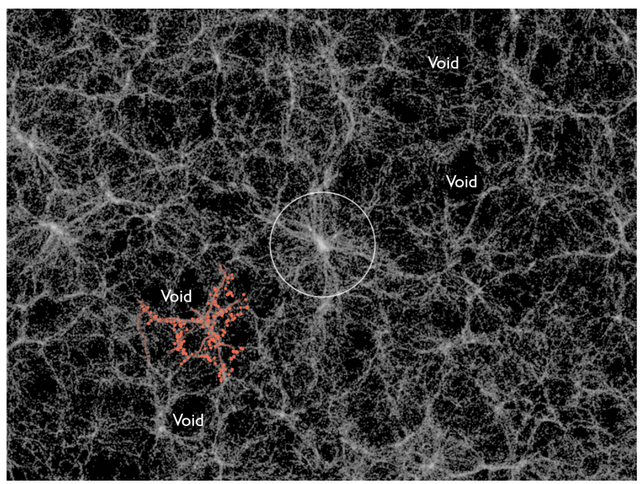
Mycelium Wall

This project is an example of using mycelium and fungi in a wall system. It resonates with the Silkhouses of Shora as fungi decorate the interior and solidify the walls.

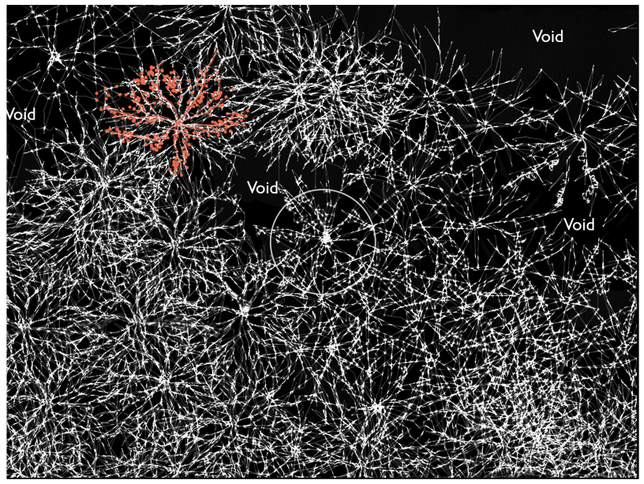
In this project, Petra Gruber and Thibaut Houette experiment with mycelium as a material to build living walls. They use agricultural waste like straw, woodchips, sawdust, and paper to grow fungal roots and stiffen

50 Ibid., 7.
51 Ibid.
52 See chapter 3.2 for further explanation.

Figure 49 *Mycelium.*



Big Bolshoi simulation



Living raft simulation

Figure 50 *Big Bolshoi simulation vs. Living raft simulation.*

the entire material. As a result, they produce a lightweight material that is solidified with the cellular networks of mycelium. To test material quality, they use different panels and experiment with various conditions. They test water resistance, material degeneration, and efficiency of materials in different growth processes.[53]

Petra Gruber is an architect concentrating on "inter- and transdisciplinary"[54] design. Her interest is in biomimetic architecture and especially walls, as they are the means of separation between inside and outside. She and her team explore the features and characteristics of living organisms to find an implementation in architecture. This integration between biology and architecture brings different qualities to the architecture. The interaction between the wall and its surroundings is dynamic, and the wall accommodates living creatures like algae or mycelium.[55]

Mycelium Project

This project shows the use of mycelium in a piece of furniture to increase the rigidity of the base and decorate the piece. It resonates with the Silkhouses' interiors as Sharers decorate them with the fruiting body of fungi. (Figure 51)

In addition to conventional design practice, Netherlands-based Studio Klarenbeek & Dros try to integrate biology with design at different scales. The Mycelium project proposes a piece of 3D-printed furniture that provides a mold for mycelium and fungi to grow in. The Mycelium grows and fills the voids in the mold to increase rigidity, and fruiting body of fungi sprout at some points of the surface.[56]

53 Philip Beesley and Sascha Hastings, eds. Living Architecture System Group Symposium 2019, 2019 (Kitchener, ON: Riverside Architectural Press), 67.
54 Ibid., 68.
55 Ibid., 65-8.
56 William Myers, ed. *Bio Design*. Revised and expanded edition ed. (UK: Thames & Hudson, 2018), 133.

Figure 51 *Mycelium project.*

3.3.3.2. Biodigital Barcelona Chair

This project demonstrates the use of living grass in a piece of furniture. The soft and hairy quality of this material resonates with the interior of the silkhouses, which Slonczewski describes as a "furry paste."[57] (Figure 52)

Biodigital Chair is an experiment by the Genetic Architecture Office and is inspired by Salvador Dali's statement that architecture will be "soft and hairy"[58] in the future. The base for the Biodigital Chair is designed by parametric design software to optimize the form for sitting. Living grass is then grown on the surface of the structure, which allows people to touch it and have a natural experience.[59]

3.3.3.3. Biocouture

Biocouture by Suzanne Lee, New York-based fashion designer, is a leather-like fabric that is grown by microorganisms. The growing process and organic approach of this project are similar to the rafts on Shora, where different kinds of organisms produce materials for the rafts and Silkhouses, and they can be composted easily once they have reached the end of their life. This precedent can also be a proposal for one of the layers of the tent-like Silkhouses, as it is described as similar to leather, but this would require further investigation. (Figure 53)

Biocouture proposes a new kind of fabric made by microorganisms. Green tea, sugar, yeast, grown microbial-cellulose, and natural dyes are the initial ingredients for this leather-like material. Given enough time, this mixture will produce a layer of soft cellulose that gets thicker and can be used as a fabric. One of the most important characteristics of this material is that it can be composted.[60]

57 Slonczewski, *A Door into Ocean*, 54.
58 Myers, *Bio Design*, 120.
59 Ibid.
60 Myers, *Bio Design*, 109.

Figure 52 *Biodigital Barcelona Chair.*

Figure 53 *BioCouture material.*

PART FOUR: CONCLUSION

Shora's rafts are interlinking filaments, particles, and clouds of living branches, corals, sponges, algae, and microorganisms in the ocean. They grow from the bottom up. They are covered with a soil-like porous substance solidified by mycelium, weed, and moss. Sharers use scaffolding and weaving techniques to create semi-permanent structures covered with living organisms. Silkhouses incorporate a shared relationship between biology, genetics, textiles, and architecture. The fusion of genetic science, and architecture in Shora offers new possibilities in materiality, tectonics, and structure. It can also offer a sustainable approach to architecture and design, addressing ecological concerns.

