MEETING MOSSES: TOWARD A CONVIVIAL BIOCULTURAL CONSERVATION

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In this dissertation I propose an ethical framework for "meeting mosses." At first glance, mosses are a tiny type of plants that have been uncritically understood as "primitive plants," to the extent that they are defined by negation as "non-vascular plants." Hence, mosses have been considered as "primitive" relatives of "true" vascular plants. This distortion is linked to the fact that mosses have been overlooked and represented as a radical otherness in Western civilization. To critically examine this distortion of, and injustice toward mosses, I use the methodology of field environmental philosophy within the conceptual framework of biocultural ethics developed by Ricardo Rozzi. I complement these concepts with foundational philosophical work by continental philosophers Martin Buber and Immanuel Levinas, and ethnobotanist and indigenous writer Robin Wall Kimmerer, with emphasis on their discourses of meeting, "face-to-face," otherness, heterogeneity, and alterity. Collectively thinking with these philosophers, I address the possibility of genuinely "meeting mosses," valuing them as such and not merely as a primitive "relative" or "ancestor" of vascular plants. Drawing on several botanists' accounts of plant language and plant wisdom has sharpened my reading of human-moss interactions and enriched my engagement with the heterogeneity and alterity of the Western philosophical tradition. In his book *Gardens: An Essay on the Human Condition*, Humanist scholar Robert Pogue Harrison argues that care (for plants and life) is the human vocation. Harrison's discussion of the diversity of "gardens" helped me to clarify multi-dimensional human-moss interactions.

In terms of content and structure, I organize my analysis based on two central dimensions of human-plant interactions stated in Rozzi's biocultural ethics: biophysical and

cultural, particularly, symbolic-linguistic dimensions. I explore the biophysical dimension of biocultural conservation focusing on mosses in a region where they represent the most diverse and abundant type of plants, southwestern South America. In this region, I conducted fieldwork at three reserves in Chile, Senda Darwin Biological Reserve on Chiloe Island, Magallanes National Reserve, and Omora Ethnobotanical Park in the Cape Horn Biosphere Reserve, south of Tierra del Fuego. I investigate the linguistic-cultural dimension, through the scientific binomial nomenclature as well as through the traditional naming by indigenous cultures, particularly in China. Additionally, I examine the arts as an important cultural expression of interacting with mosses that inspires biocultural conservation. I examine the role that the arts play in the education and conservation programs at the Omora Ethnobotanical Park in Chile and Shenzhen Fairy Lake Botanical Garden in China, as a way to invite students and others to have direct encounters with mosses which lead to hands-on (tactile and place-based) moss conservation.

I begin this study with a deliberation of the multiple injustices embedded in contemporary social-ecological-cultural dimensions of global change, and I suggest pathways towards caring for plants and the diversity of life. Caring for mosses is not a one-way human-plant-directed process. By nourishing our physical and cultural lives, we can metaphorically say that mosses “take care” of humans. Once we integrate both “caring for mosses” and being sensitive to the “mosses caring for us,” then biocultural conservation moves towards a more reciprocal conviviality. In addition to collectively thinking with other humans, metaphorically I aim to think and feel with the mosses, and therefore I am transformed by them. This is the ultimate meaning of “meeting mosses.”

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CHAPTER 1

INTRODUCTION

1.1 Background

In *A Letter from Birmingham Jail*, Martin Luther King wrote, "injustice anywhere is a threat to justice everywhere."[1] Racial segregation had been normalized and accepted as a common convention in some of the southern states before 1960s. But for King, he was destined to campaign against racial segregation. His letter also illuminates that, some ways of living and reasoning, which had been taken granted as legitimate and justified were worthy of examination. When more than one-fifth of the twenty first century has passed, in terms of climate change, biodiversity loss, environmental degradation, biocultural homogenization, and social-ecological crisis, it seems that a scenario has emerged on the Earth: injustice everywhere are threatening justice nowhere. Terms such as "everywhere" and "nowhere" here are apparently an exaggeration. But, if on this planet, there are merely two carbon-neutral countries, Bhutan and Suriname,[2] "everywhere" and "nowhere" are not an outrageous exaggeration. Rather, it is quite reasonable. The broad context of this dissertation is humanity's predicament in facing survival of its own or *not*.

Pertaining to the dissertation, humanity's predicament is contemporarily materialized as the harsh social-ecological crisis. Mosses could not escape from this social-ecological crisis. They are hunted and poached. They are retreating and vanishing from forests. Is a forest

[1] Martin Luther King Jr., 1992, "Letter from Birmingham jail," *UC Davis Law Review* 26, 835. The letter was originally written in 1963.

[2] See Xin Zhao, Xiaowei Ma, Boyang Chen, Yuping Shang, and Malin Song, 2022, "Challenges toward carbon neutrality in China: Strategies and countermeasures," *Resources, Conservation and Recycling* 176, 105959.

without mosses still a forest? I doubt. What are the drives which extremely target mosses and cause them disappearing from their dwelling places? In the Pacific Northwestern and Appalachian regions, 166,793 air dry kg (367,715 lb.) of mosses has been harvested in the year of 2000 and moss sales amounts from $6 million to $165 million per year in the US.[3] My meeting with mosses in this broad context is tinted with an anxiety or a sense of this crisis fermented by a strangeness between human affinity to mosses and damages to them. The strangeness is also shaped by many other aspects, to name a few, from the oddness of unprecedented connectedness and growing separation, from the disorder of being energetic and at the same time being exhausted, from the madness mixed with a hope for renaissance and a frustration of prevalent dumpster fires, from the delusion of urban hell and urban splendor, from the discrepancy between a yearning for heterogeneity and a carnival of eliminating diversity, and from the incongruity between the affluence of academic writings and impoverishment of the progress in solving the global social-ecological crisis.

To understand the connection between this strangeness and this discomfort, I undertake an examination of the unsettledness and realized there are at least three issues regarding human-moss co-inhabitation on this planet. At the beginning, I want to set up the stage for my meetings with mosses by presenting these three problems of injustice. Each of these three types of injustice shows a conventionalized injustice like racial segregation in Martin Luther King's time, not in the sense that racial segregation and the following three

[3] See Patricia S. Muir, "An Assessment of Commercial 'moss' Harvesting from Forested Lands in the Pacific Northwestern and Appalachian Regions of the United States: How Much Moss is Harvested and Sold Domestically and Internationally and which Species are Involved?" Final Report to US Fish and Wildlife Service and US Geological Survey, Forest and Rangeland Ecosystem Science Center, 2004.

problems share the same kernel, but in the sense that problems have been normalized as common sense and thus ignored in our daily life.

1.1.1 Inter-Species Injustice

First, from an interspecies level, during the last two hundred years, our species has dominated the planet's landscape. The space and habitats for other species have declined to a quite treacherous situation that biodiversity loss and species extinction gave rise to non-linear changes of Biodiversity and Ecosystem Functioning (BEF), provoking accelerations of biodiversity loss and species extinction.[4] Twenty years of BEF research demonstrate how biodiversity offers valuable ecosystem services to humanity. The global socio-economic system that our species relies on is essentially dependent on but phenomenally separated from the ecosystems. The infrastructure of the prevailing socio-economic system is radically different from the economy of nature. With the expansion of the human system, in the proposal of the Anthropocene, humanity as a "planetary-scale geological force" has not only dramatically transformed the terrestrial landscape, but also acted as the main drive of the Great Acceleration.[5] The post-1950 acceleration has fundamentally shifted the structure and functioning of the Earth system, exhibited by twelve indicators.[6] In the interspecies sense, injustice appears as *Homo sapiens* is prioritized through activities such as unrestrained exploitation, encroachment, and elimination. Extinction of other species and biodiversity loss

[4] See Bradley J. Cardinale, et al. "Biodiversity loss and its impact on humanity." *Nature* 486.7401 (2012): 59-67.

[5] See Will Steffen et al, "The trajectory of the Anthropocene: the great acceleration." *The Anthropocene Review* 2.1 (2015): 81-98; and John Robert McNeill, *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Harvard University Press, 2016).

[6] Steffen et al, 2015, "The trajectory of the Anthropocene: the great acceleration."

are exonerated as unexpected appendants of human enterprise. However, strong anthropocentricism proves its own weakness through contemporary social-ecological crisis.

1.1.2 Colonial Injustice

Second, another injustice that is innate to the structured and formalized socio-economic system across the globe in which the biological unity of Homo sapiens was shattered by the destructive power of colonization, alienation, and suppression. There has been an endured consensus about the intertwinement between social justice and environmental/ecological crisis. According to social ecologist Murray Bookchin, "present ecological problems cannot be clearly understood, much less resolved, without resolutely dealing with problems within society."[7] Problems of colonial, political, military, and economic power define injustices among societies, particularly between the Global North and the Global South that are embedded in ethnic, cultural, gender, and many other conflicts across the globe. Decolonial thinker Aníbal Quijano believes that the pattern of global power was a result of social classification of world population based upon the idea of race and social historical identities.[8] Furthermore, not only abstract terms such as "races," "racial," "ethnic," "anthropological," but also concrete and designating terms for social identities such as "white," "Indians," "Negroes," "yellows," and "olives" were historically and colonially coined to privilege certain social groups.[9] Walter Mignolo concurs what Quijano has scrutinized about the four aspects of the pattern of the

[7] Murray Bookchin, 2001, "What is social ecology?" In Zimmerman, ME., Callicott, JB, Sessions, G, et al. ed. *Environmental philosophy: From Animal Rights to Radical Ecology* (3rd edition) (Upper Saddle Rivers, NJ: Prentice Hall, 2001), p. 436.

[8] See Aníbal Quijano, 2000, "Coloniality of power and Eurocentrism in Latin America." *International Sociology* 15.2, 215-232.

[9] See Aníbal Quijano, 2007, "Coloniality and modernity/rationality." *Cultural studies* 21.2-3: 168-178.

colonial power ("patrón de poder colonial"), namely, control of economy, of authority, of gender and sexuality, and of knowledge have shaped the power landscape today.[10] In other words, my second sense of colonial injustice exists in the ruling of the powerful people and societies over the disadvantaged, marginalized, and powerless people and disenfranchised social groups in the socio-economic system since the outset of colonialization. Manifold hierarchies inside human societies override the biological unity and equality of *Homo sapiens*. With the awareness of the entanglement between social injustice and environmental/ecological crisis, empowering the conventionally disadvantaged people such as indigenous communities, people of color, females, youths, and liberating the colonized fetch some hope for restoring both social justice and nature's rights. The structured injustice indicates difficulties of individuals and communities to take responsibilities, particularly for individuals from the privileged side. It is highly probable to shun responsibilities rather than take actions due to the structured and institutionalized colonial injustice.

1.1.3 Epistemic Injustice

The third sense of injustice is the epistemic injustice ingrained in the mentality that some ways of thinking, reasoning, and discerning are ranked as better, more rational, more civilized, more elegant, and superior. Fortunately, anthropological studies and biocultural ethics have shown a trend of valuing multiple ways of knowing.[11] The term "epistemic injustice" was

[10] See Walter D. Mignolo, Walter D, 2007, "Delinking: The rhetoric of modernity, the logic of coloniality and the grammar of de-coloniality." *Cultural studies* 21.2-3: 449-514.

[11] See Ray Barnhardt and Angayuqaq Oscar Kawagley, 2005, "Indigenous knowledge systems and Alaska Native ways of knowing." *Anthropology & Education Quarterly* 36.1: 8-23; and Ricardo Rozzi, 2012, "Biocultural ethics: recovering the vital links between the inhabitants, their habits, and habitats." *Environmental Ethics* 34.1, 27-50.

coined by English philosopher Miranda Fricker to criticize the injustice done based on socially situated powers that control others' actions and capacity to communicate their knowledge. Although the term has been further classified into other terms such as testimonial and hermeneutical injustice, the basic idea behind epistemic injustice designates the erroneous and unjust situations that someone or some groups are downgraded or disadvantaged regarding their status as an epistemic subject.[12] From the angle of decolonial thinkers such as Arturo Escobar and Walter Mignolo, those being epistemologically downgraded were people who have been colonized. Decolonial thinkers also identify epistemic injustice through the disclosure of connections between Euro-centered capitalist colonial powers and a universal paradigm of knowledge production.[13] Thus, an epistemic delinking, viz. how to decolonize knowledge and being, is crucial to global power transformation and liberation of those depressed.[14] The biocultural ethic framework further clarifies that epistemic injustice prevails on Euro-centered worldviews of colonial powers, and it is essential to identify and sanction specific agents that are mostly responsible for current socio-environmental problems.[15] This biocultural perspective converges with feminist thinkers that criticize and demand to stop epistemic injustice. Carolyn Merchant offers a critical examination about the modern concept of nature not as a living

[12] See Miranda Fricker, 2007, *Epistemic Injustice: Power and the ethics of knowing* (New York, NW: Oxford University Press), chapter 7.

[13] See Aníbal Quijano, 2007, "Coloniality and modernity/rationality." *Cultural studies* 21.2-3, 168-178.

[14] See Walter D. Mignolo, 2007, "Delinking: The rhetoric of modernity, the logic of coloniality and the grammar of de-coloniality." *Cultural studies* 21(2-3), 449-514.

[15] See Ricardo Rozzi, 2019, "Taxonomic Chauvinism, No More!: Antidotes from Hume, Darwin, and Biocultural Ethics," *Environmental Ethics*, 41(3), 249-282.

organism but as a machine that has prevailed in Western civilization since the enlightenment.[16] Val Plumwood lucidly deconstructed the Western model of rationalist-spired human superiority, reason, mastery, manipulation, instrumentalism, and monological thinking and criticized anthropo-centrism, andro-centrism, and Eurocentrism.[17] Donna J. Haraway proposes to overcome these centrisms with a "tentacular thinking" that rejects bounded individualism and favors a collective thinking, not only human co-thinkers but also multispecies thinkers.[18] A renewal of epistemic justice rejects a hasty generalization in which some humans' thinking characterizes all humans' thinking. It also rejects thinking of solo human thinking. But it extols a thinking of the marginalized humans, of other-than-human beings, and thinking of their "thinking." These efforts disclose humanity's existence in a constantly temporary epistemic state, already prepared to abandon inappropriate and unjust thinking to embrace new ways of thinking.

The broad context and three senses of injustice set up the plateau of my meeting with mosses. This dissertation dedicates as an effort to restore the justice through a subjective interrogation. The value of it at least lies on the possibility of retrieving some necessary serenity in a world filled with the above strangeness, to resist living in a comfortably numb way, to attend to the individual capacity of being seriously sentient, to revive the root of being genuinely conscious, to meet, and to be a genuine human. The necessary serenity breeds the

[16] See Carolyn Merchant, 1989, *The Death of Nature: Women, Ecology, and the Scientific revolution* (United Kingdom: HarperCollins), particularly chapter 8 and 9.

[17] See Val Plumwood, 2005, *Environmental Culture: The ecological crisis of reason* (New York, NY: Routledge), chapter 5.

[18] See Donna J. Haraway, 2016, *Staying with the Trouble: Making kin in the Chthulucene* (United Kingdom: Duke University Press), chapter 2.

courage to re-enter the strange world and face its uncanny conditions. In simple words, through my meetings with mosses, *I* learned to free myself from the unsettled, troubled, and traumatic mourning for the death of nature within me. The "*I*" or "me" here is not just in the self-referential sense, but also referring to individuals who share akin mourning and overwhelmingness about ecological degradation and its connection with the destructive force. Mourning is a collective sentiment, as expressed by some environmentalists and animal rights activists.[19] The death was caused not only by my inhabitation in a fast-changing and increasingly homogenized world but also by my entanglement with it. I realize "meeting mosses" is *one* of myriad ways to revitalize nature within me. This revitalization is very much like a resurrection, giving hope to overcome the strangeness, corresponding materialized social-ecological crisis, and the threat of death.

1.2 Problem

Given the above examination of the broad context, in this part I present the specific problem I want to focus on through my meeting with mosses. As expected, the specific problem caters to the three senses of injustice. In 2016, based on the theory of island biogeography, American biologist Edward Osborne Wilson (1929-2021) proposed "Half-Earth" plan,

> Unless humanity learns a great deal more about global biodiversity and moves quickly to protect it, we will soon lose most of the species composing life on Earth. The Half-Earth proposal offers a first, emergency solution commensurate with the magnitude of the problem: I am convinced that only by setting aside half the planet in reserve, or more, can we save the living part of the environment and achieve the stabilization required for our own survival.[20]

[19] See Sarah Pike, 2016, "Mourning Nature: The work of grief in radical environmentalism," *Journal for the Study of Religion, Nature & Culture*, 10(4), 419-441; and Kayla Stewart, 2015, "Mourning Wave: Grieving the loss of the natural environment," MAIS Projects and Theses. 29. https://digitalcommons.tacoma.uw.edu/ias_masters/29.

[20] Edward O. Wilson, 2016, *Half-Earth: Our planet's fight for life* (New York, NY: Liveright), pp. 2-3.

The logic behind "Half-Earth" is to at least reserve 50% or save zero. Given the non-linear change of biodiversity and ecosystem functioning, "Half-Earth" is by no means scaremongering. Similar to Wilson's vision of "Half-Earth," another international community "Nature Needs Half" also pursue the goals "to protect and interconnect 50% of Earth by 2030 for the benefit of all life."[21] "Half-Earth" apparently will do justice in the interspecies level.

However, a group of international scholars questioned the "Half-Earth" plan by doubting its feasibility and repudiating the innated injustice. Questioners consider that Half-Earth risks to prevent the vast majority of humans from experiencing biodiversity which they have been displaced for. Correspondingly, rather than setting 50% of the Earth as reserves, they propose to focus on the major drives of biodiversity loss, renovate the contemporary economic system, and address inequality.[22] The rejection group proposed "convivial conservation" as an alternative vision of global conservation which contains five elements, namely, from protected (nature from people) to promoted areas (living with nonhuman nature), from saving nature to celebrating human and non-human nature, from touristic voyeurism to engaged visitation, from spectacular to everyday environmentalism, and from privatized expert technocracy to common democratic engagement.[23] These five elements reflect two fundamental principles of convivial conservation, as also claimed by themselves, post-capitalist and non-dualist.

Based on these two principles, Büscher and Fletcher, the leading scholars in the latter

[21] See NNH website, https://natureneedshalf.org, accessed on May 22, 2021.

[22] See Bram Büscher, Robert Fletcher, Dan Brockington, et al, 2017, "Half-Earth or Whole Earth? Radical ideas for conservation, and their implications," *Oryx* 51 (3), 407-410.

[23] See Büscher, Bram, and Robert Fletcher, 2019, "Towards convivial conservation," *Conservation & Society* 17 (3), 283-296.

camp classified contemporary conservation strategies into four groups. “Half-Earth” was labeled as “neoprotectionists” because of its radical proposal of returning at least half of the planet to nature and its apparent nature/culture dichotomies. Neoprotectionism like Half-Earth stands with convivial conservation in criticizing the contemporary economy directed toward growth and consumerism. In their latest book, *The Conservation Revolution: Radical Ideals for Saving Nature Beyond the Anthropocene*, Büscher and Fletcher structured four types of conservation strategy (see Table 1.1).[24]

Table 1.1: Four main positions on saving nature in the Anthropocene

	Nature/culture dichotomies	Beyond N/C dichotomies
Capitalist	Mainstream conservation	New Conservation
Beyond-capitalist	Neoprotectionism	Convivial conservation

Büscher and Fletcher take their position as “explicitly” from political ecology in opposing capitalist political economy. I give my applauses to the promising vision of convivial conservation’s double goals, seeking a conservation beyond Nature/Culture dichotomies and a renovative economy beyond capitalist. However, according to this depiction of contemporary conservation, some incommensurability appears in the juxtaposition between Neoprotectionism and convivial conservation. When convivial conservation promised to address both the nature/culture dichotomies and capitalist-based economy, there was one target missed, the hard scientific assumption that no life will survive unless half of the planet is returned to nature. Convivial conservation needs to explain, even without returning half of the

[24] Büscher, Bram, and Robert Fletcher, 2020, *The Conservation Revolution: Radical ideas for saving nature beyond the Anthropocene* (New York, NY: Verso), p. 7.

planet to nature, saving nature and its biodiversity can be fortified. Or, under their frame of political ecology, it is not only necessary to address the political importance of ecological events, but also to explain how healthy ecosystem functioning can be secured under concrete political regimes. That is, "living with nature" on the global scale is ecologically feasible and ethically justifiable. Ecological feasibility designates localized inhabitation of humans does not conflict with the functioning of ecosystem or cause biodiversity loss; and ethical justification denotes that the well-beings of marginalized humans and of other-than-human beings are guaranteed. Unless these two issues can be addressed in the scheme of "living with nature," Half-Earth as a long-term goal is inevitable.

A defense of Half-Earth from a Dutch ecologist criticizes Büscher, Fletcher, and their camp as "conservation critics" and clarifies how their critics have misapprehended the statements of Half-Earth, particularly regarding questions such as displacement, separation humans from their environment, "the real culprit" responsible for environmental damage, etc.[25] For example, regarding displacement, conservation critics, particularly, Büscher and Fletcher's term of innated injustice, have taken for granted that setting aside protected areas is equivalent to displace vulnerable human communities for the space of wildlife. However, Kopnina proves this equivalence as erroneous because the over-whelming majority of the world's poor do not live near wilderness but rather in degraded agrarian areas and urban slums. Besides, most displacements were hardly caused by conservation agencies but by large

[25] Hellen Kopnina, 2016, "Half the earth for people (or more)? Addressing ethical questions in conservation," *Biological Conservation* 203, 176-185.

industrial and agricultural projects and the system of "industrocentrism" which threatens both cultural and biological diversity.[26]

Furthermore, regarding the ecological feasibility of "Half-Earth," Ellis and Mehrabi quantitatively assessed global land types.[27] They consider the greatest challenge in implementing Half-Earth is to expand conservation areas and sustain the growing human populations with agricultural production. Given that even though 57% of Earth's land is directly used to sustain humans, and half of which is lightly used as rangelands and forests suitable for conservation, Half-Earth is feasible.[28] According to them, if well-targeted land governance or "adaptive multi-level systems of landscape governance" can thrive on the planetary scale, Half-Earth is by no means a fantasy. In that sense, both interspecies and social justice prevail. This is where my dissertation comes in. To bring justice to the meetings in interspecies encountering, human meeting, and epistemic confronting, I propose convivial biocultural conservation as the theoretical and practical frame to safeguard the socio-environmental future of the planet.

Rozzi defines biocultural conservation as "seeking social and ecological well-being through the conservation of biological and cultural diversity and their interrelationships."[29] The theoretical foundation of biocultural conservation roots in biocultural ethics highlights the links between ecology and ethics. In an interspecies sense, humans and other-than-human beings are co-inhabitants on the planet. Ethical responsibilities arise in co-habitation. In a socio-

[26] Ibid.

[27] See Erle C Ellis and Zia Mehrabi, 2019, "Half Earth: promises, pitfalls, and prospects of dedicating Half of Earth's land to conservation," *Current Opinion in Environmental Sustainability*, 38, 22-30.

[28] Ibid.

[29] Ricardo Rozzi, 2013, "Biocultural ethics: from biocultural homogenization toward biocultural conservation," In *Linking ecology and ethics for a changing World* (Springer, Dordrecht), p. 9.

economic sense, the domains of biophysical, symbolic-linguistic, and institutional-socio-political are intertwined which demonstrate that interspecies justice cannot be tackled without addressing socio and epistemological justice. The global socio-ecological crisis is rooted in biocultural homogenization, which in the epistemological sense can be explained as some worldviews and cognitions of nature/people interrelations subjugated to the force of pervasive capitalism.