Through the production of my illustrated narrative based on *A Door into Ocean*, I gained insight into the perception of an architecture integrated with nature, an architecture in which borders do not discriminate and living organisms coexist and mix with each other. Different strata of living organisms pass through each other, integrate, make new entities, rupture, and heal through time. Materials used in architecture are not extracted but created while the sun gives energy and the ocean provides the minerals. I find that in this context, humans might reach not only inner peace, but also peace with nature and the outer world.

The relationship between humanity and nature has changed a lot through time. The hope is that we are on our way to achieving a balance with nature in order not to destroy, or be destroyed. Many endeavours have aimed at achieving this goal. However, since our current approaches, ideas, and methodologies remain insufficient in this regard, it seems that we need new ones. In architecture specifically, biomimetic design tends to reduce the gap between architecture and nature. The next step could be to go further than biomimicry and achieve integration with nature. (Figure 54)

The world of Shora represents interesting ideas about psychology, sociology, language, politics, science, and architecture. These ideas represent an initial movement towards a more sustainable future. Sharers' comprehensive knowledge of nature, genetic science, and their mastery of the modification of living things can function as humanity's lighthouse to the future. Besides its aesthetics, the use of living materials in daily living spaces proposes significant features such as adaptability, self-growth, self-repair, and intelligence. The idea of sharing rather than separating can make a better world when walls and borders have no place anymore.

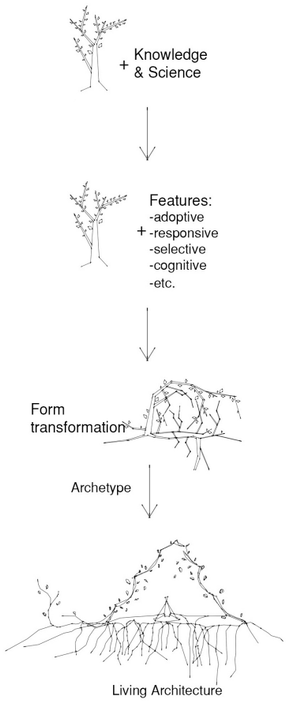


Figure 54 *Living architecture diagram.*

Life emerges from water and evolves through time to create more complex organisms. Since evolved organisms contain information from ancestral genes, an aquatic way of life might be in our unconscious. In this sense, the world of *A Door into Ocean* harmonizes with human instincts. Living in the ocean also resonates with our terrestrial birth from the water of the womb, and in this sense, it relates to feminist theory. Living in water and a return to the ocean breaks the solidity and rigidity that we have encountered in terrestrial life. Such a living environment produces mobility, oscillation, dynamism, and ever-changing qualities.

To create a world similar to Shora, the role of architects would need to be transformed. Architects would turn into biologists who have comprehensive knowledge of genetic science, synthetic biology,[1] and ecology. In this sense, architects should use their broad knowledge of nature and combine it with their artistic sense to help holistic systems evolve in better ways. Humans and nature live in symbiosis and the process becomes easier as humans are able to modify their bodies and other organisms.

If we are seeking a world in which hierarchy or totalitarianism has no place, equal rights in using spaces need to be shared among all people. These equal rights should be translated into a practice of architecture like that of Shora. Since architecture is grown by living organisms, there is no separation between the built and the natural environments, creating an integration between architecture and nature. Integration with nature can overcome the lifeless, rigid, and inert qualities of current architecture, creating varied experiences. Life can be seen at different scales, and evolution, procreation, and metabolism are three main features of this living architecture. In some sense, these are the main advantages of a living architecture over a non-living one. Interconnection can be seen at all scales, from the macro to the micro. Living cells make separate, but not isolated, compartments. Overall, the whole living environment is made up of living cells that replicate from the bottom up.

A living architecture like Shora's should act like a rhizome, which can make connections with everything. In case of rupture, it should be able to revitalize and regrow itself. Interconnection in architecture and social re-

1 Check the glossary.

lations makes new entities at every single moment and creates multiplicity. It is a world of the liminal and in-between, as there are no distinct borders. Architecture and nature are merged, becoming each other. The world of Shora emerges as an integration of two kinds of systems: arborescent and rhizomatic. A homeostasis order is the result of this integration. Centralized structures, tent-like homes, and deeply interwoven living trees are combined with rhizomatic networks of different living organisms, in non-hierarchical social relations, to create such a world.

Shora's world is fundamentally different from contemporary cities on Earth. Terrestrial cities are overwhelmingly 'arborescent' in their relatively closed boundaries and rigid hierarchical organizing geometries. Shora's fluidly 'rhizomatic' forms and organizations seem opposite to those qualities. To introduce aspects of Shora on Earth, our arborescent urban cities would need to integrate rhizomatic qualities. However, terrestrial life on Earth, human social structures and politics, our biological systems, and as a result, our architectural language, are of course inherently different from Shora's. Perhaps Earth and Shora are even polar opposites. A strategy of transformation where contemporary cities might adapt and integrate Shora's qualities lies beyond the scope of the current study. Finding solutions to combine those worlds might result in new hybrids that combine both polarized kinds of organization. This thesis is founded on the hope that through such long-term study and development, a new urban 'homeostasis' that integrates vital and constantly changing and adapting qualities might emerge.

The illustrated narrative in this thesis focuses on a tiny raft on Shora at the beginning of its growth process. That raft was conceived as a small community, serving several dozen inhabitants. If that small cluster were to grow, new kinds of organization would emerge. The whole planet of Shora contains numerous larger living rafts of different ages, with vastly more complex organization than the small tribal community shown here. Organization of the larger rafts, their forms, their relationships with each other, their capacity, the number and organization of inhabitants, and the way inhabitants interact in larger scales, are provocative questions that could be developed.

In the process of finding examples in architecture resonating with Shora, I learned about different practices such as biomimicry, biodesign, living and soft-living architecture, and ecological design. Science and design

Figure 55 *Future Venice Project.*

Figure 56 *Mycelium project.*

Figure 57 *Biodigital Barcelona Chair.*

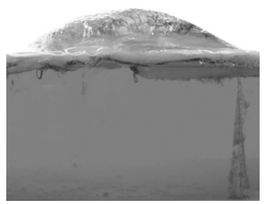


Figure 58 *BioCouture material.*

Figure 59 *Meghalaya living root bridge.*

Figure 60 *Fab Tree Hab.*

Figure 61 *Baubotanik Tower.*

overlap in these practices, creating borderless, interdisciplinary work. It is difficult to distinguish between the different categories mentioned above and box them in with rigid definitions.