Based on the above brief introduction, I claim that biocultural conservation is inherently convivial. By convivial, it not only means that biocultural conservation echoes the proposal of "convivial conservation" in solving nature/culture dichotomies and surmounting capitalist, but also resonates the conviviality in Illich's sense. Illich uses "conviviality" to designate the opposite of "industrial productivity." Industrial productivity incites a dilemma that human efforts run counter to the very motive of inventing tools, for example, the invention of transportation tools does not free humans from transportation but increase commuting time through more frequent commute and travels. Thus, more specifically, he delineates,

> I intend it to mean autonomous and creative intercourse among persons, and the intercourse of persons with their environment; and this in contrast with the conditioned response of persons to the demands made upon them by others, and by a man-made environment. I consider conviviality to be individual freedom realized in personal interdependence and, as such, an intrinsic ethical value. [30]

Based on this clarification, Illich's vision of conviviality does not completely reject or exclude a capitalism-based industrial system. It rejects its monopoly and suppression of other systems, or what Kopnina has addressed about the system of "industrocentrism."[31] The co-existence of

[30] Ivan Illich, 1973, *Tools for Conviviality* (New York, NY: Harper and Row), p. 11.

[31] See Kopnina, 2016, "Half the earth for people (or more)? Addressing ethical questions in conservation."

various systems, their interactions, and interdependence open the doors to conviviality. Various systems are not some generalized structures, but systems in the biophysical, symbolic-linguistic, and institutional-socio-political domains which biocultural conservation circumscribes and embeds.

Therefore, the central argument of the dissertation is to argue for convivial biocultural conservation as the theoretical and pragmatic frame to fasten Half-Earth and do justice in the interspecies, social, and epistemic aspects. Meeting mosses shows one of the myriad ways to manifest convivial biocultural conservation.

1.3 Chapter Structure

Based on the above inquiry into the broad context and the specific problem, in this part I lay out the chapter structure. The second chapter, "On Meeting" lays the philosophical foundation of the dissertation. As the opening session of the dissertation, the introduction part argues for the philosophical relevance of "meeting" to the dissertation. Qua an antecedent examination of "meeting" before I situate meetings with mosses in various scenarios, it starts with Martin Buber's *I and Thou* (1923), with the purpose of discussing "meeting" as the ontological event. It then follows a reading of Emmanuel Levinas's *Totality and Infinity* (1961), which handles "meeting" as the ethical event. Both Buber and Levinas also mention "meeting" as the same event related to knowing, which opens the perspective of epistemology. Accordingly, in the third section, I clarify how "meeting" has presented as an epistemological event, mostly based on the work of Ricardo Rozzi and Robin Kimmerer, who articulate their affluent, deep, and thought-provoking sentiment while meeting mosses. All three sections center on terms such as "subjectivity," "face-to-face contact," and "radical heterogeneity of the

other." The fourth part of chapter 2 supplements the argument by examining the concepts of plant intelligence, plant language, and plant personhood to clarify the "subjectivity" and "face" of mosses, and more generally plants.

Chapter 3, "Meeting Mosses in the Field: Why Not Mosses?" presents my direct encounter with mosses. In structure, this chapter serves as presenting the methodology of field environmental philosophy and the biophysical domain of convivial biocultural conservation. It starts with a brief account of field environmental philosophy and follows with my field face-to-face contact with bryophytes and lichens in southern Chile at three places. The initial field investigation of mosses was accompanied with a group of attendees of the 2019 ecological workshop in Senda Darwin Biological Station (Estación Biológica Senda Darwin) on the Chiloé Island, where I received my first training to be an elementary naturalist and learned to identify liverworts, hornworts, and mosses. It followed with a second field trip in Magallanes National Reserve (Reserva Nacional Magallanes), Punta Arenas, where a powerful sense of "meeting" occurred to me. Meeting with mosses was renewed during the last period of the field trip in the Omora Ethnobotanical Garden, Puerto Williams, where I participated in multiple activities to indulge in the seclusion of Puerto Williams and the diversity of bryophytes and lichens. The chapter also serves to follow the strategy of "letting mosses speak for themselves." The question "why not mosses?" rather than "why mosses?" conveys my concern that, the necessity of justifying mosses as the subject of a dissertation or as the target of convivial biocultural conservation seems to have already positioned mosses in an other-than-subject plight.

The fourth chapter, "Mossy Nomenclature, Meaning, and Culturing" situates itself as the

symbolic-linguistic domain of convivial biocultural conservation. It starts with the Linnaean binomial nomenclature, the naming system universal to modern biological taxonomy. While examining the binomial system, I also tried to detect the meaning of some binomial names of bryophytes. As the binomial names are named after species, and names might change on the occasions that a group of organisms are classified into sub-groups, or merge with other existing group of organisms, section two of chapter 4 examines the species concept debates in biology. It then follows with section three, with the purpose of showing how bryologists situated them in species debates. Section four of this chapter explores the etymology and names of bryophytes in other cultures, particularly the traditional nomenclature of bryophytes-related plants in Chinese ancient literatures. Although it is still quite limited in the sense that merely three customs of names are examined, viz. modern scientific nomenclature, Chinese traditional bryophytes-related nomenclature, and Chinese modern bryological nomenclature, the divergence of naming bryophytes has raised the further question of the co-existence of various nomenclature, and their roles in contemporary ecological communication and convivial biocultural conservation.

Chapter 5, “Mossy Expressiveness: Art and Gardens for Conservation,” explores the power of art works to convey ideas, thoughts, or feelings for conservation. The first section of this chapter handles Ernest Haeckel’s drawings of mosses in his *Art Forms in Nature*, through which the convergence between science and art is expressed. It follows in the second session with an analysis of three large-scale paintings of bryophytes by two female artists from Shenzhen Fairy Lake Botanical Garden. Three large-scale art works were exclusively devoted to Haeckel, and they convey copious biocultural messages to citizens toward convivial biocultural

conservation. In the third section, I explore and categorize three types of moss gardening in terms of the scales of gardening. This section not only presents the aesthetic values of mosses in conservation, but also reveals issues regarding the commodification of mosses. In the fourth section of this chapter, I assess the values of moss gardens from the perspectives of professional and amateur bryologists. Professional gardeners are usually amateur bryologists. I also discuss the ethical issues raised by moss gardening. In the last section of this chapter, an examination of unethical moss gathering and gardening reveals that those practices run counter to the true art of gardening. In moss gardening, human-moss interactions disclose human conditions and demarcates human beings from the divine, at the very beginning of human gardening.

Chapter 6, "Meeting the Invisible in Convivial Mossy Conservation" describes and evaluates the flagship species-centered conservation and bryophytes-centered conservation in Chile and China to disclose the institutional-socio-political domains of convivial biocultural conservation. Flagship species conservation, particularly China's Giant Panda (*Ailuropoda melanoleuca*) and Chile's Magellanic Woodpecker (*Campephilus magellanicus*), tremendously raised the public awareness of biological conservation. However, some epistemic biases and ethical injustice were veiled in this flagship species-centered approach. Mosses-centered conservation in Chile Omora Ethnobotanical Park and China's Shenzhen Fairy Lake Botanical Garden, on the other hand, offer opportunities of meeting with mosses. In mainstream biological conservation, many non-vascular plants and invertebrates are absent and invisible to the public and conservation programs, indicating the entanglement between epistemic bias and ethical injustice. Case studies show that moss-centered approach to conservation offers

affluent values for understanding the conviviality of biocultural conservation. A mossy reconnection, making the invisible eye-catching, charming, and prominent, calls for inclusivity at epistemic, ethical, and socio-political levels, leading to real conviviality.

CHAPTER 2

ON MEETING

All real living is meeting.
—Martin Buber

The introduction has presented questions of injustice from multiple layers and specified conservation regarding Half-Earth and convivial conservation. My approach to the debate and proposal for convivial biocultural conservation adopts neither a "neither/nor" nor an "either/or" approach, but a "both" and "plural" way to conviviality. A "both" and "plural" approach does not exclude discernment. But meeting is prior to discernment. In discernment, values such as receptiveness, cooperation, amiableness, and ambiguity are separated from confrontation, competitiveness, antagonization, and exactness. In "meeting," something divine and transcendent is revealed. This chapter examines "meeting" from the perspective of several philosophers and scientists to demarcate the philosophical connotation of "meeting mosses." Apparently, some other philosophers also contribute significantly to the theme of "meeting" in their own terms, such as Donna Haraway's "the dance of relating" or Karen Barad's "touching" which I slightly "relate" to and "touch" on later.

2.1 Martin Buber: Meeting as an Ontological Event

Meeting is an important and reiterated theme in Martin Buber's beautifully written book, *I and Thou* (1923). While I state that "meeting" is the ontological event, I mean in *I and Thou*, Buber handles "meeting" as the most fundamental event, the inescapable event of human life, *a priori*. From the Biblical view, human existence is a result out of meeting, in the sense that without God's presence and grace, humans cannot come into being. Buber states

that "the Thou meets me through grace."[32] His ultimate purpose in *I and Thou* is to unveil that among numerous events of meeting with others, meeting with the eternal *Thou* or meeting itself in all events is the absolute, pivotal, and authentic event that human life should disclose. As he claims, "in every sphere in its own way, through each process of becoming that is present to us we look out toward the fringe of the eternal *Thou*; in each we are aware of a breath from the eternal *Thou*; in each *Thou* we address the eternal *Thou*."[33] However, human realities fall in a state of meeting or not. In other words, physical encountering does not necessarily illuminate a real living or present as meeting. This relates to the twofold features of human language and our dwelling in the world.

As part of human language, according to Buber, human's twofold attitude is revealed by the primary words we speak, namely, the combination *I-Thou* and the combination *I-It*. This twofold way of speaking establishes the realm of *Thou* and the realm of *It*. From Buber's view, these two worlds are profoundly different. Humans dwell in these two worlds and drift between the two.

When humans speak *I-It*, the realm of *It* is generated out of human perception, sensation, imagination, will, feeling, thinking, etc. All those activities point to an object. At this point, Buber presents his radical challenge to the Cartesian doctrine of "thought" monism or the "pure subject" in which he claims the subject's dependence on the object, as "a subject deprived of its object is deprived of its reality."[34] Without the wax, Descartes cannot think

[32] Martin Buber, 1958, *I and Thou* (translated by Smith, RG, New York, NY: Scribner), p. 11.

[33] Ibid., p. 6.

[34] Ibid., p. 90.

when he thinks through the wax argument. A person who lives in this realm of *It* will treat others as objects to live a life fulfilled with experience, knowledge, and deployment of others. The *I* in this experiencing and objectifying sense is out of the world. Buber claims, "as experience, the world belongs to the primary word *I-It*."[35] To be specific, he explains,

> The man who experiences has no part in the world. For it is "in him" and not between him and the world that the experience arises.
>
> The world has no part in the experience. It permits itself to be experienced, but has no concern in the matter. For it does nothing to the experience, and the experience does nothing to it. [36]

This primary word *I-It* engenders the world of experience and *It*. The human condition is that he has to experience, utilize, and instrumentalize the world of *It* to succeed in using *It*. When someone speaks *I-It*, the experience in the subject is independent of the external world. It sounds quite abstruse and even paradoxical when Buber claims "the world has no part in the experience." It seems to run against our common sense about inductive reasoning and the emergence of knowledge, since a person must relate to the external world to experience, observe, and utilize *It* to form experience, inference, and knowledge. However, according to Buber, this reference to the external world does not lead to the externality of experience or knowledge. In other words, the external world and the experience are ontologically separated.

On the other hand, when someone speaks *I-Thou*, the realm of *Thou* is revealed, which has a radically different basis from the realm of *It*. That is, "the primary word *I-Thou* establishes the world of relation,"[37] viz., the world of *Thou*, and of meeting. Buber categorizes three

[35] Ibid., p.6.

[36] Ibid., p. 5.

[37] Ibid., p. 6.

spheres where relation and meeting could arise. There are three occasions that I could speak of *Thou*, namely, "our life with nature," "our life with men[sic.]," and "our life with intelligible forms."[38] Taking these three occasions into the context of environmental thoughts, they produce relation and meeting in the significance of interspecies, inter-humans, and the sphere beyond. If combining with the terms in environmental philosophy, meeting with others (in the sense others as *Thou* while meeting) unfolds in the biophysical, socio-cultural, and spiritual realms of the world. Buber believes that our meeting with others, the relation produced by meeting, is "the cradle of the Real Life."[39] *Thou* cannot be experienced like *It*. Experience only detaches our relations and turns others into *It*. When a person speaks *I-It*, the *I* is distant; when a person speaks *I-Thou*, the *I* comes into being. That is, "through the *Thou* a man[sic.] becomes *I*."[40]

The enigmatic course of the becoming of the *I* is not only different from the intoxication of experiencing and using of the world of *It*, but also involves all that a person meets. Buber describes this mysterious course of becoming and transforming as the following,

> That which confronts him comes and disappears, relational events condense, then are scattered, and in the change consciousness of the unchanging partner, of the *I*, grows clear, and each time stronger. To be sure, it is still seen caught in the web of relation with the *Thou*, as the increasingly distinguishable feature of that which reaches out to and yet in not the Thou. But is continually breaks through with more power, till a time comes when it bursts its bounds, and the *I* confronts itself for a moment, separated as though it were a *Thou*; as quickly to take possession of itself and from then on to enter into relations in consciousness of itself.[41]

[38] Ibid., p. 6.

[39] Ibid., p. 9.

[40] Ibid., p. 28.

[41] Ibid., pp. 28-29.

From the above quote, all relational events and meetings with others strengthen self-consciousness, which leads to a certain moment when *I* become the *Thou*, *I* become. Thus, "through the *Thou* a man[sic.] becomes *I*" might designate two meanings: first, the *I* germinates post-meeting, that is, subsequent to the confrontation between others and about-to-be-*I* is the germination of the *I*; second, the accumulation of confrontational events ferment the *I* to be a separated *Thou* to accomplish the pure and powerful *I*. In both senses, meeting is present and antecedent to the origin and growth of the *I*. The presence and precedence of meeting and relation among all those events at numerous specific moments demonstrate meeting as an *a priori* of relation. Based on this *a priori* relation, the world of *I-Thou* formulates and establishes as the condition of the world of *I-It*. Different from a human's dwelling in the world of *I-It*, while the human dwells in the world of *I-Thou*, others are not "objects" or "contents" in the past but true beings "in the present." By true beings, Buber means that others are the same being as *I* that dwell on the same basis of *a priori* of relation. Being *a priori* of relation, meeting is precedent to a human's effort to perceive and employ others. Whether relation is absent or not resolves the difference between objectifying others and meeting others.

Buber interprets this *a priori* of relation between I and Thou as the direct,[42] the present,[43] and the continually enduring,[44] which is opposite to but also mutually transformed to *It* of the indirect, the past, and the suspension. The twofold feature of the world as *Thou* versus *It* and the corresponding twofold attitude disclose a world of existing and becoming. The

[42] Ibid., p.12.

[43] Ibid., p.12.

[44] Ibid., p. 13.

transformation between *Thou* and *It* is also worthy of mentioning. According to Buber, when *Thou* fades away, the particular *Thou* "is bound to become an *It*"[45] and the world of *It* can "be assembled,"[46] "the particular *It*, by entering the relational event, may become a *Thou*."[47] Hence, a human lives in the world with this twofold attitude and flows with the continually conversion from *Thou* to *It* and the reverse. After particular meetings, things as particular *Thou* in relation become *It*, "sums of qualities," "things in space and time, in causal connexion[sic.], each with their its own place and appointed course, its measurability and conditioned nature."[48] To Buber, relation in meeting also denotes a feeling of exclusiveness and universality, whereas the absence of meeting in the scenario of objectifying others signifies the isolation without any feeling of exclusiveness or universality. Thus, while meeting others, a human realizes both exclusiveness and universality. The former suggests each thing's own solidarity and concreteness; the latter denotes that each thing presents as one being. Meeting is thus the ephemeral and continual interval between the *I* and *Thou* that things' very existence is renewed. Without this interval, *I* cannot become. To sum up, meeting is the ontological event in which the play between being and becoming performs eternally. Meetings are particular events which assure me of my solidarity with the unreliable world with the attributes of instant generation and vanishment, unceasing renewal, and everlasting presence. Without meeting, there is no *I*.

Taking this ontological event of meeting back into the theme of meeting mosses, is

[45] Ibid., p. 33.

[46] Ibid., p. 29.

[47] Ibid., p. 33.

[48] Ibid., p. 30.

there a possibility to meet mosses as *Thou*? Based on Buber's three realms of meeting and speaking of *I-Thou*, meeting mosses fits the category of "our life with nature" which exemplifies interspecies meetings. Although in *I and Thou*, Buber has spent a large amount of time writing about interhuman meeting and meeting the eternal *Thou*, he does not evade speaking of interspecies meetings. He states how animals' eyes "have the power to speak a great language."[49] In the following quote, he reflects on how he meets and gazes at his cat,

> Sometimes I look into a cat's eyes. ... The beginning of this cat's glance, lighting up under the touch of my glance, indisputably questioned me: "is it possible that you think of me? Do you really not just want me to have fun? Do I concern you? Do I exist in your sight? Do I really exist? What is it that surrounds me? What is it that comes to me? What is it?" ... The animal's glance, speech of disquietude, rose in its greatness – and set at once. My own glance was certainly more lasting; but it was no longer the streaming human glance. [50]

Buber interprets the "it" in the last three questions in the above quote as "the streaming human glance in the total reality of its power to enter into relation."[51] While the streaming human glance touches the cat's glance, the immediate meeting creates a moment of relation which raises many questions regarding the cat's anxiety, plight, and silent interrogation. When the cat's glance fades away, the lasting of the human's glance has entered the world of *It* and no longer in the relation. According to Buber, if a human indulges in the world of *It*, incapable of reentering the relation with others or meeting with the original spirit of *Thou*, the human becomes a slave of causal necessity and falls in "times of sickness," during which "the world of *It*, no longer penetrated and fructified by the inflowing world of *Thou* as by living streams."[52]

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[49] Ibid., p. 96.

[50] Ibid., p. 97.

[51] Ibid., p. 97.

[52] Ibid., p. 53.

This movement may end with the oppressiveness of the causal necessity and the human has to live the extensive ghost of *It*. From this position, the human who lives in environmental crisis and ecological degradation is stifled by the causal necessity of a world of objects, a failure to reentering the relation with nature or meeting nature as a *Thou*. Here, I should mention that the oppressiveness of the causal necessity is unlike the subjugation of nature which environmental philosophers have articulated for several decades. The former highlights the forfeiture of human freedom due to the incapability of leaping out of the fate; the latter focuses on the fact that the human himself or herself is the cause of the causal necessity and fate, or namely, the dwelling in the world of *It*. From this notion, meeting mosses reenters the relation with mosses, to light up a glance from mosses in the absence of a face and eyes, to interrogate whether I could really concern and meet mosses.

2.2 Emmanuel Levinas: Meeting as an Ethical Event

The section above, which is based on Buber's *I and Thou* has offered an ontological examination of meeting as the inescapable interval. In this section, I combine it with Levinas's *Totality and Infinity* to present his thoughts on "meeting" as not only a metaphysical event but more as an ethical event, as the origin of responsibility.[53] Before I examine meeting from Levinas' viewpoint, I am obligated to explain his two straightforward and contrast terms, "totality" and "infinity," to set up the frame for further elucidation of why meeting is an ethical

[53]According to William Edelglass, while continental and environmental philosophy "remain parallel streams of thought" because "environmental philosophers have tended not to utilize Levinasian resources in their explorations of environmental questions, while Continental philosophers have tended not to bring environmental concerns into their examinations of Levinas." However, this does not mean that Levinas contributes nothing to the resolution of contemporary ecological dilemmas. Through the collective efforts of environmental scholars, it shows that his philosophy can provide a great deal of insight. See William Edelglass, "Preface" to *Facing Nature: Levinas and environmental thought* (Pittsburgh, Penn: Duquesne University Press, 2012), p. vii.

event. Likewise, to my understanding, his twofold way of examination parallels and echoes Buber's twofold way of human's attitude and existence in the world.

The term "totality" discloses how Levinas responds to and summarizes the entire Western ontology. To be clear, I do not assume the uniformity of Western philosophy, and the only reason that I use the word "Western" is because of Levinas' usage of the word to designate a philosophical tradition in what we generally call the "Western" philosophy. Based on his account, Western ontology has established the core of various types of homogenizations, assimilation, violence, anonymousness, oppression, and tyranny. In section I. A, titled "Metaphysics and Transcendence," he threads Western ontology on the single string of totalization, with philosophers such as Socrates, Hegel, and Heidegger attached on the string. He identifies Western philosophy with an ontology of power, as "a reduction of the other to the same by interposition of a middle and neutral term that ensures the comprehension of being,"[54] comparable to what Buber has discussed about the objectification of the other. Levinas explicitly states that Socrates's teaching is "the neutralization of the other which becomes theme or object,"[55] and that Heideggerian ontology characterizes it as "subordinating every relation with existents to the relation with Being."[56] On this string lies the absolute egoism of Western ontology in which the relation to all others is subordinated to the power of this ontology, taking others as the reduction to the same. Under this reduction, others are totalized as the same rather than having their radical heterogeneity respected. According to

[54] Emmanuel Levinas, 1969, *Totality and Infinity: An essay on exteriority* (Pittsburgh, Penn: Duquesne University Press), p. 43.

[55] Ibid., p. 43.

[56] Ibid., p. 45.

Levinas, the purpose of this reduction is to "ensure the autarchy of an I,"[57] to separate an *I* from the rest of the world and treat the rest as the same. Furthermore, according to Levinas, to maintain oneself, for Western ontology the expedient to obliterate the heterogeneity of others into a unicity does not hold the truth. This is because in whichever modes of reduction, no matter whether the same is expressed as "Being" or another singular abstraction, it presupposes a comprehension or knowledge of "Being," a word that he must deploy even though he resolves to refute its superiority. The presentation of knowledge or comprehension of Being cannot be disentangled from the Other, the interlocutor, the existent. Levinas credits the precedence of this relationship with the Other as the "ultimate relation in Being."[58] This is another profound insight similar to Buber's ontological examination of the meeting. In a nutshell, the totality of Western ontology fails by ignoring the primacy and transcendence of the relationship with the Other.

In its radical contrast to totality and totalization's unawareness of the transcendence of the relationship with the Other, the transcendence of infinity becomes striking. By infinity, Levinas designates the relation of the same with the absolute, exterior, and transcendent other beyond any possession and depletion. This relation is different from our relations to objects. He highlights the difference between objectivity and transcendence as the guideline throughout the book of *Totality and Infinity*. Levinas appeals to Descartes' argument on the idea of the infinite to demonstrate the radical exteriority of the Other, which in this scenario, means that our idea of the infinite does not indicate any appropriation or ownership of the absolute being;

[57] Ibid., p. 46.

[58] Ibid., p. 48.

instead, it designates the infinite distance between an *I* and the radical Other, since the Infinity is "overflowing the idea of infinity,"[59] "the surplus over being,"[60] and beyond my capacity. *I*, as a container of the idea of infinity, cannot hold infinity. This overflowing reveals not only in the scenario of the idea of the infinity, but also in the encounter with a non-I, as Levinas maintains, "the presence of a being not entering into, but overflowing, the sphere of the same determines it 'status' as infinite."[61] The presence of a "non-I" expresses its transcendence. This discovery of the *transcendence*, the overflowing of the *infinity*, the rejection from the other to be totalized into the same, and the same rejection of the *I* when others are trying to totalize this ego, call for a radical amendment of Western ontology. Underneath this guideline of transcendence, Levinas dissects Western philosophy and reexamines the meaning of being, reason, will, ethics, politics, history, expression, discourse, communication, freedom, dwelling, eros, peace, justice, etc. Transcendence is the primary and primordial point to distinguish infinity from totality, as Levinas condenses the difference between the two terms, "if totality cannot be constituted it is because Infinity does not permit itself to be integrated. It is not the insufficiency of the I that prevents totalization, but the Infinity of the Other."[62] Now after this brief overview of the contrast between totality and infinity, the question is, how does meeting fit on the stage? Why, according to Levinas, is "meeting" a metaphysical and ethical event?