In general, however, biomimicry can be described as design that imitates natural behaviour and forms without using living and life-like materials. Soft-living architecture, on the other hand, proposes the deployment of lively matters[2] in design. For instance, Future Venice by Rachel Armstrong uses life-like materials with living features that grow from the bottom up and have self-organizing abilities. (Figure 55)

Biodesign tends to use living organisms in design, and goes beyond biomimicry. In this sense, it resonates with the world of *A Door into Ocean* more than the other practices. Biodesign projects such as the Mycelium Project, the Biodigital Barcelona Chair, and Biocouture deploy new materials in design, seeking a more seamless integration with nature. Biodesign is not limited to these projects, and there are larger scale projects using living materials as their main structures. These include the Meghalaya bridges, Fab Tree Hab, and Baubotanik tower. (Figures 56-61)

Finally, ecological design uses an integration of different practices to present design solutions that minimize destructive environmental impacts. These practices may or may not fall under any of the above categories.

Overall, the application of all, or a collection, of the four practices above may be part of the solution to overcome our current environmental concerns. The world of *A Door into Ocean* is fictional and speculative; however, there are new movements and practices today that share parallels with some of Shora's foundational building techniques. Although it seems early to discuss the results of these practices, they are worth exploring while discussing Shora.

Although the architecture of *A Door into Ocean* presents many fascinating features, it is not possible to guarantee that it depicts the best way to construct the future. As William Myers mentions in his book, *Bio Design*, "The integration of life into design is not a magic bullet to solve these pressing issues. Nor will it be free from harmful missteps, deliberate misuses, or controversy. Dystopian visions of the future awash in biodesign gone awry

2 Check the glossary.

are credible possibilities."[3]

Shora articulates a new world with a different language, social relations, politics, scientific approaches, and architecture. Overall, it proposes an alternative point of view on life and ways of living. Hence, to express such a world, this thesis engaged with different disciplines: from science and biology to philosophy, feminist theory, and architecture. In this sense, it is challenging to combine all these different disciplines to have a reasonable outcome in the medium of architecture. Also, based on limitations in time and knowledge regarding other fields, it seems impossible to provide enough detail for each section within the scope of this thesis.

A Door into Ocean proposes compelling ideas that can act as inspiration for the future of architecture. These ideas need the attention of a wide range of disciplines. Architects, artists, designers, biodesigners, imaginative leaders, genetic engineers, biologists, microbiologists, mycologists, oceanographers, ecologists, writers, storytellers, psychologists, and anthropologists can participate and support similar ideas behind *A Door into Ocean*. Expressing these ideas with film, animation and other visual media would engage a vaster community of people in these thought experiments. Directors, film producers, animators, and others in visual media can help emerge these speculations into reality.

One of the main ideas of *A Door into Ocean* is sharing knowledge with everyone: friends and foe alike. Even when the sharers' children are under attack, the sharers continue to share their knowledge and resources with their attackers. They do not see themselves as more worthy of survival compared to other living things. Every living organism is part of a larger system and must play its part, even if that part is detrimental to the sharers themselves. The only thing that cannot be shared is death, and attempting to share death brings violence. The answer to killing is not killing.

Looking at my thesis through this lens of unquestionable sharing and empathy, I have realized that the audience for my work goes beyond those who sympathize with the ideals presented on Shora. It is easy to say that those in creative fields who image alternatives for a living, or those in

3 William Myers, *Bio Design: Nature- Science- Creativity* (New York: The Museum of Modern Art, 2012,) 10.

the scientific community who try to answer unanswerable questions everyday, are the prime audience of this work. But it is important to also include the cynics of the world in any discussions towards a Shorian future. We need the scientist and the artists to envision this future world, but we need everyone to engage in it to make it a reality.

I believe designing and constructing buildings are not necessarily the only areas of work architects should part take in. They can have essential roles in imagining alternative ways of life. Architecture schools need to provide courses in speculation of the future to bring up new possibilities. We need to integrate our architecture and biology schools. Having labs where students use Petri dishes to experiment with different living or life-like materials (like a few schools worldwide working in the field right now) can give the future students new perspectives about architecture and design. Students need to have facilities to grow materials, examine them, and make something out of them. Architecture schools need to be more engaging with different disciplines and provide infrastructures for collaboration. These trends need to spread, they need to be advertised beyond a small group of researchers and designers. If we seek to integrate nature in our architectural environments, the first step would be integration and collaboration of different groups of specialists.

My conclusions on this project are open-ended, with a few significant questions that can lead us to the next steps. How can we bring the characteristics and features of Shora's architectural environments into our current cities? How can we reshape our cities with their complex organizations and existing social structures? Should we start from the edge of the water, or the heart of the cities? Should we move to the ocean, or stick to our terrestrial life, or have both? How to advertise these ideas on a global scale, when countries have significant contradictions? Do we need to start with policy first, or can we engage small groups that grow like a rhizome? These questions and many other questions are worth investigating.

Our time for saving the planet is limited. We need actions today, at this moment!

You are a copy of the truth,

and you are a mirror to the glory of the creator.

It is not outside of you, what the world is,

ask yourself, as you are what you are looking for!

Rumi Rubaʿi, No. 1759

ای نسخه ی نامه ی الهی، که تویی،※

وی آینه ی جمال شاهی، که تویی،※

بیرون ز تو نیست، هرچه در عالم هست؛※

از خود بطلب هر آنچه خواهی، که تویی!!※

رباعیات مولوی، شماره ی ۱۷۵۹

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Figures 9 & 10

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Derek Parker

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I am a Master of Architecture student at the University of Waterloo, ON, Canada. I used one of your pictures (Green Elfcup) in my digital paintings for my thesis. Right now I realized that the CC license for this image does not allow for modifying or making derivatives and "distributing" them. I appreciate if you give me permission regarding that. I can also send my drawings to you if you prefer to see what I produced.
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Bests,
Parisa

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Derek Parker

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Parisa,

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It is good to know that my work is being put to good use and wish you all the best in your submission.