Since Levinas spends much time interpreting the monistic egoism in Western ontology, and he features the overflowing of the Other to revolute the Western tradition, it is well-

[59] Ibid., p. 51.

[60] Ibid., p. 292.

[61] Ibid., p. 195.

[62] Ibid., p. 80.

reasoned to assume that meeting others is of critical weight. In *Totality and Infinity*, meeting is articulated as "a primordial and original relation with being,"[63] "a relation with being beyond the totality,"[64] "a face to face,"[65] "the void that breaks the totality,"[66] a "calling into question of my spontaneity by the presence of the Other,"[67] "the welcome of the Other,"[68] hospitality, and much more. All these statements and occasions are accompanied by the presence of the Other, the face-to-face encounter. Levinas reveals that Western ontology is the totalization and neutralization of the Other, which overlooks the concreteness and heterogeneity of others, due to an obliviousness of the primordial relation between the I and the Other, or the meeting between the two. The feature of relation being primordial, meeting's precedence to my comprehension of being and the world, reveal that "ontology presupposed metaphysics."[69] In other words, meeting the Other, or using Levinas' expression, "this relation with an *existent* - precedes all ontology,"[70] is *the* metaphysical event.

In what sense does this metaphysical event also become *the* ethical event? First and foremost, it lies on Levinas's definition of ethics. He delivers a deep meaning to ethics unlike the common understanding of ethics as the examination of the moral discourse, as rules and principles of behavior, or as the practice of certain moral theories in various contexts. His

[63] Ibid., p. 16.

[64] Ibid., p.22.

[65] Ibid., p. 39.

[66] Ibid., p. 40.

[67] Ibid., p. 43.

[68] Ibid., p. 254.

[69] Ibid., p. 48.

[70] Ibid.

concept of ethics is close to metaethics but not quite the same. It is the co-occurrence, co-existence, and inseparable entanglement of metaphysics and ethics in Meeting the Other. He writes the following to define ethics,

> A calling into question of the same - which cannot occur within the egoist spontaneity of the same - is brought about by the other. We name this calling into question of my spontaneity by the presence of the Other *ethics*. The strangeness of the Other, his irreducibility to the I, to my thoughts and my possessions, is precisely accomplished as a calling into question of my spontaneity, as ethics. [71]

My spontaneity, my solitary ego, my nature to maintain this ego in the vastness of the world, my tendency to separate a Self from the Other as if they are detachable, and my momentary impulse to totalize the Other into a Whole for the purpose of maintaining myself, confront the presence of the Other. Ironically, but also consistently, the Other likewise presents itself as a solitary ego, a spontaneity, a nature to maintain a self, a tendency to separate and distance from the Other (his/her others), and a momentary impulse to totalize. The mutual spontaneity shapes the strangeness and radical alterity of the Other, designates the irreducibility of the Other to my possession, and questions my spontaneity. According to Levinas, as stated above, this "calling into question of my spontaneity" is the emergence of ethics. It is thus in meeting the Other that ethical concerns arise. Meeting the Other instantaneously becomes not only the metaphysical but also ethical event. From this position, Levinas claims that any philosophy that prioritizes ontology over ethics or affirms Being over concrete existents has committed a fault, like setting the cart before the horse.

Although Levinas has stated the entanglement of metaphysics and ethics, there is still

[71] Ibid., p. 43.

the question of why I could not maintain my solitary ego with the cost of giving up my own alterity for the purpose of totalizing the Other. That would be a scenario in which relative totalizations compete against each other, leading to a Hobbesian chaos against the very original intention of totalization. Hence, a further examination to conduct is, rather than reasoning the self-contradictory feature of totalization, why meeting or the presence of the Other engenders ethical commands. For instance, how does the moral command that "you shall not commit murder" emerge from meeting the other? Levinas holds that it is because of the expression and the sensible appearance of the face, which "speaks to me and thereby invites me to a relation incommensurate with a power exercised, be it enjoyment or knowledge."[72] According to Levinas, as "the most banal incident of human history," murder "finds itself before a datum whose being cannot be *suspended* by an appropriation."[73] Murder is a power exercised differently from a comprehension, representation, grasp, or use of the other, as it "renounce(s) comprehension absolutely."[74] Even though murder causes fierce violence against the other and annihilates the existent, the non-neutralization, independence, alterity, freedom to express itself sensibly through a visage, and "the very *unforeseeableness* of his reaction" [75] escapes the power of murder. Levinas digs out the impotency and powerlessness of murder, denudes it to the infinity of the other, and authenticates the superiority of the infinity as a power stronger than murder. Levinas believes that in this very presence of the face lies the essence of man which makes being possible. He deems that in the presence of the face of the other is the face

[72] Ibid., p. 198.

[73] Ibid., p. 198.

[74] Ibid., p. 198.

[75] Ibid., p. 199.

of the divine. According to him,

> Man [*sic*] as Other comes to us form the outside, a separated - or holy - face. His exteriority, that is, his appeal to me, is his truth. ... The face to face is a final and irreducible relation which no concepts could cover without the thinker who thinks that concept finding himself forthwith before a new interlocutor; it makes possible the pluralism of society. [76]

Thus, the divine feature of the "face to face" unveils the social multiplicity which rejects totalization, neutralization, tyranny, homogenization, and other violence. The presence of the face of the Other, the intervals, and the meeting is already ethical. That is the transcendence of the Other which demands justice and rejects the privileged position of the *I* as the subject. In the transcendence of the Other arises my responsibility. It already assumes "the kingship of beings among themselves" and "their radical heterogeneity."[77] In sum, the ethical commands already emerge from the transcendence, the exteriority of the Other, the epiphany of the face of "Man[sic.] as Other," and the meeting. It is in this sense that meeting is both the metaphysical and ethical event according to Levinas. The link between radical heterogeneity of the other and responsibility seems not limited to beings with a face. For instance, according to Barad's examination of an electron's "touch" of itself and its significance to mattering, to be specific, when a negative charged electron emits a photon and absorbs its own photon, the electron actually explored self-touching, "an encounter with the infinite alterity of the self."[78] The advent of responsibility, in this sense, designates a relation to an "infinite alterity that lives in, around, and through us," "the inhuman therefore we are," and "the insensible, the

[76] Ibid., p. 291.

[77] Ibid., p. 293.

[78] Karen Barad, 2012, "On touching—The inhuman that therefore I am," *differences: Feminist Theory Out of Science,* 23(3), 206-223, p. 213.

irrational, the unfathomable, and the incalculable."[79] Under Barad's scrutiny, a perversity of quantum field theory now indicates a novel approach to our identity and ethical responsibility.

2.3 Rozzi and Kimmerer: Meetings as the Epistemological Events and Beyond

In the previous sections I have argued for the significance of meeting as the inescapable event in Buber's *I and Thou*, and as both the metaphysical and ethical event in Levinas' *Totality and Infinity*. In this section, I combine the writings of Ricardo Rozzi and Robin Wall Kimmerer to show that meeting the other is an intermittent replenishment with epistemological events and beyond. Here "beyond" refers to the complexity of the intervals, the entanglement of metaphysical, ethical, and epistemological dimensions of meetings. At this point, I want to make one unsettled question clear. Let me explain. While arguing for the significance of meeting others in the previous two sections, it has never been specific and concrete enough to situate mosses as the other. As I mentioned in 1.1, according to Buber, interspecies meeting gives humans chances to enter relation, treating other-than-human species as *thou*. But in section 1.2, I did not examine how Levinas outlooks interspecies meetings. Even though Levinas assumes "the kinship of beings among themselves" while he handles the issue of creation, on most occasions he focuses on meeting humans as the other in which the presence of a face is the ethical moment. The question is, to what extent, meeting plants, or more concretely and tangibly, meeting mosses can be regarded as a *face-to-face* encounter, since Levinas defines *face* as "the way in which the other presents himself, exceeding the idea of the other in me."[80]

[79] Ibid., p. 218.

[80] Levinas, 1969, *Totality and Infinity*, p. 50.

The pronoun, the third person singular "himself" or "herself" seems to exclude the possibility of plants as the other. I leave this question to the next section and start this section with Rozzi's lively account of meeting mosses in the sense of *face-to-face*.

In the first place, according to Rozzi, interspecies meetings, or in his terms, direct *face-to-face* encounters with actual living beings, exhibit a very important way of understanding biocultural diversity and enrich the experience of co-inhabitation.[81] Biocultural understanding regards humans and other-than-human beings as co-inhabitants of an ecological region and the planet. Through the concept of co-inhabitants, Rozzi contemplates that "other beings cease to be mere objects and acquire the status of co-inhabitant subjects."[82] This notion delicately resonates with Buber's thoughts of interspecies meeting, in which objectification of other-than-human living beings should be rejected if entering relation is desired. *Face-to-face* encounter is also a critical step of the four steps of field environmental philosophy which I discuss in chapter 3, as a direct encounter with mosses. Under a thought-provoking scrutiny of earth stewardship regarding nature-human relationship, community, and alterity, Roy May considers that *face-to-face* relation with the other nonhumans plays a vital role in widening the moral community,[83] that is to say, other-than-human beings are also worthy of moral consideration. For environmental philosophers, the moral status of other-than-human beings seems to be common sense because of the round of debates between anthropocentrism and non-

[81] Rozzi, 2013, "Biocultural ethics: from biocultural homogenization toward biocultural conservation," In *Linking ecology and ethics for a changing World* (Springer, Dordrecht), p. 27.

[82] Ibid.

[83] Roy May, 2015, "Dorothy Stang: Monkeys Cry and the Poor Die, Earth Stewardship as Liberation Ecology," In Rozzi, R., Chapin III, FS., Callicott, JB., et al. ed. (2015). *Earth Stewardship: Linking Ecology and Ethics in Theory and Practice* (Springer), p. 415.

anthropocentrism, and the contrast between biocentrism and ecocentrism. But for an audience from a non-environmental sphere, it might need to take a different angle to justify the moral status of other-than-human beings.

Grounded on the historical contexts of Latin-American, colonialism, and the subjugation of both nature and powerless people, May claims that earth stewardship could empower other-than-human beings.[84] He echoes Rozzi in appreciating serious interculturality. To my understanding, two visions are crucial here. First, the invitation to empower other-than-human beings is consistent with Buber's insight into interspecies meeting as they are not objects but subjects, the *thou*. The concepts of "interculturality" (May) and "biocultural diversity" (that Rozzi has advocated in many writings and occasions), understood as collectively and communally shared ideas, customs, values, beliefs, or a mixture, could be developed out of Levinas' view on meetings as the embodiment of social multiplicity. Ray and Rozzi seem to have no problem with defending human responsibility for plant life. Particularly, in Rozzi's biocultural ethics, other-than-human beings are co-inhabitants of ecosystems and biospheres. Empowering other-than-human beings and appreciating biocultural diversity not only appeals to the similarities between other-than-human beings and human beings, but also to the heterogeneity among them. By similarities, they are not revealed in the sense of Singer's animal ethics, referring to the capacities of suffering or utilitarian criteria based on humans, but in the sense of kinship. To clarify, other-than-human beings share common characteristics and origin of *Life*. In terms of heterogeneity, each kind of other-than-human beings is unique and dramatically

[84] Ibid., p. 416.

unlike the human species. While assuming similarities or heterogeneity, there lies the line. In Buber's terms, that is our twofold living between *it* and *thou*. In Levinas' terms, heterogeneity evokes our infinite responsibilities to others. For Rozzi, there is a "change of lenses"[85] to comprehend heterogeneity and observe biocultural diversity. This "change of lenses" opens an angle of the ethical knowing which challenges Buber's but echoes Levinas's conception of "knowing," in the sense that the former argues that experience and knowledge only allow a person to live in the realm of *it*, and the latter argues the importance of turning "thematization" into conversation, namely, "to approach the Other in conversation."[86] Rozzi's change of lenses thus presents as an ethical examination of knowing, through the epistemological angle of Meeting it calls to enter relations with other-than-human beings and other cultures.

In accordance with the above conversation, it is now comprehensible that while Rozzi describes his *face-to-face* encounter with mosses on the Cape Horn Islands, the moment is a moment of meeting. While sinking in a swamp, observing "the exuberant diversity of mosses,"[87] and facing a threat of death as well, Rozzi meets mosses by welcoming the expression of mosses and discovering a hotspot of non-vascular plants. A meeting with mosses is the retreat of the subject *I* and receiving the expression of mosses, in which mosses speak for themselves and request to be regarded as co-inhabiting subjects rather than *It*. Their expression allows people to enter the relation, which in turn enriches and directs "knowing." In

[85] Ricardo Rozzi, 2012, "Serendipity in the Origin of Ecotourism with a Hand Lens," in *Miniature forests of Cape Horn: ecotourism with a hand lens* (Denton, TX: University of North Texas Press), p. 17.

[86] Levinas, *Totality and Infinity*, p. 51.

[87] Ibid., p. 13.

Rozzi's scenario, the subsequent perception, knowledge, practice, and field activities are derivatives of the very original Meeting with *mosses*. The impacts of this "meeting" with mosses are not limited to meetings with mosses. According to Rozzi,

> Finally, the "change of lenses' to observe and conserve biodiversity led us to a change in the awareness and attitude of co-inhabitation with sub-Antarctic biodiversity, in general, and with bryophytes in particular. Together with children at the local school in Cape Horn, we composed the metaphor: "miniature forests of Cape Horn." Through the perspective of this metaphor, mosses, liverworts, lichens, insects and other organism started to be perceived as co-inhabitants rather than mere "natural resources."[88]

Apparently, the narrative of "natural resources" represents the realm of *it* and a totalization of all other-than-human beings. Thus, to empower mosses is to empower infinite other-than-human beings and raise chances of recognizing the subjectivity of infinite other-than-human beings. A "change of lenses" opens the epistemic door, turning metaphysical-ethical meeting into concrete and tangible events through which the beauty, diversity, and social-cultural-linguistic-political relevance of other-than-human beings are cherished. From the perspective of epistemology, Rozzi's proposal of a "change of lenses" proceeds beyond the taxonomic, geographical, and ecoregional boundaries to disclose the reservoirs of biocultural diversity across the globe. Biocultural diversity thus can be situated in various contexts and ecoregions without tyranny of totality. According to Levinas, what is absent in totality is the radical heterogeneity of the other. A comprehension of biocultural diversity assumes the radical heterogeneity of other-than-human beings (biological subjects), of other cultures (socio-cultural relevance), and of vital links among the inhabitants, their habits, and habitats in local

[88] Ibid., p. 17 and p. 19.

levels (biocultural diversity).[89] In this regard, the conversation among early Western philosophy, Amerindian traditional ecological knowledge, and contemporary ecological and evolutionary sciences[90] reveals the complexity of meetings as epistemological events, as the derivatives of the primordial metaphysical-and-ethical meeting.

Rozzi's calling for a change of lenses and the epistemological complexity of meetings are also observed by Kimmerer. In the preface of *Gathering Mosses*, she mentions different ways of knowing,

> In indigenous ways of knowing, we say that a thing cannot be understood until it is known by all four aspects of our being: mind, body, emotion, and spirit. The scientific way of knowing relies only on empirical information from the world, gathered by body and interpreted by mind. [91]

In this regard, the indigenous way of knowing shows much more integrity than the dichotomy of the scientific way of knowing. A contrast between the two reflects the epistemological relevance of her gathering mosses. She also clearly proclaims that the essays collected in her book "intentionally give voice to both ways of knowing."[92] Particularly, she mentions with regard to indigenous ways of knowing, "Every being is endowed with certain gifts, its own intelligence, its own spirit, its own story."[93] Accordingly, this gathering of mosses does not refer to physically collecting mosses, but bringing mosses together from scattered places, scientific knowledge, indigenous knowledge, cultures, beliefs, and practices, etc. Therefore, gathering

[89] See Ricardo Rozzi, 2012, "Biocultural ethics: recovering the vital links between the inhabitants, their habits, and habitats," *Environmental Ethics*, 34(1), 27-50.

[90] Ibid.

[91] Robin Wall Kimmerer, 2003, *Gathering Moss: A natural and cultural history of mosses* (Corvallis, OR: Oregon state university press), p. vii.

[92] Ibid.

[93] Ibid., p. 100.

mosses involves meeting mosses physically, emotionally, intelligently, and spiritually. This is verified by Kimmerer's visiting of mosses in various sites to conduct scientific and empirical investigation, her thought-provoking contemplation, and profound insights while entering intersubjective dialogues with mosses.

The epistemological relevance of those meetings appeals to be taken as intersubjective meetings in which the subjectivity of mosses is revealed. Mosses present themselves and offer their expressions to her. For example, when she notices the striking occurrence pattern of *Tetraphis* in two different forms in which the species adopts different reproductive strategies on different patches of the same habitat, she wonders why nature allows one species to have opposite reproductive behaviors.[94] Her following scientific investigation, which assumes that the physical environmental factors such as moisture and nutrients might be the decisive elements to form the occurrence of the changeable habits, does not work effectively and comes to a stagnation. The answer appears when she realizes that "mosses don't speak our language; they don't experience the world the way we do."[95] What follows is the change of pace, scale, and strategy of the research. To know mosses requires a redirection of perspective regarding proportionality, to observe not from a human perspective, but from the prospective of mosses, in their pace and scale. Years later, with her laborious work of sampling and long-term observation, she concludes that the reproductive behaviors of *Tetraphis* reveal the species as "a sequential hermaphrodite, changing its gender from female to male as the colony gets

[94] Ibid., p. 76.

[95] Ibid., p. 77.

crowded,"[96] a phenomenon never observed in mosses before. This hypothesis needed to be confirmed through experiment. Based on the hypothesis, she designed and conducted experiments, and patiently waited for answers on the timescale of mosses. It turned out the answer from *Tetraphis* confirmed the hypothesis. As she writes, "The mosses had answered, in their own way. Low density is a time for gemmae, high density for spores."[97] From this perspective, scientific research is not the subjective *I* to discover an objective and total truth, but rather to attend to what other subjects express. Knowledge is a temporary comprehension of other's expressions in continual conversation. Kimmerer apparently values her conversation with mosses. As she writes,

> To me, a good experiment is like a good conversation. Each listener creates an opening for the other's story to be told. So, to learn about how Tetraphis makes reproductive choices, I tried to listen to its story. [98]

In this quote, the other's story is the story of *Tetraphis*, a story that values radical heterogeneity, singularity, and the subjectivity of all beings. From my point of view, her research about the options between the perspective of humans and the perspective of mosses, the researcher *I* tried to totalize *Tetraphis* into a human perspective and the existing knowledge of mosses. Listening to *Tetraphis*' story engenders a veneration of the subjectivity of species, of its power to express, of its capability to cultivate changeable reproductive habits, and of its expertise in choosing the proper habit based on habitats of high or low density. This also echoes what Haraway calls "good scientists," who "learning to be invisible themselves, could

[96] Ibid., p.78.

[97] Ibid., p. 79.

[98] Ibid., p. 77.

see the scene of nature close up, as if through a peep-hole."[99] She analyses the divergence between Derrida's shame of his nudity before his cat and Smuts' acceptance of baboons' social semiotics, through the latter Smuts was accepted by baboons. Derrida could have considered "an alternative form of engagement,"[100] according to Haraway. A suitable response from a human, a radical change of being human, and mutual interspecies acknowledgement are the presence of respecting and valuing the alterity, of meeting. Haraway called Derrida the philosopher rather than the human to meet his cat seriously.[101]

Because of the above reciprocal actions of Kimmerer and *Tetraphis*, it is fair to state that Kimmerer meets *Tetraphis* in her scientific research. The epistemological relevance of her meeting lies in her insight on the impacts of changing from a human perspective to the perspective of mosses. The meeting resembles Rozzi's meeting with mosses and liverworts on the Cape Horn Islands and his calling for "a change of lenses." This change comes in terms of the reverence of others as subject. Their insights on the significance of "a change" reflects a latent issue of epistemological injustice, which was elaborated by a few scholars. For example, Aníbal Quijano claims that the European direct, political, social and cultural domination over all continents as established through Eurocentered colonialism.[102] During the colonial process, as a product of a subject-object relation, knowledge and associated mental mechanism gave rise to an "organicist concept of social totality."[103] Under such a framework, an evolutionary

[99] Donna Haraway, 2013, *When Species Meet* (Minneapolis, MN: University of Minnesota Press), p. 24.

[100] Ibid., p. 20.

[101] Ibid., p. 22.

[102] Aníbal Quijano, 2007, "Coloniality and Modernity/Rationality," *Cultural Studies*, 21(2), 168-178.

[103] Ibid., p175.

continuum of history becomes a secondary attack to assist Europe mirror itself as the future. The epistemological injustice over all continents needs reconstitution, decolonization, and liberation. It is worthy of notice that, according to Quijano, outside the "West," other cultures also hold the perspective of social totality. But their totality is compatible with historical diversity and heterogeneity which forms a delightful contrast with the linear, singular, evolutionary, and homogeneous continuum. In this regard, the significance of meetings as epistemological events has gone beyond the intersubjective meetings between humans and mosses to the intercultural dimensions.

2.4 Radical Subjectivity: Plant Intelligence, Language, and Personhood

This section is devoted to answering the unsettled question I left at the beginning of section 2.3. The question is, when Levinas defines "face," he mentions "the way in which the other presents himself, exceeding the idea of the other in me,"[104] it is still necessary to clarify what it means by the plant face if I am going to interpret my encounter with mosses as a meeting. In section 2.3, Rozzi directly explores interspecies meetings as "*face-to-face* encounter." For Kimmerer, mosses, as others have their own stories to tell and if humans attend to those stories, our knowledge can evolve. Also, in Kimmerer's writing, the indigenous way of knowing shows no difficulty in recognizing the gifts, intelligence, spirit, and story of other beings.[105] The face or the radical subjectivity of mosses, and of numerous other plants, might rest on their gifts, intelligence, spirit, or stories, or many other aspects unknown to

[104] Levinas, 1969, *Totality and Infinity*, p. 50.

[105] Kimmerer, 2003, *Gathering Moss*, p. 100.

humans. The problem is, *I* look at the world with human eyes and narrate the world via words which have already been humanized, such as gifts, intelligence, spirit, and stories. Unless *I* can sincerely appreciate the radical differences and intrinsic values of their gifts, intelligence, spirit, and stories, and admit that for such a long time, *I* have unilaterally held all those values, there is no way to see their face, to fathom their radical heterogeneity, to venerate their subjectivity, and to meet them.

In this effort to meet them, it is worth mentioning that there are at least two distinctive attitudes toward plants. One expresses their deep eulogy to plants and acclaims their capacities through growth and reproduction without navigating the form of locomotion conducted by animals and humans. The other maintains a consistent hierarchy of various capacities that living beings use to respond to their environment, and spontaneously human capacities at the acme, like what Aristotle's examination about the vegetative, animal, and human soul. At this moment, mentioning these two attitudes does not require a rejection of either one, but it would be valuable to deliberate the ethical or political allusions of these two attitudes.[106] Thus, the following focuses on plant intelligence and plant personhood to offer a supplementary argument for the subjectivity of plants, including mosses.

As mentioned above, since terms such as "intelligence" have already been humanized, appealing to them risks being complacent anthropocentrism. Plant intelligence thus becomes a

[106] The correlations between metaphysical beliefs and political realm have been disclosed by quite a few philosophers. Those mentioned in the introduction chapter are apparently included in this category. Particularly, regarding a revolution to Western metaphysical tradition from the angle of plants, Michael Marder is an indispensable figure in recent years, who proposed ethical "vegetal democracy" for its potentiality towards sharing, participation, openness, inclusion, generosity, and vitality. See Michael Marder, 2013, *Plant-thinking: A philosophy of vegetal life* (New York, NY: Columbia University Press), pp. 51-53.

novel but challenging way to resolve the unilateral possession of intelligence. The effort starts with a rethinking of intelligence among scholars from various disciplines. With their inexhaustive collection of more than seventy definitions of intelligence, Legg and Hutter classified these definitions into three groups, namely, collective definitions proposed by groups or organizations, by psychologist, and by artificial intelligence researchers. Based on the common features of these various definitions, they eventually developed a definition which claims that "intelligence measures an agent's ability to achieve goals in a wide range of environments."[107] Although their original intention was to examine intelligence particularly in the context of artificial intelligence development, this definition literally does not exclude plants. After giving attention to various definitions of intelligence from psychologists, artificial intelligence experts, and researchers from other disciplines, Trewavas defines *intelligence* as "the capacity for problem solving."[108] Trewavas clearly states that removing human bias is fundamental for recognizing plant intelligence. His recognition of plant intelligence is also based on the concept of adaptation, through phenotypic, metabolic, and genomic plasticity.[109] Elsewhere, Trewavas traces the recognition of plant intelligence to Charles Darwin (1809-1882) and Von Hartmann (1842-1906) and defends intelligent behaviors of plants from various perspectives.[110]

As for botanists, even though it seems reasonable to claim plants have intelligence,

[107] See Shane Legg and Marcus Hutter, 2007, "A collection of definitions of intelligence," in *Advances in Artificial General Intelligence: Concepts, architectures, and algorithms* 157, p. 22.

[108] Anthony Trewavas, 2015, *Plant Behaviour and Intelligence* (New York, NY: Oxford University Press), p. 197.

[109] Ibid., p. 196.

[110] See Anthony Trewavas, 2016, "Plant intelligence: an overview," *BioScience,* 66(7), 542-551, p. 542.

there are still some barriers for other scientists to acknowledge the validity of this idea. According to Michael Pollan, the debate on whether the term *intelligence* can be associated with plants is largely decided by how the term *intelligence* is defined.[111] For those who consider neurons and the brain as the evidence of intelligence, plant intelligence seems to be "foolish," absurd, inappropriate, and weird.[112] But for plant neurobiologists and behaviorists such as Trewavas and Gagliano, plants respond to chemical signals, react differently to various wavelengths of lights, "know" when encounter a solid object, or "memorize" disturbing events, just like how humans perceive and respond to the environment and circumstance via senses.[113] Based on these considerations, whether plants have intelligence depends on which camp the inquirer belongs to. One camp believes intelligence requires neuros and the brain, relegating intelligence to the capacity of conducting mental activities such as reasoning, making judgment, etc. This camp can be named the exclusion camp. The other camp supposes intelligence is the ability to respond to the challenges presented by one's environment and it can be observed through behavioral analysis. Accordingly, the second camp can be labelled as the inclusion camp. Once the demarcation between the two camps has been drawn, it seems to be the end of the debate. The inquirer picks an ideal camp based on perceived subjective preferences, and the debate is over. However, the practical suggestion goes beyond just a pick.

For the inclusion camp, recognizing the intelligence of plants creates voluminous values. With the recognition of plant intelligence, an exciting frontier of biological research appears. It

[111] Michael Pollan, 2013, "The intelligent plant," *New Yorker* (Dec. 23 & 30), 92-105.

[112] Ibid.

[113] Ibid.

also provokes an ethical reflection of biological research. That is, plant intelligence serves as a powerful armor guarding against "plant blindness," the privileged taxonomic chauvinism, zoocentrism, and the marginalization of plants in biological research.[114] For botanists, philosophers, and humanists who appreciate plants intelligence, it even opens a new perspective toward language. Language is no longer a tool or mechanical result of individual living subjects, but is "an ecology produced by organism in an interdependent and multispecies interrelation"[115] and is "a truly ecological, dynamic process of relationships by which meaning emerges."[116] In this sense, plants have their own languages and accordingly, plant languages can be categorized into two classes, extrinsic and intrinsic languages. By extrinsic language, researchers designate "the ways in which scientists, theorists, writers, artists, and others express what is peculiar about plant being,"[117] including scientific language, philosophical articulation, literary representation, and various other ways of presenting plant being. In other words, extrinsic language is the language deployed by humans to describe the existence of plants.

On the other hand, just as the name suggests, intrinsic language is the language deployed not by humans but by plants, even though it must be represented in a verbal form for human comprehension, which "encompasses the modes of communication and articulation

[114] See Monica Gagliano, John C Ryan, and Patrícia Vieira, 2017, "Introduction," *The Language of Plants: Science, philosophy, literature* (Minneapolis, MN: University of Minnesota Press), p. viii.

[115] Ibid., xviii.

[116] Monica Gagliano, 2017, "Breaking the silence: Green Mudras and the faculty of languages in plants," in *The Language of Plants: Science, philosophy, literature* (Minneapolis, MN: University of Minnesota Press), p. 95.

[117] Monica Gagliano, John C Ryan, and Patrícia Vieira, 2017, "Introduction," xvii.

used by vegetal species to negotiate ecologically with their biotic and abiotic environments."[118] Intrinsic language might include the contents researched by fields such as biochemistry (electronic signaling), plant neurobiology (responsive adaptation to the environment), and plant bioacoustics (plants response to acoustic signals).[119] This differentiation leads to an embodied conception of language which "offer(s) a valuable step toward the deobjectification of plants and the recognition of their subjectivity and inherent worth and dignity, renewing a sense of ecological intimacy and kinship with these nonhuman living others and, thus, promoting human care for nature." [120] Thus, a rejection of the human monopoly of language or its arbitrary superiority requires the recognition of the subjectivity of other organisms. In this sense, sincere communication involves how to face other organisms and attend to how they are making meanings. For plants such as mosses, sincere communication demands granting their subjectivity and their ability to create meaning through their interactions with others in an ecological sense. Subjectivity is the key.

Like plant language, which seeks sincere communication and rejects "plant blindness," one recent examination of philosophical traditions reflects a parallel trajectory that leads to the embracement of plant personhood. According to Matthew Hall, human marginalization of plants in Western societies was historically intertwined with themes such as radical separation, zoocentrism, exclusion, and hierarchical value ordering within philosophical traditions.[121] For

[118] Monica Gagliano, John C Ryan, and Patrícia Vieira, 2017, "Introduction," xvii-xviii.

[119] Ibid.

[120] Monica Gagliano, 2017, "Breaking the silence: Green Mudras and the faculty of languages in plants," p. 95.

[121] See Matthew Hall, 2011, "A philosophical botany," *Plants as Persons: A philosophical botany* (Albany, NY: Suny Press). Another philosopher who also specialized in plant philosophy and plant wisdom is Michael Marder, who proposed "vegetal anti-metaphysics" to address how plants have been marginalized and excluded by the core values of autonomy, individualization, self-identity, essentiality by traditional Western philosophy. See Michael

example, in terms of hierarchical value ordering, Aristotle's soul theory overwhelmingly dominated Western views on plants. Consequently, a different vision on plants proposed by Theophrastus (371–ca. 287 BCE), who considered plants as volitional, minded, intentional, autonomous beings, was disregarded in Western botanical history. Hall's scrutiny of other cultures, religions, and communities such as Hinduism, Jainism, Buddhism, East Asian Buddhism, Indigenous animist societies, and European Pagans disclose the complexity of plant views. Based on whether plants are regarded as autonomous subjects, Hall draws a line between two different understandings of plants, which can be traced back to ancient Greek philosophy,

> One was based upon exclusion, separation, and superiority; the other was based more upon inclusion, connection, and appreciation of autonomy. [122]

The *exclusion* view tolerates and even tacitly encourages instrumental exploitation of plants. The *inclusion* view recognizes plants as persons. For instance, according to Hall's investigation of indigenous animist cultures, not in the "old animism" sense to believe in nature spirits, but in the "new animism" sense to appreciate the kinship between humans and other-than-human beings, "the world is full of persons" and this statement does not exclude plants.[123] Furthermore, the new animism is "a sophisticated way of both being in the world and of

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Marder, 2011, "Vegetal anti-metaphysics: Learning from plants," *Continental Philosophy Review* 44(4), 469-489. Based on his ontological-hermeneutical approach, Marder also reinterpreted plant life as a type of weakness, "neither differentiated in its capacities, nor separated enough from the exteriority of its environment," to mark its strength of a passive resistance of mainstream thinking pattern on identity and alterity. It is interesting that Marder interpreted Plants' capacity for nourishments as the assimilation or appropriation of alterity/the other to the same. The uncanny part is that all life forms own plants' capacity for nourishment. See Michael Marder, 2011, "Plant-Soul: The elusive meanings of vegetative life," *Environmental Philosophy* 8 (1), 83-100.

[122] Hall, *Plant as Persons*, p. 35.

[123] Ibid., p. 105.

knowing the world; it is a relational epistemology and a relational ontology."[124] Recognition of plant personhood does not allude to ascribing plants human attributes or anthropomorphic projection. Rather, it expresses the gratitude that plants are living beings within their own perspective, with "the ability to communicate in their own way,"[125] unique in "a significant way of 'representing interiority' or 'subjectivity',[126] and a provision of "a complex system 'for encountering the world'."[127] Hall apparently rejects Western/Eastern or Western/Indigenous dualism. He believes that the current scientific debates over the sentience and intelligence of plants will eventually converge Western attitudes and other attitudes that value plants personhood. This convergence will include plants within moral consideration through which Western attitudes toward plants as zoocentric and hierarchical will be amended. Given that science particularly emerged in a Western context, this convergence makes sense.

The above discussion of plant intelligence, language, and personhood unfolds the subjectivity of plants. Along each thread, the divergence between exclusion and inclusion of "plants being subjects" is conspicuous. The ethical discernment behind these two camps might present a more perplexing situation to the inquirer. For the exclusion camp, which rejects the idea that plants possess intelligence, language, and personhood, it is necessary to ask whether humans' appropriations of reasoning, language, making tools, writing, cultures, civilization, etc. are results of narcissism at the species level, highly artificial, colonial, and monopolistic. This species narcissism shades our horizon and in turn produces barriers to welcoming the

[124] Ibid., p. 105.

[125] Ibid., p. 105.

[126] Ibid., p. 106.

[127] Ibid., p. 107.

subjectivity of other-than-human beings, particularly those beings close to the bottom of the conventional hierarchy. Some people challenge the exclusion camp by asking, when the term artificial intelligence is widely accepted and even human-made machines can be ascribed intelligence, what is the problem with regarding living plants as being intelligent? Although the question here appeals to a hierarchical order of the world, it makes a fair point for a cross-examination. Similar questions can be considered from the angles of plant language and plant personhood.

CHAPTER 3

MEETING MOSSES IN THE FIELD: WHY NOT MOSSES?

> *We may gather knowledge from the accounts of others; but it is much more pleasant to see things with our own eyes.*
>
> —Carl Linnaeus

As mentioned in the introduction, this chapter serves as the methodology chapter and the biophysical dimension of convivial biocultural conservation. It begins with a brief introduction to field environmental philosophy (FEP) and an apprehension of the merits of it. In the rest three sections, I describe my field trips to southern Chile in December 2019. The field trip did open a vast moss-cosmos, tangible, intriguing, and rich in expressiveness. The further I travelled to the south, the more magnificence I observed and appreciated, at physical, conceptual, epistemic, and ethical levels. Mosses present themselves in astonishing and amazing ways, whether I attend to them or not, whether I can articulate their significance or not. The only thing more astonishing is that I call myself an environmentalist and mosses are invisible to me. This is now a multiple challenge from cognitive, aesthetic, and ethical angles.

3.1 Field Environmental Philosophy (FEP)

In 1999, a group of philosophers and ecologists from the University of North Texas (UNT), the University of Magallanes (UM), and the Omora Ethnobotanical Park (OEP) proposed the methodology of field environmental philosophy. It has facilitated international collaboration on research, education, and biocultural conservation since then.[128] As a four-step

[128] See Ricardo Rozzi, Juan J Armesto, Bernard Goffinet, et al., 2008, "Changing lenses to assess biodiversity: patterns of species richness in sub-Antarctic plants and implications for global conservation," *Frontiers in Ecology and the Environment*, 6(3), 131-137, and Ricardo Rozzi, Christopher B. Anderson, J. Cristóbal Pizarro et al, 2010, "Field environmental philosophy and biocultural conservation at the Omora Ethnobotanical Park: Methodological

cycle methodology, it shows powerful merits to environmental education and biocultural conservation.

3.1.1 Four-Step Circle of FEP

According to Rozzi's description of field environmental philosophy, it contains four steps, research (interdisciplinary ecological and philosophical research), communication (the composition of metaphors and communication through narratives), field activities (guided with an ecological and ethical orientation), and *in situ* conservation (implementation of areas for *in situ* biocultural conservation).[129] Figuratively, although field environmental philosophy forms a loop which indicates that each step could be a starting point of a research project, I take field trip as the initiation of the dissertation project.

Ecologically and ethically oriented field activities are an integral part of field environmental philosophy. In the field, participants could have face-to-face encounters with other-than-human beings. In my project, field activities have allowed me to have face-to-face encounters with mosses and the biocultural diversity of southwestern South America. This step in the designing of field environmental philosophy aims at helping participants to cross both physical and conceptual barriers produced by the ongoing global urbanization, biocultural homogenization, and monotonous formal education.[130] Deliberately designed field activities help me in conducting learning and research activities at three sites in southern Chile, and my

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approaches to broaden the ways of integrating the social component (S) in Long-Term Socio-Ecological Research (LTSER) Sites," *Revista Chilena de Historia Natural*, 83(1), 27-68.

[129] Ricardo Rozzi, Christopher B. Anderson, J. Cristóbal Pizarro et al, 2010.

[130] Ricardo Rozzi, Ximena Arango, Francisca Massardo, et al., 2008, "Field environmental philosophy and biocultural conservation: the Omora Ethnobotanical Park educational program," *Environmental Ethics* 30(3), 325-336.

empirical knowledge of bryophytes and their endemic diversity gradually grow as the field trip goes further south, as I report in detail in the three sections below. This direct encountering, not available in most formal education, allows for the integration of the ecology of mosses, their biocultural values, and ethics of how to co-inhabit with these non-vascular plants. Fieldwork facilitates biophysical encounter with mosses, a first intimate and genuine encounter in the interspecies sense.

The second step, research, begins with an initiative comprehension of the natural and cultural history of mosses (Figure 3.1). In the "Philosophy of Ecology" class at UNT, students have learned about the endemic diversity of southern Chilean bryophytes. Demonstrated by the Omora research team, the Magellanic subantarctic ecoregion is identified as a global "hotspot" for bryophytes diversity.[131] The question at this stage is, how mosses are embedded in various cultures through human-moss co-inhabitance. In other words, the goal of this step is to investigate the diversity, endemic species, sociocultural diversities, linguistic phenomena regarding mosses, their habitats, habits, and co-inhabitation with humans and other-than-human co-inhabitants in various societies and cultures, especially the indigenous cultures in southern Chile, Chinese culture, bryophytes art works, moss gardening, etc. Apparently, due to my limited knowledge of the rich reservoirs of natural and cultural history of mosses, the research cannot be exhaustive. This step may also carry the risk that cognitive biases may misdirect the research or result in questionable ethical judgment.

The third step is the composition of metaphors and narratives for the purpose of

[131] Ibid. See also Bernard Goffinet, Ricardo Rozzi, Lily Lewis et al., 2012, *Miniature Forests of Cape Horn: Ecotourism with a hand lens* (Denton, TX: University of North Texas Press).

communication. It is worth noting that constitutive metaphors do not present themselves as random preliminary conversations or engaging in meaningless narratives. Rather, it is a re-consideration of the ecological or ethical issues raised as the fieldwork and subsequent research continue to progress, and a re-consideration of mosses based on the reflection of these issues. In addition, regarding mosses, it is worth pointing out that botanical gardens and conservation institutions such as in Chile and China have successfully constructed metaphors to facilitate biocultural communication, such as "miniature forests,"[132] "miniature angels,"[133] etc. Practice has shown that these metaphors have played a crucial role in bryophytes conservation. Therefore, the question may be whether constructing more metaphors or narratives becomes a redundancy. Or, if it is necessary to construct more metaphors or narratives, what purpose do they serve?

The fourth step is to implement *in situ* biocultural conservation, seeking to translate experiences and theories into pragmatic insights or policy recommendations. In this project, it would be important to explore the specific ecological and ethical issues in bryophytes biocultural conservation through the conservation of endemic diversity of southern Chile, or through conservation efforts in the Shenzhen Fairy Lake Botanical Garden, and through the way people interact with mosses in contemporary societies. This step also implies that we need to reflect on some of the moral problems that exist in a capitalized society, such as the massive gathering of mosses, moss farming, and the incorporation of mosses in the industrialized indoor

[132] Ibid.

[133] See Li Zhang, Qin Zuo, Hong, Baoying Hong, 2015, *The Miniature Angels in the Plant Kingdom* (《植物王國的小矮人》) (Macao, CHN: Department of Gardens and Green Areas, Civic and Municipal Affairs of Bureau of Macao Special Administrative Region).

greening, etc. If *in situ* conservation in Chile and *ex situ* conservation in China constitute positive paradigms, some of the ways in which people interact with mosses in our time are in stark contrast. The concept of co-inhabitance in biocultural conservation in the regional and global level demonstrates its conviviality. As I argue in the following chapters, conviviality carries an ethical lens.

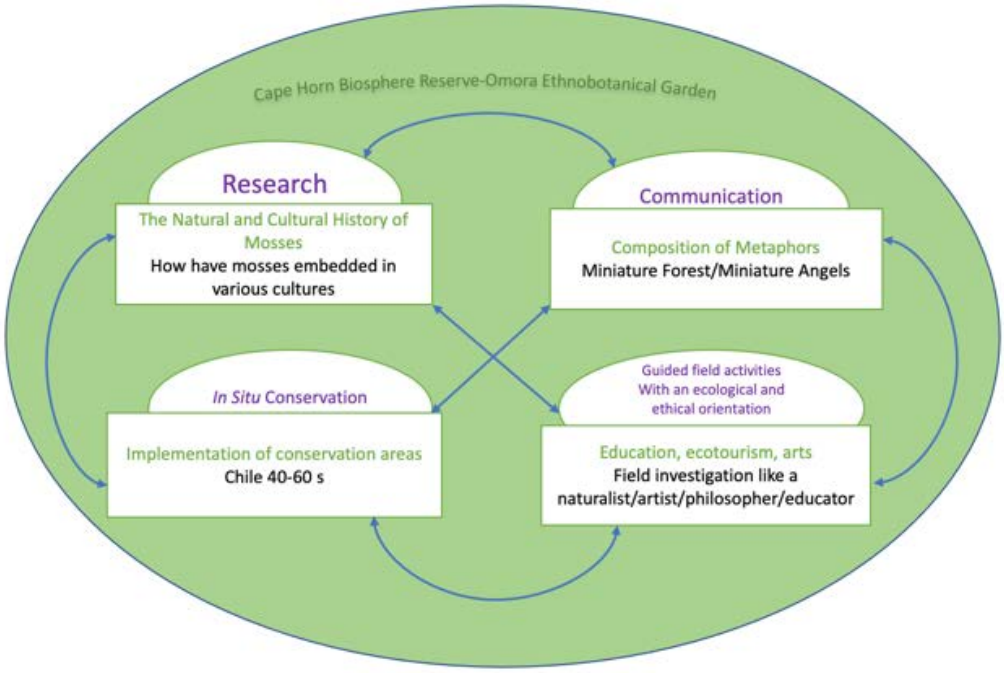


Figure 3.1: Four Steps of FEP.[134]

With the above-mentioned four steps, it becomes obvious what can be expected during different stages and the structure of this dissertation. Field trip initiates; research clarifies; communication creates; and conservation accomplishes. Before turning to my fieldwork in the

[134] The four steps were adjusted according to Rozzi, R., Anderson, C. B., Pizarro, J. C., Massardo, F., Medina, Y., et al. (2010). Field environmental philosophy and biocultural conservation at the Omora Ethnobotanical Park: Methodological approaches to broaden the ways of integrating the social component ("S") in long-term socio-ecological research (LTSER) sites. *Revista Chilena de Historia Natural*, 83(1), 27-68.

south, I think it is important to address the four main strengths of field environmental philosophy. Based on my superficial understanding, I believe that the main strengths of field environmental philosophy are interdisciplinarity, integration, contextualization, and a collaborative approach to knowledge and ethics.

3.1.2 The Merits of FEP

Rozzi places particular emphasis on interdisciplinary, especially in linking ecological science and environmental ethics, as there can be reciprocity between the two.[135] The interdisciplinarity runs counter to the strict delineation of and adherence to disciplinary boundaries, which tend to create barriers among various disciplines. Despite the growing clamor over the interdisciplinarity in the last decade, disciplinary barriers are by no means exaggerated, but occur within the institutionalization of academia. This point reminds me of my former experience as a faculty member in the department of philosophy, where a younger generation of scholars (graduate students) were often asked by the older generation to explain their interdisciplinary research projects as "pure" philosophical research. Emphasizing demarcation and boundaries frequently ignores the fact that knowledge is not isolated nodes or islands, and that our cognition has been embedded in epistemic networks since the formation of characters, numbers, arithmetic, and writing, as Renn illustrates with abundant examples, including but not limited to Greek sciences, medieval cosmological and geographical knowledge, thirteenth century knowledge of spheres, and the theory of general relativity.[136] In

[135] See Ricardo Rozzi, Juan J Armesto, Bernard Goffinet, et al., 2008, "Changing Lenses to Assess Biodiversity: Patterns of Species Richness in Sub-Antarctic Plants and Implications for Global Conservation."

[136] See Jürgen Renn, 2020, *The Evolution of Knowledge: Rethinking science for the Anthropocene* (Princeton, NJ: Princeton University Press), chapter 13.

Renn's ambitious historical research on the evolution of global knowledge, epistemic networks and the emergence of epistemic communities present themselves as self-organizing dynamics under interdisciplinary ventures. Renn's invigorating research of epistemic webs indicates that new problems, knowledge, fields, and communities usually emerge at the interdisciplinary belt, in his terms, where "borderline problems"[137] are produced. Thus, if knowledge is embedded in epistemic networks, interdisciplinary research is not only inevitable but also recommendable. Within this evolutionary scheme of knowledge, the emergence and development of environmental ethics is in no case an exception. In other words, interdisciplinarity has played significant roles in the evolvement of environmental philosophy. In an examination of the recent trend of environmental thoughts, some researchers also call for a reconfiguration of all academic fields and claim that all research with the prefix "eco-" is interdisciplinary investigation, such as ecocriticism, ecofeminism, ecopsychology, ecosociology, ecosophy, ecospirituality, ecotheology, ecotourism, and so on.[138] Interdisciplinarity is an inherent good for the sake of knowledge evolution and prosperity.

Field environmental philosophy facilitates and integrates biocultural education, environmental decision-making, ecosystem management, ecotourism, and *in situ* conservation. In other words, multi-dimensional characters of global environmental issues are incorporated into the continuum of the four-step loop. Field environmental philosophy situates itself in a wicked trend of biocultural homogenization, in which accelerated linguistic loss, cultural

[137] Ibid., p. 81 and p 427.