I would also be very interested in seeing how you have used it and so look forward to seeing your drawings

Regards,

Derek

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Figures 5 & 27

Alfredo Barroso - Underwater Cameraman

Alfredo Barroso - Underwater Cameraman
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Artist

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Hi Alfredo. I hope you are doing well. I am an architecture student at university of Waterloo and I am working on my thesis right now. I found one of your posts regarding Mangrove forest on YouTube and I was wondering if I can use a screenshot of min 0:17 on my thesis. I want to use it as the base of my drawing and mix it with digital painting. I really appreciate if you give me the permission for that. For sure I will give the credit to you.

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Hi Parissa, yes, definitely, use it. Sorry for the delay answering. I was out at Sea working. Cheers and I wish you success with your Thesis!

Thank you so much Alfredo. I will send the final result for you. Merry Christmas.

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Figures 48 & 61

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Dear Professor Ludwig,

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All the bests,
Parisa

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best
FL

Figure 36

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Hi Parisa -

Many thanks for reaching out, and for taking a look over my blog!

Yes, absolutely do feel free to use my pictures of Rockwood Conservation Area in your thesis.

Please let me know if there is any other support I can provide to you.

Warm regards,

Maria

On Fri, 13 Oct 2017 at 17:55 Parisa Hassanzadegan <donotreply@wordpress.com> wrote:

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Email: parisa.hassanzadegan@gmail.com

Website:

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Thank you for your website. I am a Master of architecture student in University of Waterloo, Ontario, Canada. I am working on my thesis right now and my current site is Rockwood conservation area. I want to know if it is possible to use your pictures in the process of my thesis. I would appreciate if you send me an Email.

Best regards,
Parisa

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Contact Form URL: https://mariaklegault.com/contact/
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Figure 65

RockwoodHeaven.com

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to me

Hi Parisa,

Yes you can use whatever images you want. I should have all the high resolution originals too, if you need them. Just let me know.

Colin Smith
Rockwood, Ontario

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Message
Hi, I am a master of architecture student at university of Waterloo. The site that I have chosen for my thesis is Rockwood conservation area. I was wondering if I can use pictures of this website in my thesis. For sure I will mention the sources. I appreciate if you can tell me about the possibilities. Bests, Parisa

Figures 66 & 67

Pete West <pete@bioquest.com.au>
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Hi Parisa,

Congratulations on your work and thank you for your appreciation of ours.

We are happy to grant you permission to use our images in relation to your non commercial project.

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Parisa Hassanzadegan
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I am a Master of Architecture student at the University of Waterloo, ON, Canada. I am working on my thesis right now, and I used one of your pictures to produce two digital paintings:
https://www.microworldsphotography.com/Galleries/Macro-of-corals/i-rxDQ8bm
My drawings are attached to this email. As they show the process of my thesis, I would like to put them in my appendices. I appreciate if you give me permission for that.

All the best,
Parisa

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APPENDICES

From the beginning of this thesis, I wanted to pursue the concept of integration with nature and I sought to imagine architecture as a part of nature. I started with a series of paintings to show the anger of nature about the man-made environment. The story is about the root of life (symbol of nature) that has a desire to grow and change continuously.

7.1. Scene 1: Story of the Root of Life

A girl with a bare mind and free of superstitions confronts nature and existence. She finds it alive, beautiful, and life-giving. She starts exploring nature and meets the roots of nature and life. The roots grow and pass through history, potholes, rivers, and the earth. They crack the rock bed and find their path. The girl explores further, and finds herself in front of a man-built world gate covered by roots. She enters this underground world. As she goes on, all the forms turn into labyrinths, closed doors, dark spaces, and unanswered questions. However, the roots (nature) are her lighthouse. Nature is life-giving and generous. The girl follows the roots and finds herself in chaos, where all the roots are woven together. Nature destroys mankind's immorality and debauchery with all man-made structures. The world mankind was proud of is going to be a desolation. But nature still tries to save the girl and teach her how to live, and gives life.
In the end, nature shows its violence by destroying the man-made building. Nature is the best leader to understand ways of living. (Figures 62-65)

Figure 62 *The cracker root.*
Figure 63 *The underground gate.*
Figure 64 *The Maze.*
Figure 65 *The Castle.*