[138] See Aurélie Choné, Isabelle Hajek, Philippe Hamman, 2017, "Introduction: Rethinking the idea of nature," *Rethinking Nature: Challenging disciplinary boundaries* (New York, NY: Routledge).

assimilation, ecological degradation, and social-environmental injustice are all entwined.[139] In practicing field environmental philosophy, participants have the opportunity to engage in immersive activities, confront the ubiquitous biocultural loss, and come face-to-face with the few remaining vestiges of the world's biocultural diversity, thereby enhancing learning, research, and understanding. The interrelations among 3Hs (Habits, Habitats, and co-in-Habitants) at various levels (biophysical, symbolic-linguistic, and institutional-socio-political levels), and the common calling presented by contemporary ecological sciences, pre-Socratic Philosophy, non-mainstream Western philosophy, and various traditional ecological knowledges offer a vision of co-existence without sacrificing biocultural diversity.[140] This vision of co-existence demonstrates not only the integrity of field activities, but also the capacity of field environmental philosophy to develop communications and nurture relationships. Rozzi mentions how field environmental philosophy can integrate the epistemological and ethical dimensions of co-inhabitation,[141] as well as integrate social components with ecological research.[142] Other scholars highlight the integration capacities of the field environmental philosophy, such as integrating social components and biocultural education through designed

[139] See Ricardo Rozzi, Juan J Armesto, Bernard Goffinet, et al., 2008, "Changing Lenses to Assess Biodiversity: Patterns of Species Richness in Sub-Antarctic Plants and Implications for Global Conservation."

[140] Ricardo Rozzi, 2013, "Biocultural ethics: from biocultural homogenization toward biocultural conservation," in *Linking ecology and ethics for a changing World* (Springer, Dordrecht), pp. 9-32.

[141] Ibid.

[142] Ricardo Rozzi, Christopher B. Anderson, J. Cristóbal Pizarro et al, 2010, "Field environmental philosophy and biocultural conservation at the Omora Ethnobotanical Park: Methodological approaches to broaden the ways of integrating the social component ("S") in Long-Term Socio-Ecological Research (LTSER) Sites."

programs,[143] integrating ethical literacy and environmental education,[144] and integrating ecotourism and environmental education.[145] In Poole's collaborative work, researchers have illustrated various ways of integrating ethical literacy and environmental education through six existing programs. Each of these programs demonstrates that integration between ethical literacy and environmental education has become far more than just a pursuit of FEP-directed programs, but also a claim of many other environmental conservation programs.

Contextualization designates that field environmental philosophy adapts to the biocultural context in the regional and local level, that is to say, to restore vital ecological links and critical cultural habits. Field environmental philosophy has great potential to situate itself in local biocultural context and produce prosperous knowledge and field activities. Originally, field environmental philosophy emerged as a methodology to address the long-term social ecological issues in the Latin-American region, particularly in the Magellanic sub-Antarctic region of Chile. Subsequently, research from other regions was also involved in field environmental philosophy with productive effects such as restoring the lost biocultural links, environmental education, and other activities. For example, field environmental philosophy since 2007 has fostered restoration activities and revitalization of commons at the lake area of Kamoko on Sado Island, Japan.[146] Within the experiment on this Japanese island, various

[143] See Jorge F. Aguirre Sala, 2015, "Hermeneutics and field environmental philosophy: integrating ecological sciences and ethics into earth stewardship," in *Earth Stewardship* (Springer, Cham), pp. 235-247.

[144] Alexandria K. Poole, Eugene C. Hargrove, Philip Day, et al., 2013, "A call for ethics literacy in environmental education," in *Linking Ecology and Ethics for a Changing World* (Springer, Dordrecht), pp. 349-371.

[145] Alejandra Tauro, Jaime Ojeda, Terrance Caviness, et al., 2021, "Field environmental philosophy: A biocultural ethic approach to education and ecotourism for sustainability," *Sustainability* 13 (8): 4526.

[146] Mitsuyo Toyoda, 2018, "Revitalizing local commons: a democratic approach to collective management," in *From Biocultural Homogenization to Biocultural Conservation* (Springer, Cham), pp. 443-457.

participatory environmental projects such as environmental educational activities for local schools, conservation activities targeted at local citizens, and collaborative activities among different stakeholders have attracted public interest and gradually transformed people's relationship to their habitats. Another example of this contextualization comes from the online communication and collaborative forums with scholars from China's Jiuzhaigou Biosphere Reserve in 2020, who also present strong interest in incorporating field environmental philosophy into graduate programs and contextualizing field environmental philosophy to design activities for citizen environmental education, ecotourism, and local activities.

Collaborative approaches to knowledge and ethics call not only the collaboration among humans from different disciplines, but also for collaboration between humans and other-than-human beings. Field environmental philosophy has demonstrated collaboration in the first sense with copious case studies, such as in "Ecotourism with a Hand-Lens" (EHL) at Omora, which highlights the collaboration among ecologists, bryologists, philosophers, indigenous people, and local citizens.[147] In Japan's Kamoko region, philosophers, educators, local oyster farmers, and even KFC participate in the revitalizing project.[148] For collaboration in the second sense, as shown by the various field practices, there are few that do not involve other-than-human. In the case of EHL, bryophytes and lichens are of particular importance to field environmental philosophy practices. In another field activity, "open your eyes to dive," oysters, other invertebrates, and the marine ecosystems are important components of the field

[147] See Ricardo Rozzi, María Teresa La Valle, Shaun Russell, et al., 2020, "Ecotourism with a Hand-Lens: A Field Environmental Philosophy Experience from the South of the World," in *A Guide to Field Philosophy* (New York, NY: Routledge), pp. 222-239.

[148] See Toyoda, 2018, "Revitalizing local commons: a democratic approach to collective management."

activity.[149] Refusal to value these other-than-human beings as vividly presented in the field environmental philosophy would manifest itself not only as being confined by anthropocentrism or human exceptionalism, but also by arrogance. Collaboration in both senses counters my enduring bias that philosophy is independent thinking, an unallied and transcendental activity to unfold the scrolled, unveil the obscured, and unmask the covered. Perhaps this bias needs to be abandoned. Philosophy may be more than contemplative activity. More than that, it requires physical and mental engagement.

Based on the above four characteristics of field environmental philosophy, it now seems that field environmental philosophy is a way to meeting, to participate, to understand, to experience, and to welcome the presence of others.

3.2 Senda Darwin Biological Station: Recognize Bryophytes

Senda Darwin Biological Station (Estación Biológica Senda Darwin, EBSD) is located around 6 miles north of the town of Ancud on the northern coast of Chiloé Island, Chile. Serving as a private protected area (53 hectares) and an independent non-profit organization, it is administered by the Senda Darwin Foundation (FSD) with support from the Institute of Ecology and Biodiversity (Instituto de Ecologia y Biodiversida, IEB). The station is also satellite of the Chilean Network of Long-Term Socio-Ecological Studies Sites (LTSER-Chile) and the International Network of Long-Term Ecological Studies Sites (ILTER). It announces the mission as the following,

[149] See Ricardo Rozzi, 2019, "Taxonomic Chauvinism, No More! Antidotes from Hume, Darwin, and Biocultural Ethics"; and Alejandra Tauro, Jaime Ojeda, Terrance Caviness, et al., 2021, "Field environmental philosophy: A biocultural ethic approach to education and ecotourism for sustainability."

> to support scientific research, develop environmental education and promote the application of this knowledge for the conservation of biodiversity. Through these links, we seek to contribute to local and biosphere sustainability. [150]

The station has successfully provided the infrastructure to host workshops and seminars, develop projects and courses, and promote collaborations to link scientific knowledge, education, and application.[151] Since the inception of the station, the Institute of Ecology and Biodiversity has continually organized annual courses on "Ecology and Biodiversity of the Temperate Forests of South America" to train young professionals in ecology and related fields. From December 14 to 22, 2019, I attended the course and worked with a team specialized in bryophytes, which allowed me to begin an interspecies encounter with mosses in multiple dimensions. During the course, forest ecologist Juan Armestro, the president of the station and recently elected as "Miembro Correspondiente de la Academia Chilena de Ciencias" (Corresponding Member of the Chilean Academy of Sciences), and UNT professor Ricardo Rozzi guided the field trip of the moss team. We followed two trails in the protected area to identify bryophytes and lichens.

Bryophytes do not have a vascular system to transport water and nutrition. For that reason, they are negatively defined as non-vascular plants. They absorb water and nutrition from the environment. They grow on soils and rocks, attached to tree trunks, stumps, logs, wooded floor, peatland, and creek walls. They are found almost in all habitats except marine ecosystems. The diversity of bryophytes is enormous, with approximately 13,000 species of

[150] Cited from the website of EBSD at https://www.sendadarwin.cl/inicio/quienes-somos/, accessed on May 15, 2021.

[151] Juan Armesto, Ricardo Rozzi, and Mary F Willson, 1996, "Bridging scientific knowledge, education, and application in temperate ecosystems of southern South America," *Bulletin of the Ecological Society of America* 77(2), 120-122.

mosses, around 5,000 species of liverworts, and over 150 species of hornworts.[152] The three groups also possess their own, bewildering, and even tedious Latinized division names, mosses as *Bryophyta*, liverworts as *Marchantiophyta*, and hornworts as *Anthocerotophyta*. My encounter with mosses turns out to be an encounter with bryophytes, which opens a vast moss-cosmos in the sense that mosses as the most diversified division of bryophytes to represent in the three groups. As a novice, with zero bryological knowledge before walking on the trails, my utter amazement was mixed with perplexity when I was exposed to the endemic diversity of bryophytes in EBSD.

During field activities, Rozzi taught students to identify the three groups of bryophytes by looking at the morphological characters of the plants. To better understand these tiny plants, it was indispensable to return to the trail repeatedly with a digital camera and a hand lens. These instruments make a meeting possible. The following discussion provides a brief overview of the morphological differences of the three groups of plants and their visual magnificence in the landscape, aiming to reveal a progressive, complex, and collaborative learning process demonstrated by FEP, as well as the biophysical dimension of biocultural conservation.

The body structure of bryophytes is usually organized into three parts, namely, the sporophyte, the gametophyte, and the rhizoid (Figure 3.2). Rudimentary identification starts with the gametophyte, the main body part that provides nutrition to sporophyte and the

[152] Bernard Goffinet and A Jonathan Shaw, 2009, *Bryophytes Biology* (2nd edition) (New York, NY: Cambridge University Press), p. 1, p. 55, and p. 139.

dominant stage of the life circle of bryophytes.[153] When I was alone on the trail, I had to recall what Rozzi had taught us about the first principle of discerning the three: the gametophytes of all mosses present a radial symmetry (Figure 3.2, left), with leaves spirally arranged on the stem. Liverworts are either bilateral foliose or with flat thallus. For the hornworts, their gametophytes resemble those of thalloid liverworts, but different from liverworts in their horn-like sporophyte (Figure 3.2, middle and right).

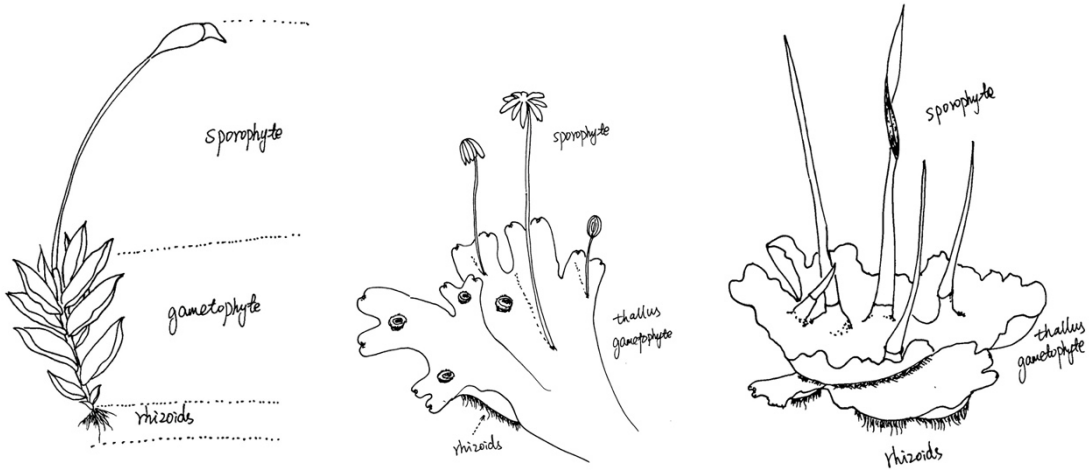


Figure 3.2: Body structure of moss, liverworts, and hornworts. [154]

The first principle of morphological differences is easy to memorize, but not so easy to practice. The reason is simple. Because in the field, tiny plants grow unusually intimately, huddled together, entwined, overlapping, and covering the earth (Figure 3.3). Rozzi knows non-vascular plants very well. At first glance, he could tell whether a tiny plant belongs to the group of bryophytes or not. But he also carefully exercised due diligence with his teaching in our field

[153] Ibid.

[154] The left, middle, and right drawings show respectively the body structure of moss and its spirally arranged leaves, liverworts with flat thallus, and hornworts with a horn-like sporophyte and flat thallus. All the drawings and photos in the dissertation were created by the author except those with source demonstration.

classroom. To ensure effective teaching and learning, he might intentionally emphasize some morphological characters presented by a plant to see whether the novice was already clear about the difference between vascular plants and non-vascular plants when they share similar morphological features. Tiny ferns with bilateral structure grow next to mosses; one must be cautious not to confuse them with liverworts. Unnamed seedlings poke out of the brown soil. Although these seedlings might have spiral structures, frequently they are not mosses. Furthermore, the novice must have been dazzled by the overwhelming diversity of bryophytes in the station. Rozzi had to ask repeated questions along the trail to make sure the novice was getting acquainted with bryophytes.

Gradually, based on their morphological features, in the station I learned to distinguish mosses from seedlings of other vascular plants, and to distinguish liverworts from ferns. The hand-lens are fantastic. With only ten-times magnification, it is quite convenient to observe these miniature plants. Some of the tiny plants weave a spectacularly large yellow-orange-red mat.

Figure 3.3: The occurrence of tiny plants on a log in EBSD.

Figure 3.4: The body structure of *Sphagnum magellanicum.*

A closer look reveals them to be moss, as all the leaves spiral tightly around the stems (Figure 3.4). Surprisedly, they are *Sphagnum magellanicum*. The genus *Sphagnum* is well-known for its various commercial uses and even novices know the genus name. Also, do not be perplexed by the similarity between the names of *Sphagnum magellanicum* and *Sphagnum fimbriatum*. Although they belong to the same genus, their morphological characteristics are quite different. Branches of *Sphagnum magellanicum* are sturdy and the leaves are spoon-shaped, while *Sphagnum fimbriatum* has thinner branches and more pointed leaves. In addition, *Sphagnum fimbriatum* is always green in color, in contrast to *Sphagnum magellanicum* which has a broader spectrum of warm colors.[155] When *Sphagnum magellanicum* takes over the peatlands (Figure 3.5) and is exposed to sufficient moisture and sunlight, the little plants huddle together and weave into autumn-inspired mats interspersed with vibrant warm colors, from transparent pink, gradually transitioning to moonbeam yellow,

[155] Goffinet, Rozzi, and Lewis, 2012, *Miniature forests of Cape Horn*, p. 408.

Indian yellow, cardinal red, ruby-red, and claret-red, etc. Apparently, the spectrum of the colors is far beyond my linguistic color literacy. Perhaps a color expert from Schminke or KILZ could match the rich, meticulous, and infinite tones of *Sphagnum magellanicum* with their professional color vocabulary.

Figure 3.5: *Sphagnum magellanicum* mat.

Another spectacular sight is cast by cushions of *Polytrichadelphus magellanicus*. The stems of this species are erect and mostly unbranched. In the station, *Polytrichadelphus magellanicus* shows varying shades of green in contrast to the various tones of warm colors of *Sphagnum magellanicum*. They grow in swampy areas. During the field class, as students gathered on the plank road to cross the peatland and the instructor explained the ecological succession of the landscape, densely huddled *Polytrichadelphus magellanicus* jutted upright from the land beneath the plank road. The cushion of *Polytrichadelphus magellanicus* appears to be undulating hills, covered by forest of emerald miniature pine forests. The brown stems at the bottom resemble tree trunks and near the apex resemble tree crowns. Each stem displays

an upright posture. What an intuitive, visually striking, and experiential encounter! This species exemplifies the radial structure of moss leaves under naked-eye observation; with a hand-lens, toothed edges of the leaves are visible. All moss species need photosynthesis to capture carbon dioxide and water to convert them into sugar for nutrition. The architecture of the leaf of *Polytrichadelphus magellanicus* is "designed to maximize photosynthetic efficiency."[156] The morphological features of the gametophytes are significant for understanding the physiological process of the species.

In Chiloé Island, the moss flora contains 134 species, distributed in 66 genera and 35 families.[157] According to research in 2007, 93 moss species have been identified within the station area,[158] which also formed the basis for the workshop of the moss team. The moss team conducted field activities to investigate species richness patterns in the two types of forest within the station. For other bryology, forestry, or ecology students, they made 3.9 inches by 3.9 inches (10 cm by 10 cm) boxes and took them into the field to collect samples. They were adept at marking the location of sampling sites, collecting digital evidence, observing samples under microscope in the lab to identify the species with greater accuracy, and analyzing whether there was any difference in species distribution between the older and younger forest. These are valuable hands-on learning experiences. For a philosophy student, I continued to

[156] Goffinet, Rozzi, and Lewis, 2012, *Miniature forests of Cape Horn*, p. 97.

[157] See Carolina Villagrán and Elizabeth Barrera, 2019, Musgos del Archipiélago de Chiloé, Chile (Mosses of the Chiloé Archipelago, Chile, EBSD workshops material). Fundación Senda Darwin (Senda Darwin Foundation).

[158] See Juan Larraín, 2007, "Musgos (Bryophyta) de la estación biológica Senda Darwin, Ancud, Isla de Chiloé, Chile. Claves para su identificación y lista de especies" (Mosses (Bryophyta) of Senda Darwin biological station, Ancud, Chiloé Island, Chile: Keys for identification and species list). Accessed on April 20, 2021, from the online library of EBSD at https://www.sendadarwin.cl/inicio/investigacion/biblioteca/.

indulge in the morphological features and the visual delightfulness. Other species that attracted my attention in the station include *Hypopterygium arbuscula Brid.* (a moss that resembles an umbrella), *Hypnum skottsbergii* (a feather-like moss), *Lophocolea bidentata* (a leafy liverworts with almost transparent bilateral leaves), *Rigodium implexum* (a moss with thin stems and branches), *Dicranoloma imponens* (a yellow-greenish moss with needle leaf ends), etc.

The learning experience in the station was my first serious encounter with mosses. The morphological characteristics of each non-vascular plant were unique enough to distinguish each from one another. When I was exposed to the diversity of bryophytes, I still had concerns and doubts about the feasibility of philosophizing about mosses. I had been apprehensive that these non-vascular plants did not have faces and that they might not respond to my questions. Additionally, I was also filled with other concerns, such as the high possibility of forming a barrier to recognizing the unique life of mosses, accepting their value, and capturing the wisdom that moss life conveys because of my superficial knowledge about them. These questions haunted me. But I also had to depart for the second field site as planned.

3.3 Reserva Nacional Magallanes: Recognize Lichens

On December 23, 2019, TC (a young bryologist, prospective coordinator of the Omora Park Program, and Robin Kimmerer's student), Jerry (my son), and I left Chiloé Island and arrived at Punta Arenas. The destination of my field investigation was Puerto Williams, the southernmost town on the Earth, and home to the Omora Ethnobotanical Park which exhibits the most endemic diversity of bryophytes. Before taking the ferryboat to Puerto Williams, we had to stay in Punta Arenas for three days to wait for the operation of the ferryboat, as it only runs twice per week. We stayed at the Casa Hotel Hain. According to the illustration of the

hotel, “Hain” in Selk’nam language means “Espacio y Ceremonia de Iniciación de los jóvenes en la vida adulta” (“Space and Ceremony of Initiation of young people into adult life”). At the hotel entrance, the walls were decorated with pictures of Selk’nam people, one of the three indigenous tribes in the Patagonian region. According to James Kelly, they had been hunted and murdered by settlers during the nineteenth century in exchange for money.[159] When I gazed at the images on the wall, I later realized that the Selk’nam people and their connection to the land had been erased. The drive and consequences of colonization and biocultural homogenization touched me even more dramatically. Biocultural homogenization produced something far beyond the substitution of roses and Mickey Mouse for native plants and cultural images of the local humans. In the reception area of the hotel, the walls were lined with a demonstration gallery of rock paintings, native trees, and other flowering plants endemic to southern Patagonia. On the reception desk, a female statue caught my attention because her body had been decorated with lichens. Could this statue be related to the mythological worldview of Selk’nam people? These lichens were not only found on the reception desk of the hotel, but also in many of the local souvenir stores, as I soon noticed.

Before taking the ferry, on December 25, we decided to hike the Magallanes National Reserve (Reserva Nacional Magallanes, MNR) and explore whether the difference in latitude would allow us to encounter different bryophytes and landscapes, since Punta Arenas is around 1,200 miles south of Chiloé. It took us five hours to complete the entire loop. Shortly after we encountered a brown rabbit and some birds of *Austral Thrush* foraging in the woods, we

[159] See James Kelly, 2017, “In Search of Paradise Lost in Tierra del Fuego,” *Earth Island Journal* (Earth Island Institute), retrieved on April 29, 2021, at: https://www.earthisland.org/journal/index.php/articles/entry/in_search_of_paradise_lost_in_tierra_del_fuego/.

realized that the landscape we were exposed to was quite different from the landscape of the Senda Darwin Biological Station. The station presents a horizontal mosaic of forest, prairie, and peatland. As for the Magallanes National Reserve, although it is merely 600 meters above sea level, it displays vertical difference in flora distribution. The lower landscape is forest and close to the apex it changes to meadow. In contrast to the flatness of the station, Magallanes National Reserve is corrugated with meandering creeks and valleys of varying depths.

The tourist brochure tells the history of the Magallanes National Reserve. It was created on February 13, 1932, to protect the hydrographic basin and empower natural recovery of the forest. Since1848, when settlers arrived in Punta Arenas, the forest has been exploited for activities such as deforestation, fire farming, introduction of livestock, coal mining, road construction, and recreation. In order to identify forest types in the Magallanes National Reserve, I attempted to learn the history of floristic zoning information in Chile. In 1981, Chilean botanist Donoso defined twelve forest types based on the dominant tree species in various ecoregions; in 1994, another Chilean botanist Gajardo described eight zones of vegetation in terms of plant community types. Gajardo's efforts were considered the "apex" of several centuries of botanical exploration since 1767, given that French naturalist Philibert Commerson (1727-1773) and the explorer Louis Bougainvelle (1729-1811) had first collected the flora of Chile. Three species dominate the flora of the Magallanes National Reserve according to our observations, namely, lenga (*Nothofagus pumilio*), coigüe (*Nothofagus betuloides*), and ñirre (*Nothofagus antarctica*). These three species belong to the same genus and the trick to identify them was their leaf margins. I had to draw the shape of their leaves in my notebook to avoid any confusion (Figure 3.6). In accordance with the floristic zoning of

Chile,[160] forests in the Senda Darwin Biological Station are typical Valdivian rainforest, containing "evergreen broadleaf trees and shrubs with waxy, dark green, laurel-like leaves."[161] The forest in the Magallanes National Reserve, on the other hand, is boggy Magellanic rainforest, usually coigüe dominated, "exposed to strong gale and heavy rain."[162] Because of the strong winds and heavy rains, these trees, along with the lichens on them, have developed their unique postures.