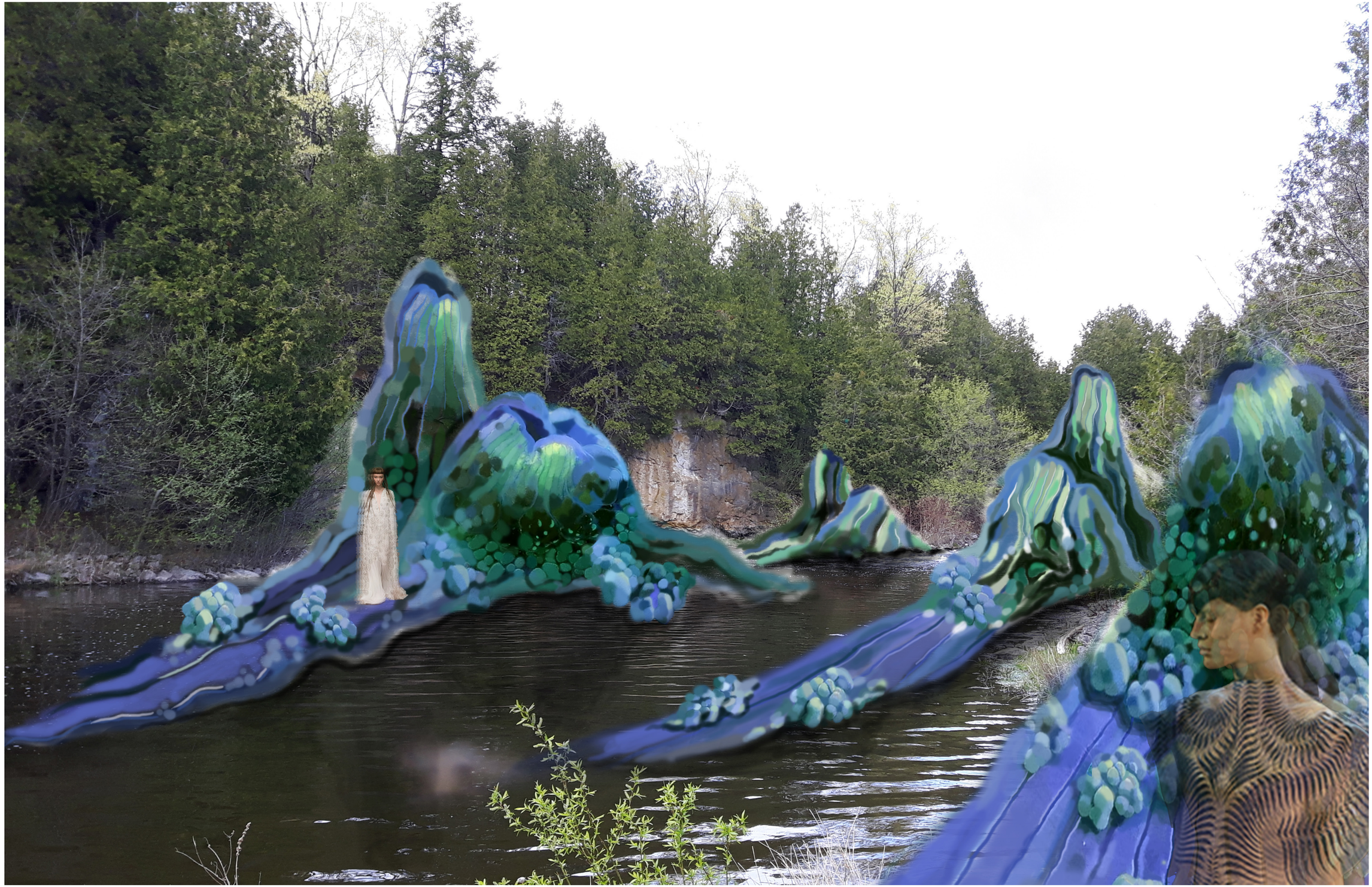
7.2. Scene 2: Polyp Shape Dwellings

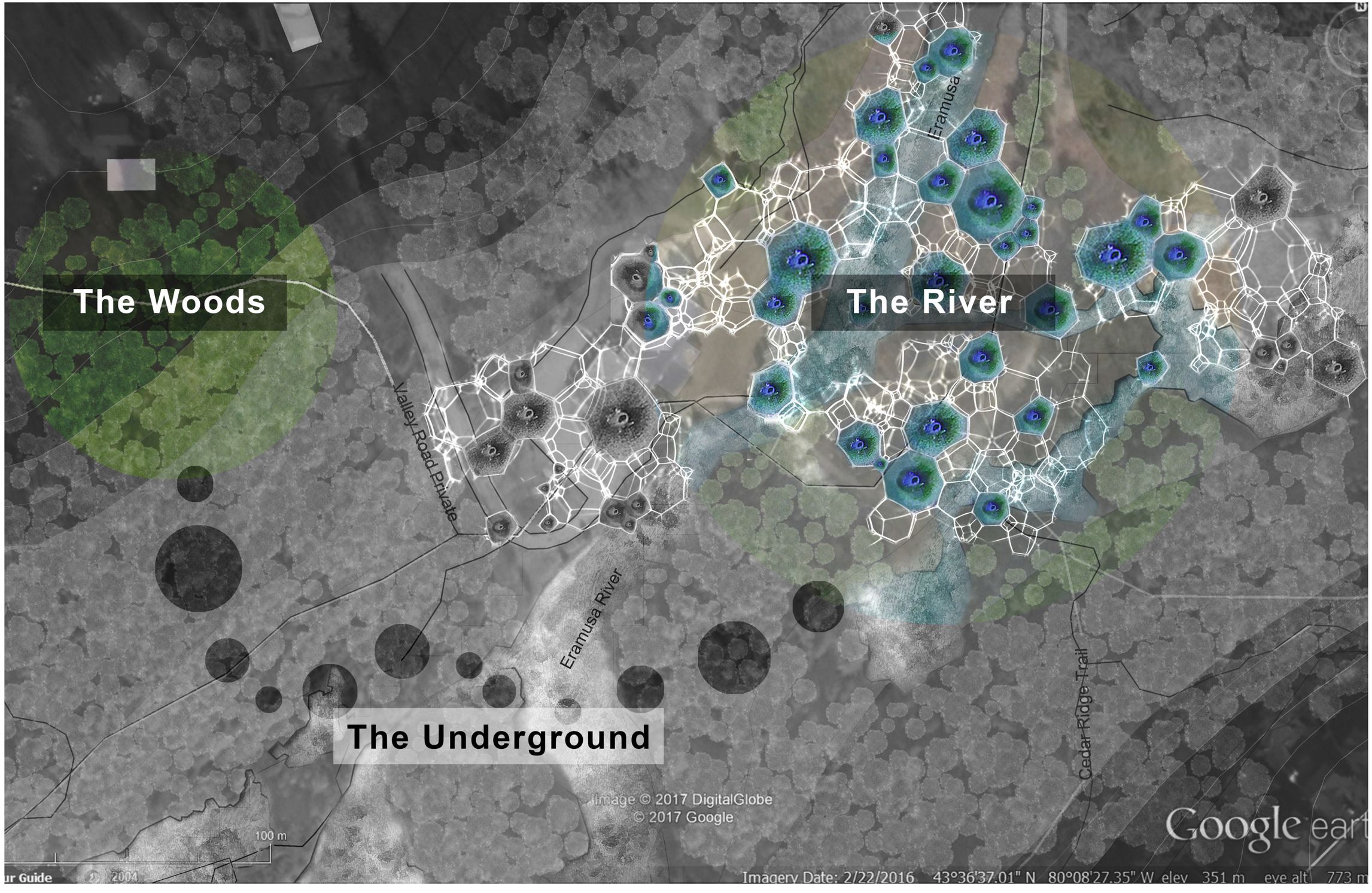
This scene shows a floating, futuristic settlement whose inhabitants are a community of women. A picture of a coral polyp is the inspiration for these scenes. Here, I imagined what it might look like to live in a coral polyp. It represents a new materiality, which is viscous, mucous, lifelike, and has a desire to move, change, and constantly grow, just like nature. (Figures 66-68)

Figure 66 *Polyp form dwellings.*

Figure 67 *Inside polyp.*

Figure 68 *Polyp shape dwellings site plan.*




The Woods
The River
The Underground
Eramusa
Valley Road Private
Eramusa River
Cedar Ridge Trail
Image © 2017 DigitalGlobe
© 2017 Google
100 m
Google earth
Imagery Date: 2/22/2016 43°36'37.01" N 80°08'27.35" W elev 351 m eye alt 773 m