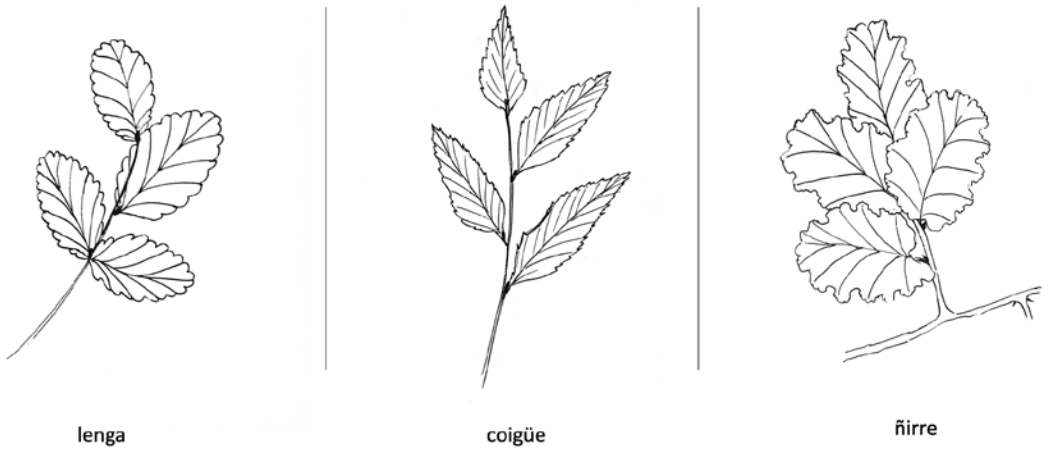


Figure 3.6: Drawing of the leaves of lenga, coigüe, and ñirre.

There was always much to learn and observe on the field trip along a forest hiking trail. In the beginning, by the side of the hiking trail in the lower forest, we were quickly drawn to Darwin's bread, or Pan de Indio (*Cyttaria darwinii*), a yellow fungus that parasitizes on the branches of coigüe trees. I wondered why this globular fungus was named "bread," no matter whether it was Darwin's bread or Pan de Indio (Indian's bread). In terms of color and shape,

[160] See Sharon Chester, 2008, *A Wildlife Guide to Chile: continental Chile, Chilean Antarctica, Easter Island, Juan Fernándex Archipelago* (Princeton, NJ: Princeton University Press).

[161] Ibid., p. 52.

[162] Ibid.

they resembled oranges rather than bread. As it turns out, the fungus had been the only vegetable food besides dwarf *Arbutus* that Yaghans ate, as documented by Darwin in 1835.[163] Learning this information, we could almost visualize that Yaghan people gathering the fungus in the forest. Nowadays, since no one collects the fungus for food, many of them fall on the trail, dehydrate, and decay.

As we walked deeper into the forest, various mosses and lichens presented striking patterns. Mosses in the Magallanes National Reserve appeared in the form of cushions. Using a hand-lens and with TC's professional help, I identified at least several species. For example, the sporophytes of *Bartramia mossmaniana* were hidden beneath the leaves. All the fascicular leaves of *Chorisodontium aciphyllum* straightly pointed upwards. *Acrocladium auriculatum* had many conspicuous sporophytes, with branches spreading and distinctly pointed (Figure 3.7).

Figure 3.7: Bryophytes observed in the Magallanes National Reserve and their scientific names.

At the Magallanes National Reserve, the diversity of lichens also attracted our attention. At the Senda Darwin Biological station, a variety of lichens also inhabited the tree trunks or branches. However, during my stay at the station, I was almost overwhelmed by the vibrant colors and diversity of the bryophytes. Although I did notice the tiny and delicate *Cladonia*

[163] Ibid., p. 58.

ustulata, a lichen with a red cap or ring at the apex, lichens somehow escaped my attention due to a lack of related knowledge, or epistemic deficiency. In other words, lichens were out of my epistemic scope, not only because they were different from bryophytes in taxonomy, but also because I knew very little about them. Lichens are also non-vascular plants which absorb nutrients and moisture in the air. Epistemic impoverishment generates invisibility and ignorance. That was the first lesson those lichens taught me.

Since the 1990s, biologists and ecologists have investigated the habitat ecology and geographic distribution of lichens in various biomes of southern Chile. One report shows that lichens in southern Chile comprises of 319 taxa in 87 genera.[164] According to their fieldwork report, this collection is incomplete due to "inaccessibility, complex topography and extent of the region,"[165] which in turn indicates the incompleteness of lichen knowledge. The survey also discloses that the highest diversity of lichens occurs in temperate rainforest, including the most common habitats such as the bark or branches of large trees, but not excluding other types of habitats such as rock outcrops, rotten logs, stumps, bogs, scrubs, soil, plant debris, trail edges, forest margins, and heaths.[166] The forest of Magallanes National Reserve offered me a great opportunity to fill in a bit of the huge gap in my knowledge of lichens. To a large extent, their own capacity to express themselves attracted my attention. This was clearly a sign that the non-vascular plants were speaking for themselves. As we hiked deeper into the forest, we soon discovered two spectacular phenomena in the Magallanes National Reserve. First, there was

[164] See Wanda Quilhot, Mauricio Cuellar, Rodrigo Diaz et al., 2012, "Lichens of Aisen, Southern Chile," *Gayana. Botánica*, 69(1), 57-87.

[165] Ibid., p. 59.

[166] Ibid.

rarely a coigüe trunk that was not inhabited by *Menegazzia magallanica*; and second, as we entered deeper into the coigüe forest, *Protousnea Magallanica* replaced *Menegazzia magallanica* and took the lead.

Menegazzia magallanica *Protousnea Magallanica*

Figure 3.8: The dominated lichens in MNR and their scientific names.

The species *Menegazzia magallanica* is endemic to the southernmost South America. It proliferates on the barks of coigüe trees with holes on the surface of the smoothy greenish-grey leaves. According to the joint research by Norwegian and Chilean universities,[167] the first holotype of the species was collected in 1896 at Punta Arenas and it was named in 1942 by Swedish lichenologists Rolf Santesson (1916-2013). The species is distributed between latitude $50^0$50' and $55^0$30'. In other words, we could expect another encounter with *Menegazzia magallanica* in the Omora Ethnobotanical Park. Lichenologists identified the key features of this species as "soralia variable; soredia numerous; perforations ± circular; occasionally fertile;

[167] See Jarle W Bjerke, Arve Elvebakk, and Wanda Quilhot, 2003, "Distribution and habitat ecology of the sorediate species of Menegazzia (Parmeliaceae, lichenized Ascomycota) in Chile," *Revista Chilena de Historia Natural* 76(1), 79-98.

stictic acid complex present,"[168] suggesting that a combination of morphological, physiological, and biochemical knowledge is necessary to identify the species. The photograph I took could display its morphological features, but not the other two (Figure 3.8, left). The species *Protousnea Magallanica* is a hair-like lichen (Figure 3.8, right). Therefore, it has an English common name "Old Man's Beard" and a Spanish name "Barba de Viejo." A more interesting fact is that non-European cultures also name this species based on its hair-like morphological feature. For example, in Mapuche language, this lichen was called "calcha" (hairs). Mapuche people pay particular attention to the habitats of hair-like lichens and other use, and respectively name them as "calchacura" (hairs of stone), "calchaliwen" (hairs of late tree), or "calchalawen" (hairs with medical properties).[169] Before taxonomists revised the scientific name of this lichen from *Usnea maganellanica* to *Protousnea Magallanica* in 2005, its scientific genus name had originated from the Arabic name "Ushnah,"[170] meaning "moss." This congruence among European, Arabic, and Mapuche traditional ecological knowledge regarding the Old Man's Beard lichen demonstrates the biocultural diversity on this planet. As Goffinett and Rozzi once claimed, "we co-inhabit at the cognitive and ethical intersections that emerge between the diverse living beings and the different languages and forms of ecological knowledge through which we interact with them."[171] Hence, in a sense, encountering the Old Man's Beard in the Magallanes National Reserve was also a terrific confrontation of the marvelous biocultural diversity of the planet. However, the ongoing climate change and other

[168] Ibid., p. 94.

[169] Goffinet, Rozzi, and Lewis, 2012, *Miniature Forests of Cape Horn*, p. 66.

[170] Ibid., pp. 64-67.

[171] Ibid., p. 64.

environmental degradation have exacerbated species extinction, leaving “Old Man’s Beard” not immune. The species was once widely distributed throughout the planet. Contemporarily, it no longer grows in Europe and other regions where the level of air pollution makes the species unviable. This is because the species is very sensitive to air pollutants, particularly sulfur dioxide. Southern Chile might be one of its last few sanctuaries.

The Magallanes National Reserve trip was a journey of openness, discovery, and connection. Openness lies in the ability of lichens to present themselves. Discovery allows me to see the presence of lichens and thus examine my own cognitive biases. In getting to know *Protousnea Magallanica*, I further perceived the biocultural diversity of the planet. Connection meant that I experienced a kind of meeting from the perspective of Levinas. As we climbed to the topmost meadow of the reserve, we encountered a storm. Strong winds were mixed with vehement rain, and despite wearing waterproof clothes, we could hear the snap of raindrops on our clothes. Isn’t this the above-mentioned “strong gale and heavy rain”? I experienced what these coigüe trees and lichens experience regularly. This gale and rain made me empathize with the conditions under which lichens and coigüe trees survive. Walking on the meadow also stirred up an indescribable sense of nostalgia, reminding me of the alpine meadows of the Qinling Mountains in China, the watershed between the northern and southern rivers of China, where the southern and northern winds meet, and where Giant Pandas live. At the Magallanes National Reserve, the wind from the Pacific Ocean meets the wind from the Atlantic Ocean. In high winds and rain, we were jubilant in response.

3.4 Omora Ethnobotanical Park: Habits and Co-inhabitation

On December 26, 2019, we took the ferryboat and departed for Puerto Williams. We

arrived at Navarino Island harbor at dusk the next day in light rain. The field station, cofounded by IEB, UNT, LTSER-Chile, and UM, is in a higher position of the town. From the second floor, one could enjoy a panorama view of Puerto Williams, the Beagle Channel, and mountains around. On the third day, TC guided me on a field trip to the Omora Ethnobotanical Park to visit the miniature forest of Cape Horn. The interdisciplinary, multi-dimensional, and collaborative characteristics (ref. 3.1) of field environmental philosophy proved to be highly illuminating, entertaining, and productive, without disrupting the integrity of learning. "Integrity" designates to what Robin Kimmerer means about engaging one's mind, body, emotion, and spirit to learn, as I mentioned earlier in the introductory chapter. In this section, I describe my learning process at Omora and the accomplishments that resulted from the application of field environmental philosophy, particularly regarding the habits of non-vascular plants and the conception of living together within the framework of the 3Hs of biocultural ethics.

At the entrance of the miniature forest trail, a wood board informed me that "the miniature forest of Cape Horn represents a biodiversity hotspot with over 1,500 small species." That is to say, the Cape Horn Biosphere Reserve, which covers less than 0.01% of the Earth's surface, shelters 5% of the world's bryophytes diversity.[172] Although the miniature trail of Omora does not exhibit all 1500 species, it displays a tremendous amount of diversity, with the highest concentration of my three field sites. In Omora, images of bryophytes and lichens were engraved on wood boards to help visitors identify these small plants. For those seeking more

[172] See Ricardo Rozzi, Christopher B. Anderson, J. Cristóbal Pizarro, et al, 2010, "Field environmental philosophy and biocultural conservation at the Omora Ethnobotanical Park: Methodological approaches to broaden the ways of integrating the social component ("S") in Long-Term Socio-Ecological Research (LTSER) Sites."

scientific accuracy, visitors can also refer to the labels with their scientific names next to many of the bryophytes.

Figure 3.9: Rehydration experiment on *Syntricha* sp., before and after.

The diversity, morphological characteristics, growth forms, economic value, and intimate co-occurrence of bryophytes with other plants reveals a fascinating and treasured world of miniature plants during the two previous field trips. The purpose of the field activities in Omora was to recognize the habits of mosses and their co-habitation with other organisms, including humans. In the field activity at the Senda Darwin Biological Station documented in section 1.2, Rozzi described the resilient survival strategy of non-vascular plants to absorb water and nutrients from the environment. In Omora, to visualize the unique capacity of bryophytes to capture water, TC did a saturation experiment on dehydrated *Syntrichia*. The genus is renowned for its extreme tolerance of drought and quick rehydrated resuscitation. Once water was poured into the yellow, curled, withered *Syntrichia sp.*, it turned green, stretched, and vibrant within a minute (Figure 3.9). For evolutionary biologists, this incredible resilience has allowed bryophytes to survive more than 400 million years of sporadic planetary

catastrophes or extreme climatic conditions, assuming that these 400 million years are in no case similar to the uniformed and static Holocene.

In accordance with the genus *Syntrichia*'s resilient survival strategy, the genus *Sphagnum*'s extraordinary habit of containing water to 200 times more than dehydrated condition, makes people throughout the world use them as "diaper and bandage materials"[173] and "germination beds and growth medium for orchids."[174] When *Sphagnum* form peatland, they provide invaluable ecosystem services to human society such as acting as a hydrological buffer zone against flooding, filtering groundwater, preserving ecological information, regulating atmospheric quality, and serving as an energy reservoir. [175] These ecosystem services have also contributed to peatland restoration, where developing *Sphagnum* mats has become one of the most important restoration goals and *Sphagnum* mosses have become key plants in peatland restoration.[176] In previous field investigation, Chilean ecologists have demarcated two types of peatlands in Chiloé Island, namely, primary/natural and secondary/anthropogenic peatlands.[177] Anthropogenic peatlands were generated by human activities and were referred to as "pomponales." Why are they called "pomponales?" People named *Sphagnum* mosses

[173] Goffinet, Rozzi, and Lewis, 2012, *Miniature Forests of Cape Horn*, p. 254.

[174] Line Rochefort, 2000, "Sphagnum: A keystone genus in habitat restoration," *The Bryologist* 103(3), 503-508, p. 503.

[175] Although the concept of ecosystem services has encountered criticism from many perspectives, such as from environmental ethics, human-nature relations, conflicts with the concept of biodiversity, and too much focus on economic discourse, further research has shown that these criticisms and their counterarguments have in fact contributed greatly to developing the concept in greater depth. See Matthias Schröter, Emma H. Van der Zanden, Alexander PE van Oudenhoven, et al. (2014). "Ecosystem services as a contested concept: a synthesis of critique and counter-arguments." *Conservation Letters* 7(6), 514-523.

[176] See Rochefort, 2000, "Sphagnum: A keystone genus in habitat restoration," p. 504.

[177] See Martín R Carmona, JC Aravena, Marcela A Bustamante-Sanchez, et al., 2010, "Senda Darwin Biological Station: Long-term ecological research at the interface between science and society," *Revista Chilena de History Natural* (Santiago, Chile), 83, 113-142.

"pompon", evidently referring to the morphological characters of the gametophytes of the genus.

In Omora, to better understand the co-inhabitation within the 3Hs framework of bicultural ethic, I conducted field surveys of non-vascular plants in a variety of habitats. With TC's guidance and frequent communication with Rozzi, I categorized habitats into three types, namely, tree barks/branches, soil, and rock surface. Considering that one step of field environmental philosophy is to construct meaningful metaphors to communicate with citizens, Rozzi also suggested that I draw the species and name them metaphorically because most non-vascular plants do not have common names. As Robin Kimmerer once explained, "mosses don't usually have common names, for no one has bothered with them."[178] The lengthy scientific names of bryophytes frustrate even novice students majoring in bryology. Some struggle with recording their scientific names. Absolutely, constructing metaphors to name mosses in Omora would be a challenge. Given my meager knowledge of non-vascular plants, the metaphoric nomenclature relied almost entirely on morphological features that I have observed. Working closely with TC proved once again that his expertise rescued me from my paucity in bryophytes classification.

Over the next few days, TC and I collected approximately twenty samples from a variety of habitats around the town rather than in Omora. These samples were taken back to the lab of the station, where we would place the stem, or a leaf under a microscope to observe its structure. Based on the morphological features we observed, along with TC's professional

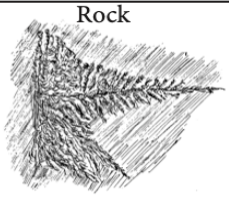
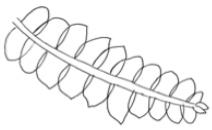
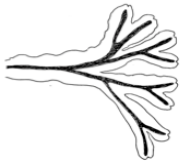
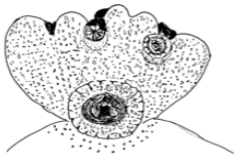
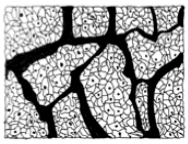
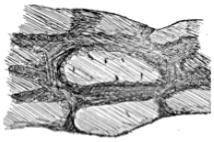
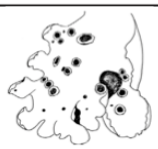
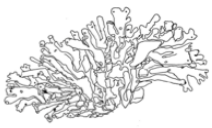
[178] See Kimmerer, 2003, *Gathering Moss*, p. 2.

judgment, and repeated review of a taxonomic manual that described the principles of identifying bryophytes, we were capable to identify all species and confirm their scientific names. The thought pattern in identifying the scientific names in the manual was comparable to the process of searching for a word in a dictionary. Similar to how dictionaries are usually arranged in an alphabetical sequence, the manual book of bryophytes classification is arranged in the order in which morphological characters are observed, from growth form, stem, leaf shape, leaf edges, to even cellular structure. All collected samples of non-vascular plants were shown in Table 3.1 except *Plagiochila elata*, which was added to the table after the field trip based on *Briofitas de los Bosques Templados de Chile* (*Bryophytes of the Temperate Forests of Chile*).[179] Under scientific names, I list the metaphorical names I have coined. Each metaphorical name was constructed based on the typical morphological characteristics or habitats of the species, or by analogy to other entities. Due to ethical concern, we did not collect samples directly from OEP, but from areas around the town.

Formerly, I have questioned whether this activity of constructing more metaphoric names was redundant. At this point, I must be clear that this process of naming a species has allowed me to employ my imagination to get better at learning. Although I do not wish to improperly belittle myself, I have to say that the metaphorical names recorded in ancient literatures are far more tantalizing than the ones I have listed in the Table 3.1. I discuss those fascinating names and the nomenclature of bryophytes in chapter 4.

[179] See Victor Ardiles Huerta, Jorge Cuvertino Santoni, Felipe Osorio Zúñiga et al, 2008, *Briófitas de los bosques templados de Chile: una introducción al mundo de los musgos, hepáticas y antocerotes: guía de campo* (*Bryophytes of Chile's Temperate Forests: An Introduction to the World of Mosses, Liverworts, and Anthocerotes: A Field Guide*). Chile.

Table 3.1: Non-vascular plant samples (mosses, liverworts, and lichens) in various habitats (rocks, soil, and barks) around OEP region.

Co-Inhabitant	Habit	Habitat: Rock	Habitat: Soil	Habitat: Bark
Moss	Pleurocarp	 *Brachythecium paradoxum* "The spreading"	 *Brachythecium subplicatum* "Clustering"	 *Hypnum skottsbergii* "Green feather on the log"
	Acrocarp	 *Orthotrichum rupestre* "The moss on the rock"	 *Polytrichadelphus magellanicus* "Star moss"	 *Ulota magallanica* "Cadillo on the twig"
Liverwort	Leafy	 *Syzygiella jacquinotii* "Translucency"	 *Noteroclada confluens* "Cicada's wing"	 *Plagiochila elata* "Featherwort"
	Thallose	 *Symphyogyna circinata* "Slingshots"	 *Marchantia berteroana* "Bellver castle"	 *Metageria decipiens* "Ramifying"
Lichen	Crustose	 *Porpidia crustulata* "The littles"	 *Diploschistes scruposus* "Similar Vein"	 *Chrysothrix candelaris* "The Yellow"
	Fruticose	 *Ramalina terebrata* "The bride with white hair"	 *Cladonia usulata* "Hoodwinked"	 *Cladonia arahinae* "Trumpet"
	Leafy	 *Nephroma parile* "Ear of the rock"	 *Pseudocyphellaria freycinetii* "Ruby embedded on jade"	 *Menegazzia magallanica* "Fractal"

In Omora, a focus on habits of bryophytes evoked further investigation of the growth forms of bryophytes and lichen, and how they dwell in various habitats. For example, when a species forms a mat or a cushion, the elements that determine these structures are observable to the naked eyes. Previously, in the Senda Darwin Biological Station, the very stunning and spectacular mat of *Sphagnum magellanicum* communities led me learn slightly more about their entanglement with humans. Their appearance might have been influenced by human activities. For instance, in the station, human disturbances such as burning, clearcutting, and peat mosses in Chiloé during the twentieth century. Chilean ecologists recommended assessing more recently commercial use of *Sphagnum magellanicum* in horticulture have exploited the peatland ecosystems, researching hydrology, conducting experiments to evaluate *Sphagnum* regeneration, and promoting magellanicum mat might still not exist. The co-inhabitance between humans and bryophytes is entangled with the dynamics of the various activities embedded in large socio-environmental context.

Regarding growth forms, or the general appearance of bryophytes colony, British bryologist Gimingham and Robinson recognize and define at least five major growth forms: cushions, turfs, miniature forest, mats, and wefts.[180] Each of these has sub-forms except for miniature forest. Based on light intensity, humidity, and other environmental conditions, they analyze the occurrence of colony types in various habitats such as pine-litter, rock-surface, and boulder-top debris. They also differentiate rocks in mountain streams, by lakeside, on limestone fells, on silicious fells, on walls, etc. According to their research, there are five general

[180] CH Gimingham and ET Robertson, 1950, "Preliminary investigations on the structure of bryophytic communities," *Transactions of the British Bryological Society* 1(4), 330-344.

appearances related to growth forms in different habitats, such as “individual shoot” and “type of branching.”[181] For example, tall turf grows at relatively high humidity, and short turf grows particularly well in high light conditions. In Omora, I observed all five appearances of bryophytes community.

3.5 Conclusion

From the above description of the field environmental philosophy and my field activities at the three sites, it does highlight its four main strengths discussed in 3.1, namely, interdisciplinarity, integration of learning and research, contextualization, and the importance of collaboration for cognitive and ethical thinking. In terms of the last major strength, the close collaboration with Rozzi, the moss team in the Senda Darwin Biological Station, the young bryologist TC, and other researchers at the Omora field station were indispensable to the success of the field activities. In fieldwork, bryophytes and lichens do have their own ways of displaying and expressing themselves through unique morphological features, their habits, and entangled co-inhabitation with other species. In getting to know them, part of my cognitive bias was corrected. More than that, the vastness of the moss-cosmos demands that I remain open to epistemological, aesthetic, and ethical thinking. By the end of chapter 3, my final thought is that, whether according to evolutionary biology or other theories of the origin of life, human life appears either extremely short compared to the life history of bryophytes or, although not extremely short, appears still later than that of moss plants. There is intelligence and wisdom in the fragility, endurance, and resilience reflected in the survival strategies of these tiny plants.

[181] Ibid.