7.3. Crochet Coral Reef

Here, I experiment with crochet as a technique to model complicated forms of corals. It gave me a sense of the forms and geometries of these complex species. The origin of corals in myth traces back to the battle of Perseus and Medusa. Corals are the symbol of "vital forces" and have transformative features.[10] They are the most diverse living organisms on the earth, with millions of different species. Unfortunately, they are at risk of extinction due to global warming, overfishing, and water pollution.[11] In their Crochet Coral Reef project, Margaret and Christine Wertheim "hope to bring some of the most complicated mathematical models embodied in our universe into the minds (and hands) of the masses."[12] They use crochet since it is the best way to model forms with "hyperbolic anatomical features."[13] (Figures 69-72)

10 Margaret Wertheim and Christine Wertheim, *Crochet Coral Reef* (Los Angles: Institute of Figuring, 2015), 29.
11 "Coral Reefs," MARINEBIO, assessed January 14, 2018, http:// marinebio.org/oceans/coral-reefs/.
12 "Hyperbolic Crochet Coral Reef," *PROACTIVE ART*, accessed April 4, 2019, http://proactive-art.org/post/263771911103/hyperbolic-crochet-coral-reef.
13 Wertheim and Wertheim, *Crochet Coral Reef*, 42.

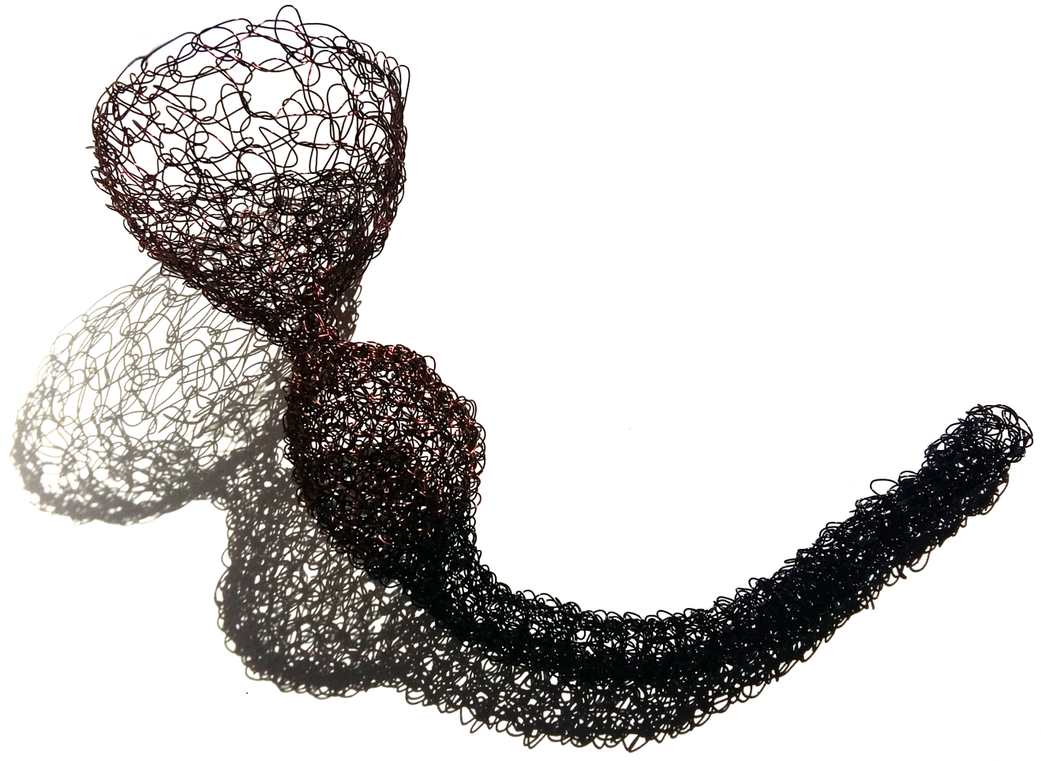
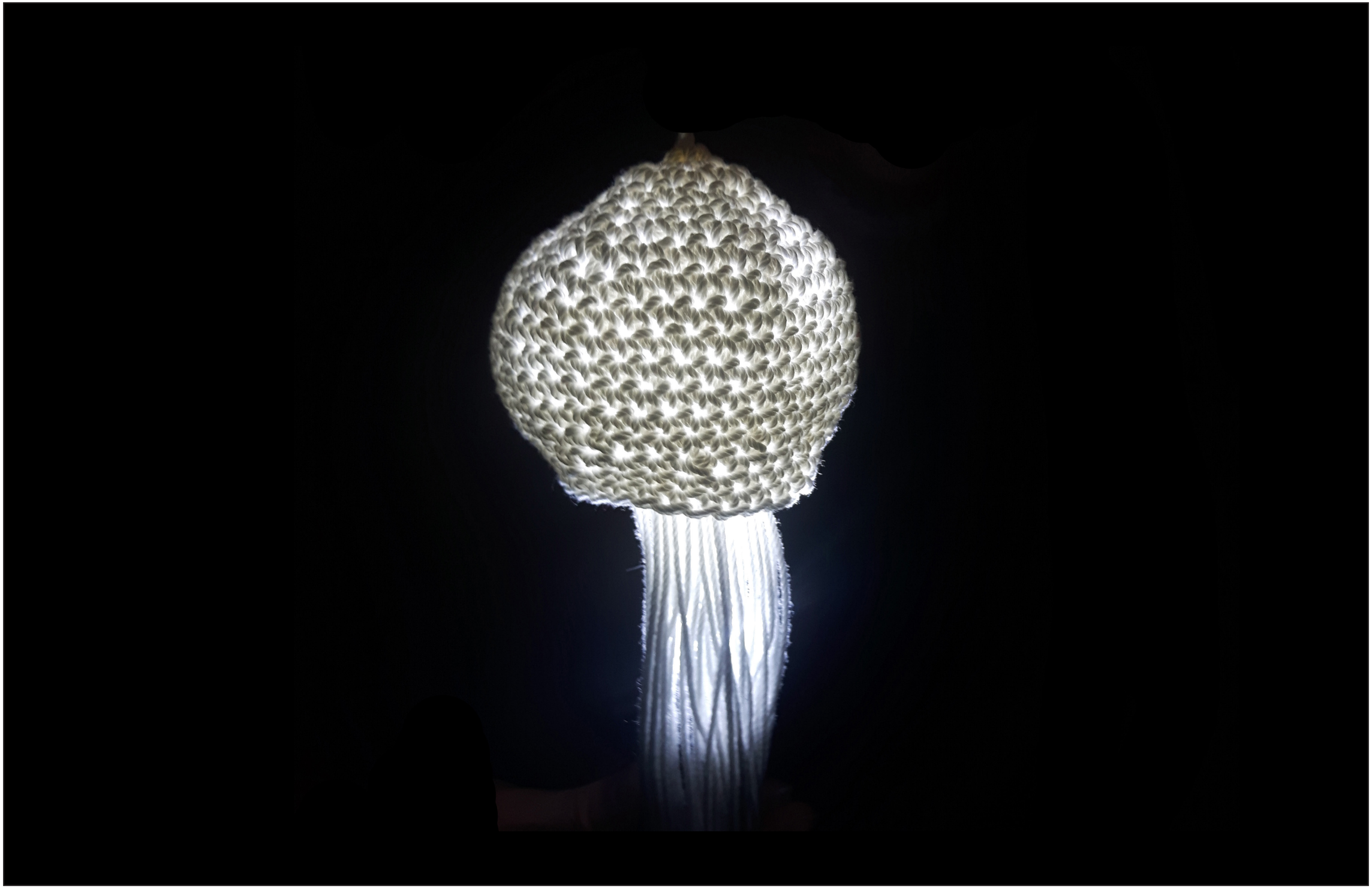


Figure 69 *Wire Crochet.*

Figure 70 *Crochet polyp.*

Figure 71 *Crochet coral reef.*

Figure 72 *Inside crochet corals.*

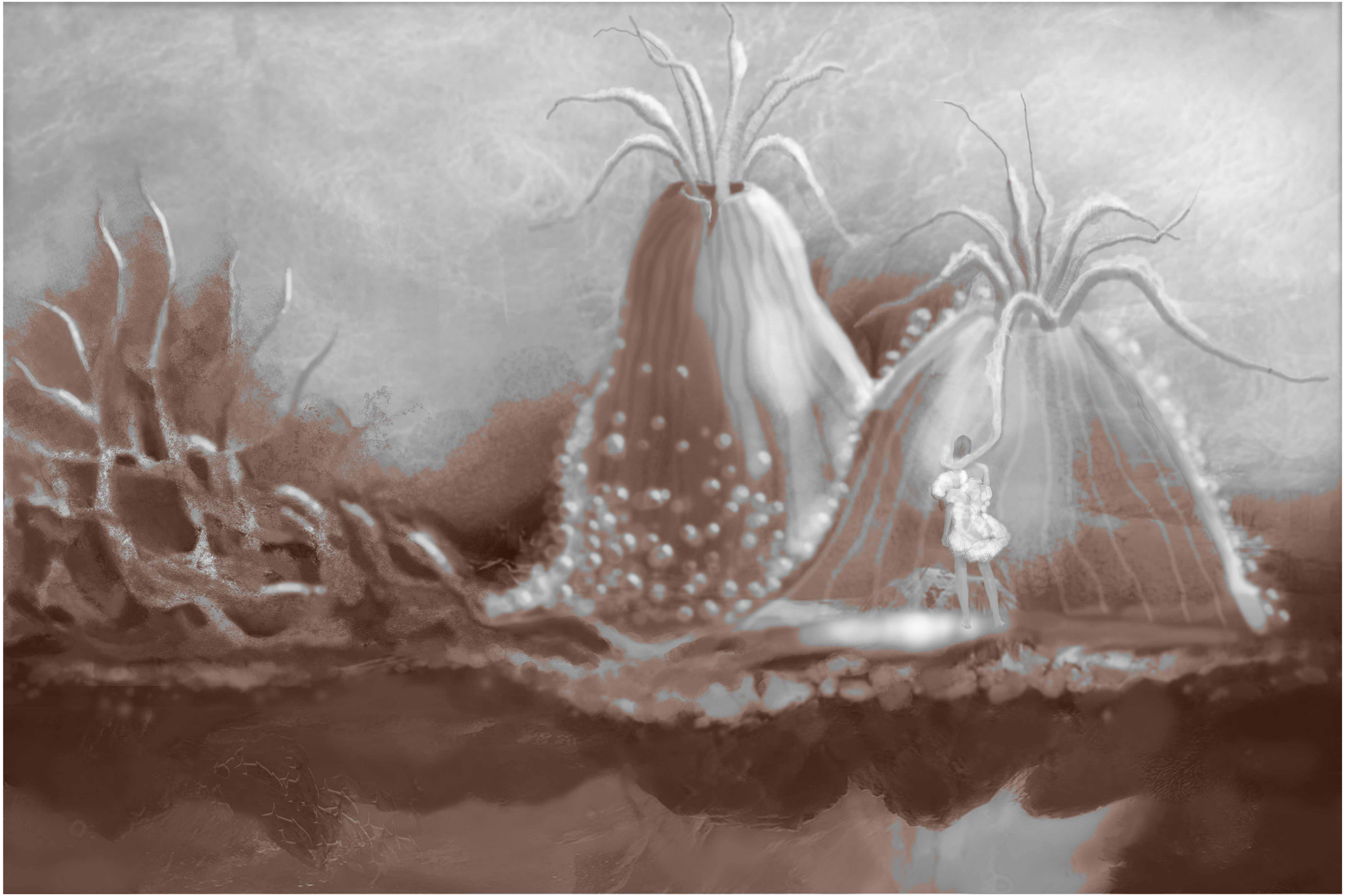


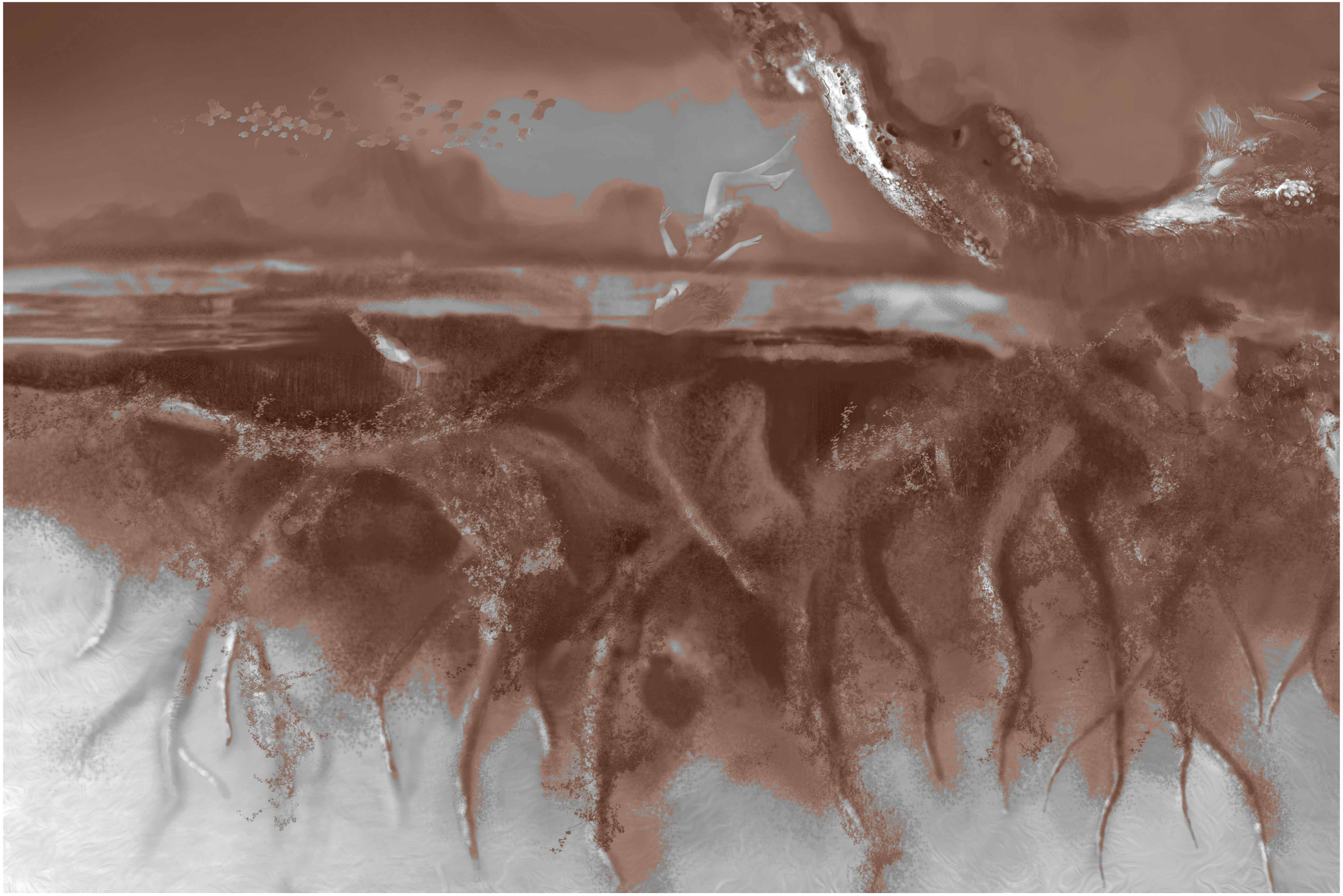
7.4. Initial Inspirations from A Door into Ocean

These drawings show my initial inspirations from *A Door into Ocean*. (Figures 73-74)

Figure 73 *Live dwellings.*

Figure 74 *Swimming in a floating island.*





GLOSSARY

Biodesign: "Biodesign harnesses living materials, whether they are cultured tissues or plants, and embodies the dream of organic design: watching objects grow and, after the first impulse, letting nature, the best among all engineers and architects, run its course. It goes without saying that when the materials of design is not plastics, wood, ceramics, or glass, but rather living beings or living tissues, the implications of every project reach far beyond the form/function equation and any idea of comfort, modernity, or progress."[1]

Clickfly (*A Door into Ocean*): Clickflies are insects that store information in their extra chromosomes, by genetic codes. They pass data on to their offspring, and they bring and spread messages for Sharers.[2]

Constructive intelligence: Constructive intelligence "Like human muscles, tree branches naturally strengthen in response to stress or increased loads."[3]

Lifeshaper (*A Door into Ocean*): Lifeshapers have the most important task in Shora. They are the genetic engineers who work on living things and decode and modify them whenever needed. For example, one of their duties is working with breathmicrobes, which are modified to coexist with a Sharer on her skin to absorb and release oxygen.

Lively matter: A material that shares a few features with living organisms, but cannot be considered as fully alive. 'New materialism' talks about this kind of material.[4]