In learning about the ecosystem services provided by peat mosses and other moss species, I also realized that the justice/injustice perspective presented at the beginning of the dissertation might have the potential to be interpreted from other angles. Injustice may seem to be simply that human activities have triggered the adverse living conditions of mosses, their retreat from the forest, or even extinction. However, from the perspective of ecosystem services, I think that ecosystem services could be understood as a kind of care provided by mosses, that is, mosses as caregivers have shown benevolence just by their existence. The difficulties of the worsening of their living conditions, their retreat and extinction caused by human activities is that we deprived them of the possibility to show their benevolence and realize their care-giving gift. Any other ethical language would seem to pale before the phrase "deprive them of the ability to care." In thinking about this point, I realize that my doubts in section 3.2 are misplaced and extraneous. If I want to capture the fleeting light between my encounter with mosses, it is not about me, but about the alterity inside of me, the possibility of mosses as thou, about human-moss as *I-Thou*, about the emergence of meaning between an *I* and mosses.

CHAPTER 4

MOSSY NOMENCLATURE, MEANING, AND CULTURING

> *Now the LORD God had formed out of the ground all the wild animals and all the birds in the sky. He brought them to the man to see what he would name them; and whatever the man called each living creature, that was its name.*
>
> Genesis 2: 19, NIV

In this chapter, I focus on the names of bryophytes. According to Gagliano and her collaborators' distinction of the language of plants between extrinsic and intrinsic language, this chapter handles the extrinsic language of mosses, viz. "the ways scientists, theorists, writers, and others express what is 'peculiar' about plant being,"[182] about moss being. Through a multi-linguistic approach, I examine the binomial nomenclature in bryology, Chinese traditional nomenclature of bryophytes-related plants, and modern Chinese nomenclature of bryophytes. In contrast to tedious scientific names, traditional nomenclature appears simple and straightforward. Naming mosses shows the different ways in which people live and interact with mosses.

4.1 Binomial Nomenclature: The Linnaean and Phylogenetic Systems

Non-vascular plants are itty-bitty. Not as conspicuous as most vascular plants, their unique capacity to convert barren earth into green land has earned them an iconic name, "the pioneers." Carolus Linnaeus (1707-1778), the renowned Swedish naturalist and taxonomist, opened his introduction to the plant Kingdom with a description of the pioneering, guarding, and enduring abilities of bryophytes,

[182] Gagliano et al., 2017, "Introduction," *The Language of Plants*, p. xvii.

> … the Vegetable Kingdom offers itself to our contemplation. Of all its productions, the first covering of the earth was furnished by the wintry mosses; of such variety in their forms, that they scarcely yield to herbs in number; and although extremely minute, yet of so admirable a structure, that they undoubtedly excel the stately Palms of India. These mosses are dried up in summer, but in winter they revive, and in the early spring guard the roots of other plants from cold, as they afterwards do from the injuries of summer suns. [183]

Mosses were apparently not invisible to Linnaeus. He valued how the life circles of mosses could add up to the Kingdom of plants. For him, learning about the Kingdoms of fossils, plants, and animals was "leisure with enjoyment," "a veneration for the Deity," and to "examine the admirable works of his Creator." [184] Identifying and naming them was a requisite for this examination activity.

When a rudimentary naturalist encounters mosses on a field trip, a good place to start is to determine the species' scientific name in the binomial naming system through field identification. As introduced in chapter 3, I identified around twenty species' scientific names based on their morphological characteristics in conjunction with the book *Miniature Forests of Cape Horn* and an extra identification manual. As I explained earlier, mosses are just one of the three groups of bryophytes. In non-academic contexts, the word *mosses* is often employed to designate all three groups of bryophytes. In everyday communication, amateur bryologists might invent common names based on their habitats or morphological features. For instance, some moss gardeners invent names such as "tree moss," "rock moss," "lawn moss," "woodland moss," "feather moss," "fern moss," "rose moss," "umbrella moss," etc.[185] For scientific

[183] Carl von Linnaeus, 1785, *Reflections on the Study of Nature* (UK: G. Nicol), pp. 6-7.

[184] Ibid., pp. 19-24.

[185] George Schenk, 1997, *Moss Gardening: Including lichens, liverworts, and other miniatures* (Portland, OR: Timber Press), pp. 17-18.

purposes, these names are not accurate enough to designate the specific species or appropriate for precise biological and ecological communication.

Every bryophyte has a scientific name, actual or potential (names of unknown species are yet to be invented). For humans, each individual person possesses a name as part of that person's identity. However, in botany and zoology, individual plants and animals do not have their own names, unless certain individuals are assigned a name for some reason, as pets often have their names, a privilege of being humans' companions. All organisms in botany and zoology are named after their species name, just as all human beings share the same name "*Homo sapiens*," the taxonomic binomial species name for modern humans. It is well-known that "*Homo sapiens*" was coined by Linnaeus. The genus name "*Homo*" is derived from Latin "*Homō*" (human) and the species name, Latin word "*sapiens*" means "wise" and "knowledgeable." This binomial nomenclature, a combination of capitalized generic name (usually a Latin singular noun) and a specific name (usually a Latin adjective or noun), devotes to name all organisms in nature. It was not a coincidence that Carolus Linnaeus was commonly recognized as the Second Adam.

In binomial nomenclature, although biologists have established code systems in principle to name the two parts of a scientific name, both names might carry meaning, rather than as some biologists claim, "most taxon names in biology have little or no meaning in and of themselves …the names themselves become meaningful only when the concepts attached to them are understood."[186] Archaeological difficulty in proving or verifying the meaning of a

[186] Randall T Schuh, 2003, "The Linnaean system and its 250-year persistence," *Botanical Review*, 69(1), 59-78, p. 61.

binomial name does not mean that the name is not meaningful at all. This can be demonstrated by the following examples. For the first part, the generic name might be invented for several reasons. The expression of morphological characters could be a source of generic names. For example, *Brachythecium subplicatum*, a moss which is distributed in southern South America and New Zealand, derives its generic name from its morphological characteristics, as Brachythecium is dissected into *Brachy-* (short, stout) and *-thereon* (little vessel, container), possibly alluding to the short and fat leaves while they harbor adequate water. Another example is *Conostomum pentastichum*, a cosmopolitan moss. Its genus name "*Conostomum*" is a combination of *cones-* (cone) and *-stoma* (mouth), "referring to the characteristic cone shaped peristome of these mosses."[187] The genus name of mosses could also be derived from a person's name, usually a botanist or bryologist. For instance, *Grimmia trichophylla*, a cosmopolitan moss that grows on bare rocks, was given its genus name *Grimmia* after John F. K. Grimm (1737-1821), a German physician and botanist. *Grimmia* was coined by Jacob F. Ehrhart (1742-1795), who was also a German botanist and a student of Carl Linnaeus. He coined the genus name *Grimmia* in memory of Grimm.[188] Another example would be *Marchantia berteroana*, a liverwort of the Southern Hemisphere, which can be easily identified from its morphological characters. However, its genus name *Marchantia* does not match its morphological features, and it was named after Nicolas Marchant (d. 1678), a French pharmacist and botanist, who was also "director of horticulture at the Jardin du Roi and a

[187] Goffinet, Rozzi, and Lewis et al., 2012, *Miniature Forests of Cape Horn*, p. 208.

[188] David Meagher, 2011, "An etymology of Australian bryophyte genera. 2 – Mosses," *Muelleria* 29(1), 33-61, p. 43.

favorite of Gaston Duc d'Orléans."[189] His son Jean Marchant (1650-1738) coined the genus name *Marchantia* to honor his father. A third way to derive a genus name is to indicate the usage of the species. For example, *Hypnum skottsbergii* is a moss that inhabits tree trunks and logs with leaves that strongly bent and curved in one direction. The genus name *Hypnum* was derived from *Hypno* (sleep), alluding to the ancient use of this genus as "filler for pillows and cushions."[190]

The second part of a scientific name in the binomial taxonomy is the species name, which identifies the species in the genus. The derivation of the species name is intriguing as it must be consistent with the genus name in terms of grammatical gender, namely, masculine, feminine, or neuter. Thus, in binomial nomenclature, the Latin adjectives of the species names also correspond to the genus names with three genders, indicated by the suffixes of the adjectives. For example, for *Hypnum skottsbergii*, both Latin words are neuter. As to whether the grammatical gender of a species' scientific name is somehow necessarily linked to the biological characters of that species, it is a riddle. In addition to being consistent in grammatical gender, the specific name of a species may address some specific characteristics of the species, such as geographic distribution or morphological features. In terms of geographical distribution, examples are *Blindia magellanica*, *Sphagnum magellanicium*, *Ulota magellanica*, and *Gackstroemia magellanica*, designating species endemic to the Magallanes and Chilean Antarctica Region, including Torres del Paine, Cape Horn, Tierra del Fuego Island, and the Strait

[189] David Meagher, 2008, "An Etymology of Australian Bryophyte Genera. 1 – Liverworts and Hornworts," *Fieldiana Botany* 47, 257-269. https://doi.org/10.3158/0015-0746-47.1.257.

[190] Goffinet, Rozzi, and Lewis et al., 2012, *Miniature Forests of Cape Horn*, p. 220.

of Magellan. These four species share similar specific names, but not their generic names, which makes it possible that each binomial name matches only one species. Similarly, *Trichocolepsis tsinlingensis* indicates that the species is endemic to the Qinling Mountains. As I mentioned in the previous chapter, the Qinling Mountains are an east-west mountain range in central China, a watershed between northern and southern rivers, and home to Giant Pandas. *Dicranum japanicum* is a species distributed in Japan, Korea, and east China. In terms of morphological characters, examples are *Dicranoloma robustum*, *Orthotrichum crassifolium*, and *Conostomum pentastichum*. For the second part of those three binomial names, *robustum* (strong and robust) refers to the grand size of this robust moss;[191] *crassifolium* is likely combined by *crassus* (thick) and *folium* (leaf), referring to the thick-leafed stem; and *pentastichum* is combined by *penta* (five) and *stichus* (march in line or order), refers to "the leaves inserted in five ranks."[192]

In 1735, Linnaeus published his *Systema Naturae* and created the ranks of hierarchical taxonomy in which the natural world was divided into three kingdoms, namely, the Fossil Kingdom, the Vegetable Kingdom, and the Animal Kingdom. Subsequently and successively, he then classified each Kingdom into classes, orders, genera, and species. For more than 250 years, taxonomists have combined this hierarchy and nomenclature to name more than two million species of organisms on Earth, including bryophytes. Knowing the generic and specific names of a species in Linnaean hierarchy basically means that biologists have the information regarding the relationships of organisms based on the Linnaean hierarchy.

[191] Ibid., p. 212.

[192] Ibid., p. 208.

However, in 1994, some vertebrate and herpetological researchers proposed to replace the Linnaean system with a phylogenetic nomenclature system because "the current nomenclatural system's basis in Linnaean taxonomic categories promotes neither explicitness, universality nor stability with regard to the phylogenetic meanings of taxon names."[193] They considered biological nomenclature as the fundamental language and tool for scientific communication, arguing that it must be unambiguous, explicit, universal, and stable because the link between name and taxon must be a one-to-one relationship. They also challenged the Linnaean system, accusing its non-evolutionary character,

> although the first international codes of nomenclature came into existence after the publication of On the Origin of Species and currently include elements that were not present in Linnaeus' work, the codes are Linnaean rather than evolutionary in that their most fundamental concepts and principles are based on the Linnaean taxonomic categories. Moreover, these concepts and principles make reference neither to common descent nor to any other evolutionary phenomenon. But most importantly, under evolutionary interpretations of higher taxa and their names, the current system fails to accomplish its own stated purpose.[194]

In their proposal, they further raised a practical question regarding the lumping or splitting of a species, and the resulting change in name and designation. Lumping induces a more inclusive taxa and splitting induces the reverse. The result of lumping and splitting might move a species from one biological taxa to another, or change its scientific name, or even cause it to lose its scientific name. The phylogenetic system, as de Queiroz and Gauthier have stated, is devoted to establishing a pairwise match between taxon names and monophyletic (one-tribe) taxa so that evolutionary relationships among species can be determined. When all members of a group of

[193] See Kevin de Queiroz and Jacques Gauthier, 1994, "Toward a phylogenetic system of biological nomenclature," *Trends in Ecology & Evolution* 9(1), 27-31, p. 28.

[194] Ibid., p. 27.

organisms share the same ancestor, they form an evolutionary clade, i.e., a single branch on the "tree of life." Molecular biology and DNA barcoding have become promising technical tools in clarifying monophyletic relationships, which has made phylogenetic systems highly acclaimed in the last two decades.

The first draft of the International Code of Phylogenetic Nomenclature (PhyloCode) was created on April 8, 2010. It has been revised gradually and the newest version was updated on June 6, 2020.[195] Since the proposal of the phylogenetic nomenclature, there has been persistent debates between the Linnaean system and the phylogenetic system among biologists, taxonomists, and philosophers. The advocators on both sides have debated the merits and flaws of both systems.

In terms of the transition from the Linnaean binomial system to other systems, Samir Okasha's succinct but profound insight captures the change in the underlying scientific worldview,

> … Linnaeus belonged to the pre-Darwinian era and was a devout Christian who accepted the biblical story of creation. He regarded his classification system as an attempt to discover the objective, eternal divisions between living organisms that God had created. For Linnaeus, the idea that contemporary species are descended from common ancestors would have been entirely foreign. … The key idea of phylogenetic systematics is that classification should 'reflect evolutionary history', that is, species should be grouped according to how closely related they are. More precisely, all taxonomic groups above the species level, be they genera, families, orders, or whatever, are required to be monophyletic, according to phylogenetic systematics.[196]

Narrowing to the sphere of botanical nomenclature, Dan H. Nicolson conducted a thorough

[195] See http://phylonames.org/code/.

[196] Samir Okasha, 2019, *Philosophy of Biology: A very short introduction* (New York, NY: Oxford University Press), pp, 65-77.

comprehensive chronological study of the changes in different code systems, dividing the history of botanical nomenclature into three overlapping stages: the schismatic period (1840-1930), the dark age (1915-1950), and the IAPT renaissance (1950-).[197] In 1950, the Stockholm Congress established the International Association for Plant Taxonomy (IAPT) and published the journal *Taxon*, which forged the frontier for subsequent coding, grouping, and classifying amendments. During the 1990s and beyond, the debates between multiple schemes and systems became increasingly acrimonious. The debate is closely related to the understanding of what constitutes a species. I will elaborate on the different definitions of the concept of species as understood by researchers in the coming section. Bryologists such as Jonathan Shaw, Karen S. Renzaglia, and Brent D. Mishler have contributed to the debates. In section 3.3, I discuss how bryologists have positioned themselves in the debates.

4.2 A Rabbit Hole: The Species Problem

This subsection is devoted to exploring the various species concepts that have emerged in recent decades and how biologists understand the ontological status of species. It is not intended to be an exhaustive explanation of species concepts from the Linnaean ranking system to the latest phylogenetic system. But because biological nomenclature is closely related to classification and taxonomy, this section begins with a brief timeline of the corresponding debates among biologists, taxonomists, and philosophers, with a focus on the philosophical issues that accompany the general species problem. The practical issue here is that, to some extent, the species problem is unavoidable because species are not only the basic units and

[197] Dan H. Nicolson, 1991, "A History of Botanical Nomenclature," *Annals of the Missouri Botanical Garden* 78(1), 33-56.

members of the moss-cosmos, but are also vital to ecological communication, biocultural conservation, and interspecies meeting.

The so-called species problem is indeed a matter of two problems. One concerns what basal criteria or principles biologists, ecologists, and taxonomists use to classify an organism as a member of a species, or in the terminology commonly used by taxonomists, species delimitation. The other concerns the ontological status of species, that is, to ask what a species, a group of organisms, essentially is. Let us review the previous section a bit. In biology, not only do multiple species naming systems exist, species and their nomenclature may not form a pairwise match in different taxonomic systems. In the Linnaean ranking system, morphological characteristics play an important role, while genealogical relationships among species do not become a concern. In contrast, for phylogenetic systems, morphological or other characters may be of secondary importance and genealogical relationships between species are instead the first element. In chapter 3 on the fieldwork, I described how different levels of morphological characters (plants, leaves, cells) can show considerable advantages in the identification of and initial encounters with bryophytes. Although morphological features remain important, with the development of evolutionary biology, some biologists are no longer content to ask how to rank organisms, but why they occur in this or that order. Thus, the mechanisms behind the organic world have attracted a large number of biologists in terms of species delimitation.

4.2.1 Species Delimitation

Regarding the historical development of the species concept, the following figure shows the main six types of species concepts and when they were proposed. Each blue dot represents

an article on a new proposal for a species concept. As can be seen from the figure, the phylogenetic species concept and its sub-types have dominated the debate since the mid-1960s. It is also clear that in the 1970s, how to group and classify organisms, biological entities, and phenomena have become the gist of the conversation. Characters (morphological or behavioral), lineages, and natural taxa were the competing criteria. In 1979, Edward Orlando Wiley defined three types of classification and classifiers, namely, phenetic taxonomists, phylogenetic systematists, and evolutionary taxonomists, which respectively group organisms based on "overall similarity of one organism to another," "genealogical descent," and "a combination of overall similarity and genealogy."[198] Considering the differences among the three types, Wiley believes that appropriate revisions to the Linnaeus system are needed. In addition to this, some other biologists have even proposed a complete replacement of the Linnaeus system (see 4.1). In the following, I take the opportunity to introduce the main three competing species concepts, namely, the biological species concept (BSC), the ecological species concept (ESC), and the phylogenetic species concept (PSC).

The biological species concept (BSC) emerged in 1942 and had dominated for some time until the 1960s. Ernst Mayr suggested that we adopt reproductive barriers as a crucial and explicit condition for differentiating species. In his definition, species is "groups of interbreeding natural populations that are reproductively isolated from other such groups" or in a more concise way, a species is "a reproductively cohesive assemblage of populations."[199] Mayr

[198] See Edward O Wiley, 1979, "An annotated Linnaean Hierarchy, with comments on natural taxa and competing systems," *Systematic Zoology* 28, 308-337, p. 309.

[199] Ernst Mayr, 2000, "The biological species concepts," in *Species Concepts and Phylogenetic Theory: A debate* (New York, NY: Columbia University Press), p. 17.

particularly pointed out that biological species concept is no longer focused on morphological feature but rather emphasizes genetic relationships. Morphological features are unreliable not only because some sibling species do not differ in morphological features, but also because within a species, organisms may exhibit entirely different morphological types due to individual genetic variation or life category, such as morphological differences between males and females, or between immatures and matures. Thus, the biological species concept emerged as a "save" to the morphological species concept that had prevailed before the 1940s but was unsatisfactory. Although biological species concept sounds like a big step toward a more refined and integrated species concept, it faces three challenges, namely, exclusion of asexually reproductive organisms, overlooking the hard fact of hybridization between different species, and the logical problem of ring species.[200] In the case of ring species, neighboring populations within the ring interbreed, while at the end of the ring, populations do not interbreed.

Responding to Mayr's biological species concept, Leigh Van Valen proposed the ecological species concept (ESC), which he defines as follows:

> A species is a lineage (or a closely related set of lineages) which occupies an adaptive zone minimally different from that of any other lineage in its range and which evolves separately from all lineages outside its range. A lineage is a clone or an ancestral-descendent sequence of populations. A population is a group of individuals in which adjacent individuals at least occasionally exchange genes with each other reproductively, and in which adjacent individuals do so more frequently than with individuals outside the population.[201]

Thus, the ecological species concept takes into account not only lineage as a condition for species placement, but also species and their niche, i.e., the adaptive zone they occupy. To my

[200] See Okasha, 2019, *Philosophy of Biology: A very short introduction*, pp. 69-72.

[201] Van Valen, 1976, "Ecological Species, Multispecies, and Oaks," *Taxon*, 25(2/3), 233-239, pp. 233-234.

understanding, this "niche" is the core of the ecological species concept. It considers species distribution and environmental conditions such as geographical (i.e., altitude), biophysical (i.e., soil texture), and chemical (i.e., PH) factors. Although the ESC priorities "niche," it does not exclude gene flow among isolated populations of the same species, and even values the importance of gene flow to adaptation. Given the emergence of island geography theory in the 1960s and its contribution to population ecology, as well as the long-standing field of biogeography, this shift from biological to ecological species concept may be considered as a general evolution of ecological theory in which the species concept has been involved. In this regard, Van Valen claims that similar populations on isolated islands should not be split to a different species.[202]

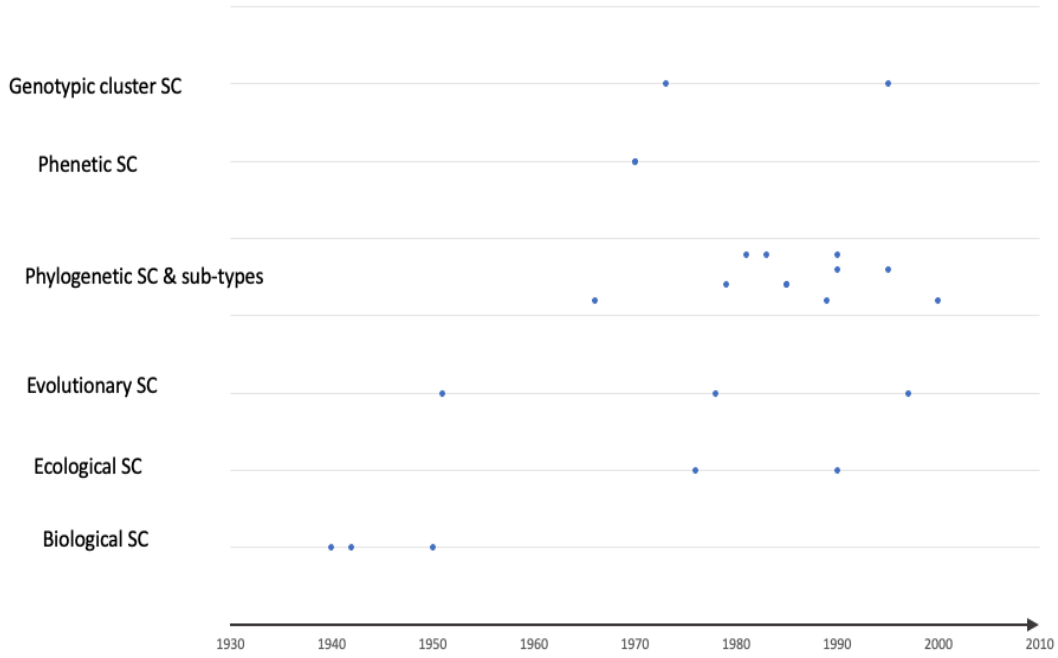


Figure 4.1: Species concepts and their proposed time. [203]

[202] Ibid.

[203] Based on Wheeler & Meier, 2000, *Species Concepts and Phylogenetic Theory: A debate* (Columbia University Press), and de Queiroz, 2007, "Species concepts and species delimitation." *Systematic Biology*, 56(6), 879-886.

As for the phylogenetic species concept (PSC), Brent D. Mishler and Edward C. Theriot studied its history and subversions of the concept.[204] It is generally acknowledged that the PSC was originally proposed by German biologist Willi Hennig (1913-1976), who defined a species as a monophyletic group consisting "of a stem species and all its descendants."[205] A stem species is the species in a lineage of the phylogenetic tree that leads to new species. Wheeler and Meier also noted that although Hennig discussed this concept on many occasions, contemporary biologists seldom attended to his work due to its conflicts with Mayr's BSC and other species concepts. It was not until the 1980s that Hennig's species concept was revitalized and accepted by zoologists and paleontologists. As a result, in the 1980s, Hennig's species concept was revised to emphasize the importance of speciation event, accordingly, "a speciation event marks the beginning of a pair of biospecies."[206] Hennig's delimitation of the species made it explicit that species is a temporal set of populations, and subsequent demarcation specifies speciation events as either splitting or extinction. Through close examination of the subversions of PSC, Mishler and Theriot gave the following definition:

> A species is the least inclusive taxon recognized in a formal phylogenetic classification. As with all hierarchical levels of taxa in such a classification, organisms are grouped into species because of evidence of monophyly. Taxa are ranked as species rather than at some higher level because they are the smallest monophyletic groups deemed worthy of formal recognition, because of the amount of support for their monophyly and/or because of their importance in biological processes operating on the lineage in question.[207]

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[204] Brent D. Mishler and Edward C. Theriot, 2000, "The phylogenetic species concept (sensu Mishler and Theriot): monophyly, apomorphy, and phylogenetic species concepts," in *Species Concepts and Phylogenetic Theory: A debate* (New York, NY: Columbia University Press).