1 Myers, William. 2012. *Bio Design: Nature- Science- Creativity*. New York: The Museum of Modern Art, 7.
2 Joan Slonczewski, *A Door into Ocean* (New York: A Tom Doherty Associates Book, 1986), 116.
3 Myers, *Bio Design*, 37.
4 Rachel Armstrong, *Soft Living Architecture: An Alternative View of Bio-Informed Practice* (New York, London: Bloomsbury visual arts, 2018), 183.

Mycelium: "The network of fungal threads in soil that acts as interfaces between plant roots and nutrients."[5]

Pleaching: "The ancient process of tree shaping in which tree branches are woven together so that as they continue to grow they form archways, lattices, or screens."[6]

Ramet: "A physiologically distinct organism that is part of a group of genetically identical individuals derived from one progenitor, as a tree in a group of trees that have all sprouted from a single parent plant."[7]

Science of lifeshaping (*A Door into Ocean*): "Sharers use advanced skills of 'lifeshaping,' a kind of genetic engineering, to manage the ecology of their ocean-covered planet. They must use all their skills, as well as the discipline of nonviolence, to repel invading traders and soldiers, without destroying their own way of life."[8]

Vivipary: The process of growing embryos on the tree to make the propagules.[9]

▼ **Figure 75** *Living raft*

5 Stamets, Paul. 2005. *Mycelium Running (How Mushrooms Can Help Save the World)*. New York: Ten Speed Press, vii.
6 Myers, *Bio Design*,58.
7 "ramet," YourDictionary, accessed April 10, 2019, https://www.yourdictionary.com/ramet.
8 Joan Slonczewski, "A door into ocean" Kenyon College, Accessed March 08, 2019 http://biology.kenyon.edu/slonc/books/adoor_art/adoor_study.htm.
9 Peter J. Hogarth, *The Biology of Mangroves and Seagrasses* (Oxford: Oxford University Press, 2015), 33.