[205] Ibid., p. 34.

[206] Rainer Willlmann, 1986, "Reproductive isolation and the limits of the species in time," *Cladistics* 2(3), 356-358.

[207] See Mishler and Theriot, 2000, pp. 46-47.

Monophyly indicates that organisms of the same species share the same ancestor. "The least inclusive" indicates that all organisms from the same ancestor are included in the species taxon. For biologists who prefer the PSC over other species concepts, they consider classification systems are human constructed for the purpose of "communication, data storage and retrieval, and predictivity."[208]

4.2.2 The Ontological Status of Species

As mentioned above, the ontological question essentially asks, "what is a species?" The ontological question is not a separate question, as it has been entangled with the above-mentioned problem of species delimitation. The emergence of the competitive species concepts in the late 1970s are not content with the contemporary species concepts presented, such as morphological, genetic, and physiological approaches. Biologist Michael T. Ghiselin has proposed a different definition, defining species as "the most extensive units in the natural economy such that reproductive competition occurs among their parts."[209] He draws an analogy between biology and economics by claiming that biological species are individuals just like firms. Therefore, the organism in a given species is merely a part of the individual whole. Based on this part-individual scheme, he has also refuted the former species concepts that those concepts "treat composite wholes as if they were classes defined in terms of the intrinsic properties of their members,"[210] which marks the ontological status of a species as an

[208] Ibid., p. 48.

[209] Michael T Ghiselin, 1974, "A Radical Solution to the Species Problem," *Systematic Zoology* 23(4), 536-544, p. 538.

[210] Ibid., p. 539.

individual. According to bryologist Mishler, this individualistic approach of the species concept views species taxa as "real, genetically integrated, cohesive, and comparable units of evolution" that are fundamentally different from taxa at higher levels.[211]

American philosopher David L. Hull (1935-2010) agreed with Ghiselin that biological species and monophyletic taxa are not natural kinds or classes but individuals. David B. Kitt and David J. Kitts oppose Ghiselin and Hull's view of a species as an individual. They claim that the analogy between firms and species fails because "there is nothing in economic theory which forbids the replacement of the part of one firm by the part of another," but "a part or a member of a species is necessarily of that species rather than of any other."[212] In my opinion, this refutation reveals the difference between a nominalist and a realist. Although the concept of species-as-an-individual faced refutation from other biologists, Okasha values their contribution to the species problem, as "they sought to re-orient the species discussion by rethinking its philosophical basis."[213] It is a cogent assessment, as the debates over taxonomy, classification, and nomenclature continue to heat up, significantly, in the wake of Ghiselin and Hull's work.

Meanwhile, ontological debates about whether species are individuals or classes continued in the 1980s. The incompatibility of the aforementioned strategies and the associated practical criteria remained perplexing. Taking into account the individuality of

[211] Brent D Mishler, 1985, "The morphological, developmental, and phylogenetic basis of species concepts in bryophytes," *Bryologist* 88(3), 207-214.

[212] See David B Kitts & David J Kitts, 1979, "Biological species as natural kinds," *Philosophy of Science* 46(4), 613-622, p. 615.

[213] See Okasha, 2019, *Philosophy of Biology: A very short introduction*, p. 73.

species, zoologists Mark Ridley has claimed that the biological and ecological species concepts should be subordinated to the cladistic species concept,[214] which adopts Hennig's phylogenetic systematics. In terms of the phylogenetic relations, unlike Dupré, Ridley has proposed a different perspective, stating that the improbability of constructing a flawless phylogenetic tree does not deny the existence, uniqueness, objectivity, and unambiguity of phylogenetic relations. The lack of sufficient information simply indicates that more efforts are still needed to recognize these relationships, not to deny their existence. Other biologists adopting a phylogenetic approach define species either as "the smallest detected samples of self-perpetuating organisms that have unique sets of characters"[215] or as "a cluster of organisms defined by a unique combination of ancestral and derived characters."[216] But according to the Canadian philosopher Marc Ereshefsky, despite the fact that various biologists taking a phylogenetic approach offer different criteria for ranking species, including geological age, geographical distribution, morphological gaps, ecological factors, derived characteristics, they agree that "species are basal monophyletic taxa."[217] In response to the species problem, Ereshefsky has enriched the argument by adding some assessment of species pluralism from a political angle. He labels some pioneering contributors to the species problem as providing a conservative or liberal form of species pluralism, and proposes a prudent eliminative pluralism that embraces the coexistence of multiple taxonomies and the inclusion of different basal taxa.

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[214] Mark Ridley, 1989, "The cladistic solution to the species problem," *Biology and Philosophy* 4(1), 1-16.

[215] See Brent D Mishler, "The morphological, developmental, and phylogenetic basis of species concepts in bryophytes.," *Bryologist* 88(3), 207-214.

[216] Brent D Mishler and Robert N Brandon, "Individuality, pluralism, and the phylogenetic species concept," *Biology and Philosophy* 2(4), 397-414, p. 408.

[217] Marc Ereshefsky, 1992, "Eliminative pluralism," *Philosophy of Science* 59(4), 671-690, p. 674.

In 1981, British philosopher John Dupré joined the debates and amplified the species problem in terms of philosophical issues such as the theory of meaning, discernment between real and nominal essence, and the difference between ordinary language and scientific taxonomy. Dupré clarified the strategies of dividing the members of species into three types, namely, strategies based on the "intrinsic properties of the individuals," the "reproductive isolation of a group of individuals," and the "evolutionary descent of a group of individuals."[218] It is necessary to note that, when Dupré uses the term individuals, he actually designates "organisms" in a different sense than individuals as expressed by Ghiselin. He reviews these three strategies and refutes each of them in turn. In terms of intrinsic properties, he argues that "gross morphological properties are not sufficient for the unambiguous and exhaustive partition of individuals into species"; this is equivalent to saying that those organisms with similar morphological features may belong to completely different species. Likewise, genetic material as a privileged property is similar to a morphological feature, since "intraspecific genetic variability may overlap interspecific variation."[219] In other words, genetic material is not enough to be a crucial basis for the identification of species. As for the second, the strategy of reproductive isolation, Dupré states that those challenges are already mentioned by other biologists. For the third strategy, it seems to require the construction of both taxonomic and phylogenetic trees of life for all organisms on Earth and find ways to converge the two. He mentions the impossibility of constructing a complete phylogenetic tree, since tracing the entire evolutionary history seems infeasible. Further, the convergence between taxonomic and

[218] John Dupré, 1981, "Natural kinds and biological taxa," *The Philosophical Review* 90(1), 66-90, p. 84.

[219] Ibid., p. 84.

phylogenetic trees also have proved to be redundant, given that the extinction of some species has left no traces at all. This makes species differentiation a gradual and uncertain process in which species are always splitting or merging. Since no strategy is sufficient to define the members of a species or what a species is, Dupré opens the gate to a pluralism of species concepts.

Later debates in the 1990s involved philosophers, biologists, and taxonomists, including Ian Hacking, Richard Boyd (1942-2021), Marc Ereshefsky, Kevin de Queiroz, and others. Canadian philosopher Ian Hacking traced the philosophical trajectory of the term Kind for this purpose, examining the works of John Stuart Mill (1806-1873), John Venn (1834-1923), Charles Sanders Peirce (1839-1914), Bertrand Russell (1872-1970), and Hilary Putnam (1926-2016). [220] Hacking (1991) defined and clarified different types of "kind" theories, such as "Mill-Kinds," "Peirce-Kinds," and "Leibniz-kinds." Although Hacking claimed that he handled the tradition of natural kinds, and he incisively attended to the radical difference between nominalism and realism, he did not touch upon biological classification to a satisfactory level. Besides that, from his scientific realist position that human intellectual achievement is reliable, Boyd reflected on the taxonomic practice of science and distinguished between natural kinds and social kinds. As the names of the two terms suggest, natural kinds are *a priori* property cluster kinds, while social kinds are a *posteriori* construction of knowledge. Boyd viewed the two as compatible, arguing that biological species are homeostatic cluster kinds, natural kinds that "the imperfectly shared and homeostatically related morphological, physiological and behavioral features which

[220] Ian Kacking, 1991, "A Tradition of Natural Kinds." *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, 61(1/2), 109-126.

characterize its members."[221] His demarcation defined species as ontological entities rather than just something intellectually constructed for communication or other inductive purposes. Furthermore, intellectual construction and biological speciation were based on the shared *a priori* properties.

4.3 Bryophytes and Species Concepts

In the previous section, I examined the species problem, in terms of the pluralistic species concepts of recent decades and the trend toward a phylogenetic concept. The examination of the species question is not tangential, because the scientific names of bryophytes and related species delimitation are also issues that cannot be avoided in taxonomy. In a general sense, the nomenclature and bryophytes delimitation should also have evolved with the evolution of the species concept. In addition, some biologists have pointed out that bryophytes are quite crucial for advancing the study of species problem, considering some of their unique characteristics. For example, Mishler has claimed that the characteristics possessed by mosses, such as the easily accessible manipulation of experimental conditions, their strategies of sexual and asexual reproduction, and the diversity of ecological and geographic conditions of bryophytes, show the worth of mosses for advancing the study of species problem.[222] In this section, I explore species delimitation in bryology, specifically the classification of mosses, and examine whether the history of moss classification is relevant to the general species concept debate. Since the 1990s, species delimitation in bryology has

[221] Richard Boyd, 1991, "Realism, anti-foundationalism and the enthusiasm for natural kinds," *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 61(1/2), 127-148, p. 142.

[222] See Mishler, 1985, "The morphological, developmental, and phylogenetic basis of species concepts in bryophytes."

applied molecular methods and DNA barcoding to identify species.[223] The history of moss classification is reviewed below to show the stages of species delimitation, classification, and taxonomy in bryology.

4.3.1 Moss Classification: Morphology Based

Based on Vitt's historic research of moss classification and Buck's pleurocarpous[224] moss classification over two hundred years,[225] I have drawn this timeline figure 4.2 to sketch whether moss classification has remained consistent with the general species delimitation. The figure shows that morphological features have played a significant role in moss classification for over two hundred years. Morphological characters were still in use even in the 1990s when molecular data were available for moss classification.

German botanist Johannes Hedwig's *Species Muscorum* (1801) was generally credited as a landmark in bryophytes classification and taxonomy. As shown in figure 4.2, he was also the first person who has been able to recognize the diversity of mosses. Before he studied the morphological features of mosses, particularly the microscopic details of the peristomes and male inflorescence, Johann J. Dillenius (1684-1747) and Carolus Linnaeus had contributed to moss classification.[226] Dillenius' *Historia Muscorum*, first published in 1741, collected mosses,

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[223] See Bernard Goffinet, William R. Buck, and A. Jonatham Shaw, 2009, "Morphology, anatomy, and classification of the Bryophyta," in *Bryophyte Biology* (2nd edition) (New York, NY: Cambridge University Press), 55-138.

[224] Bryologists distinguished pleurocarpous mosses from acrocarpous mosses based on growth patterns and the position of sporophytes. Pleurocarpous mosses usually grow horizontally and much branched with sporophytes produced from the sides of stems. Acrocarpous mosses grow vertically, unbranched, and produce their sporophytes at the ends of main stems.

[225] See Dale H Vitt, 2000, "The classification of mosses: Two-hundred years after Hedwig," *Nova Hedwigia*, 25-36; and Buck, 2007, "The history of pleurocarp classification: two steps forward, one step back," in *Pleurocarpous Mosses: Systematics and Evolution* (Boca Raton, FL: CRC Press).

[226] See Vitt, 2000, "The classification of mosses: Two-hundred years after Hedwig."

hornworts, liverworts, and lichens with figures illustrating general morphological features (Figure 4.3, left). Hedwig's Species Muscorum carried the morphological description and species identification to a more detailed level (Figure 4.3, right), with a depiction of the peristome.[227]

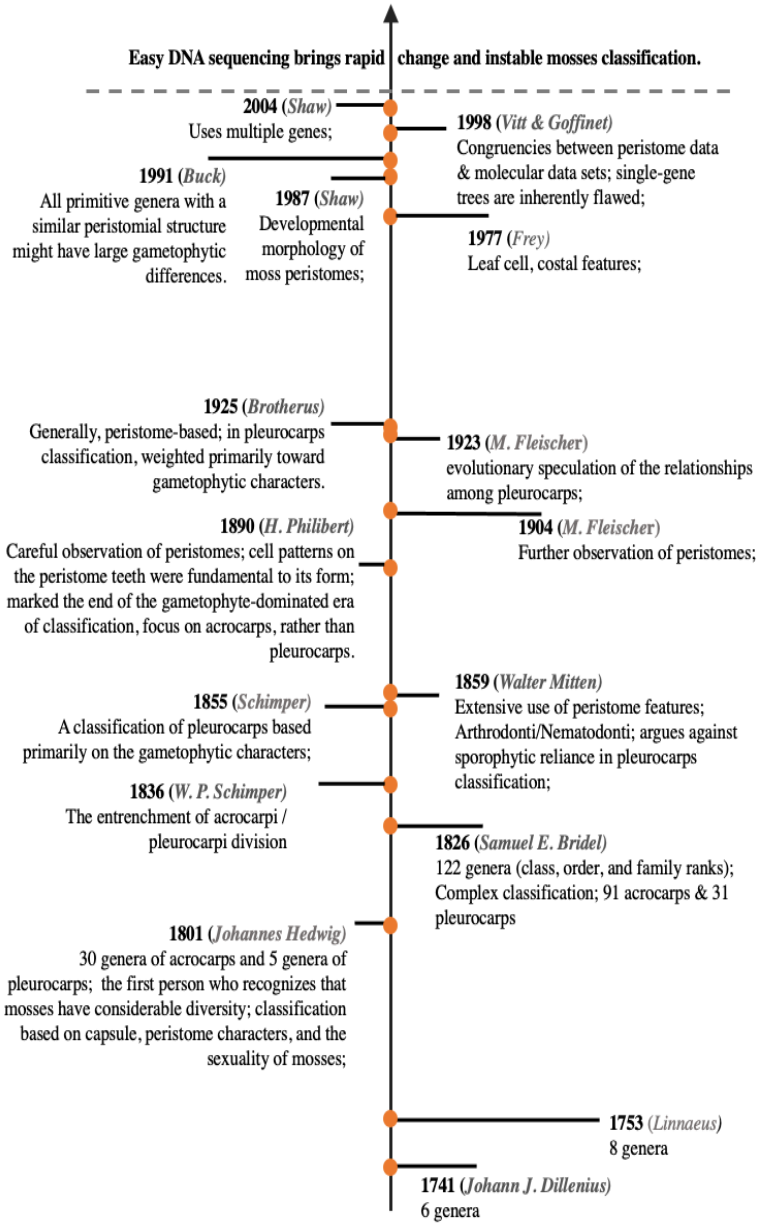

Figure 4.2: Timeline of mosses classification, based on Vitt (2000) and Buck (2007).

[227] Peristome, from the Greek peri (around, about) and stoma (mouth), is an anatomical feature that surrounds the mouth of the capsule. See also Figure 4.3, right, illustration 12.

Figure 4.3: ***Hypnum. Left: Hypnum*** **in Dillenius'** ***Historia Muscorum. Right: Hypnum*** **in Hedwig's** ***Species Muscorum.*** [228]

From the former section, it is quite clear that new concepts of species emerged after the 1940s to cope with the difficulty raised by the species concept based on morphological features. In conjunction with the above timeline of mosses classification, bryologists had been working under a morphology-based species concept in the period prior to the 1940s. This early-stage work on the accumulation of taxonomic knowledge of mosses also established a platform for the evolution of the knowledge regarding classification and taxonomy.

In the early morphology-based stage, two features on the timeline appear particularly significant. One is the peristome architecture; the other is the stem structure. These two strategies seem to focus either on sporophyte or gametophyte, respectively. For Hedwig (1801) and Mitten (1859), they were much more concerned with the former, while for Bridel (1826), his complex classification focused on the latter with a collection of ninety-one acrocarpous and

[228] See Dillenius, 1768, *Historia Muscorum: A General History of Land and Water & Mosses and Corals* (UK: J. Millan); and Hedwig, 1801, *Species muscorum frondosorum* (Germany: Sumtu Ioannis Ambrosii Barthii).

thirty-one pleurocarpous mosses.[229] The difference between these two strategies were not irreconcilable, because when both sides adopted one feature as the primary concern, they did not exclude other morphological features. According to William Buck, most bryologists of the first half of the nineteenth century followed the principles established by Hedwig.[230] Even in contemporary classification, the structure or organography of both the sporophyte and the gametophyte play an important role. For example, in the second edition of *Bryophytes Biology*,[231] *Brymela websteri* was used as an example to visualize morphological and anatomic features (Figure 4.4).

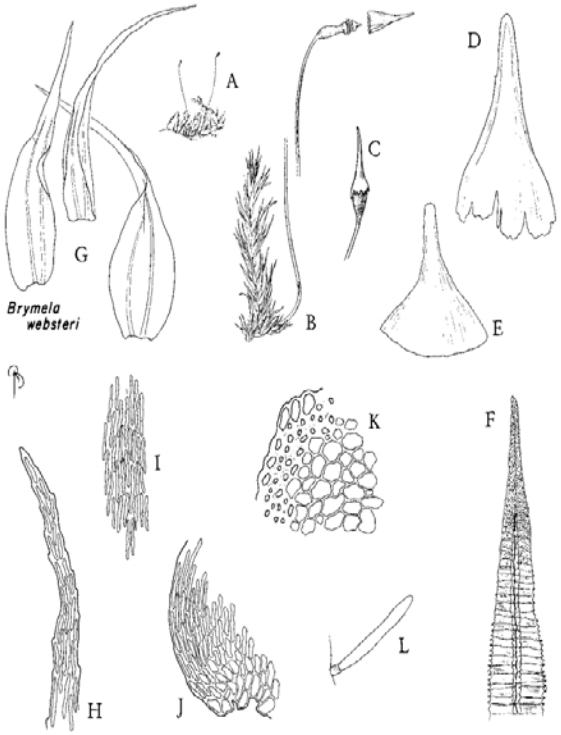

Figure 4.4: *Brymela websteri*. [232]

[229] See figure 4.2.

[230] See Buck, 2007, "The history of pleurocarp classification: two steps forward, one step back."

[231] See Goffinet and Shaw, 2009, *Bryophytes Biology*.

[232] Goffinet and Shaw use this species as an example to show morphological and anatomic features. See Goffinet and Shaw, 2009, *Bryophytes Biology*, p. 59.

Each letter in the figure represents one important morphological or anatomic feature of this species. When Buck, who had committed almost his entire earlier classification career to morphology, began to consider the impact of molecular data on the classification of pleurocarpous mosses, he reminded his peers that "we have over 200 years of history dealing solely with morphology."[233] In other words, although no bryologist had yet proposed a morphological species concept, it is undeniable that most bryologists worked under this default setting of the morphological species concept.

As also shown in the timeline figure, the fact that, to a large extent, bryologists worked under the morphological scheme does not mean that the history of moss classification remained static. Based on the classification of pleurocarpous mosses, Buck claims that not only have the classification schemes changed, but also the underlying philosophies on which those classification schemes are based. In his terms, the classification of pleurocarp mosses has been conditioned by "the historic philosophic oscillations and the ramifications."[234] By philosophic oscillations and ramifications, Buck probably meant that the philosophies underlying the selection of sporophytic or gametophytic characters to classify mosses into different groups were different when chosen by bryologists. It is somewhat regrettable that although Buck has elaborated the historical details of the changes and informed the changes of the underlying philosophies in pleurocarp classification, he does not take a further step to explicitly unravel the underlying philosophies.

Indeed, as a prestigious bryological systematist, Buck does stress the significance of

[233] See Buck, 2007, *Pleurocarpous Mosses*, p. 2.

[234] Buck, 2007, *Pleurocarpous Mosses*, p. 2.

morphological characters in general, claiming that

> Any taxonomic category, whether it be from a lowly variety to a mighty order, will not gain favour[sic.] in the systematic community if it cannot be identified morphologically. When DNA sequencing now takes so little time, that cannot be used as an excuse for not studying the plants themselves. I personally went into systematics because it was the plants themselves that attracted me and by studying them I have come to feel how they are related to one another. Trying to unravel that evolutionary puzzle is what has motivated me. [235]

In other words, the advancement of DNA sequencing technology has made it quite convenient to obtain DNA sequence data, which may revise the existing moss classification at higher taxonomic levels. However, the increased accessibility of DNA data and its revision of moss classification are not sufficient conditions to abandon morphology-based studies of mosses. For Buck, morphological features belong to the phenomenological signatures of the plant itself. There is a fundamental difference between addressing these phenomenological signatures directly and using DNA techniques. In contrast, DNA techniques involve a large degree of artificial elements, such as theoretical dependence. It seems that molecular data and morphological characters are indispensable to understand the genealogical relationships among bryophytes as well as within the three groups. In the quote above, Buck mentions that the ultimate goal is to "unravel the evolutionary puzzle." Does this mean building a phylogenetic tree of bryophytes and moving to a phylogenetic species concept? Before I turn to address the PSC in bryology, I think there is another species concept that is relevant to the current discussion, namely, the ecological species concept.

[235] Ibid., p. 15.

4.3.2 Bryophytes and the Ecological Species Concept

From the above section, morphology-based species concept was pervasive in bryophytes classification, whether the classification focused on sporophytic or on gametophytic characters. Most bryologists apparently worked under the morphological species concept described above. In Section 3.2, I briefly described the species concept debate in which the morphology-based species concept was challenged by the biological species concept. This debate did raise some concerns among bryologists after the biological species concept and other species concepts were proposed. However, the biological species concept, with its emphasis on reproductive barriers, does not appear to be well suited to bryology. The difficulty with transferring the biological species concept to botanical studies, as Jonathan Shaw has stated, is the lack of knowledge of the genetics and reproductive biology of most plants, including bryophytes. The biological species concept is particularly suited to animal studies and animal taxonomy, but not to plants. An additional reason may be applicable to bryophytes, since the biological species concept excludes organisms that reproduce asexually. It is well known that bryophytes are capable of both sexual and asexual reproduction.

In terms of the species debate or the species problem, Shaw reviewed how the concept of ecological niche was relevant to taxonomic problems in bryophytes. Based on Hutchinson's distinction between "the realized niche" and "the fundamental niche," Shaw claimed that ecological data could also be valuable to species taxonomy. The realized niche was defined "as the range of ecological variation of a species as found in nature when it faces interspecific interactions such as competition, predation, or mutualism," while the fundamental niche was defined "as ecological hypervolume occupied by a species in the absence of such interspecific

interactions; it is bounded by the limits of physiological tolerance of the specie relation to each environmental factor."[236] According to these two definitions, the fundamental niche can be understood as the potential environmental conditions that a species could inhabit alone, while the realized niche can be understood as the actual environment the species inhabits. In nature, species rarely inhabit in the absence of interspecific interactions and thus achieve a much narrower realized niche than the fundamental one. It is a puzzle why species are often excluded from ecological niches where environmental conditions are suitable for the species to colonize or grow. In terms of the relations between ecological data and speciation, Shaw claimed that there was no definite sequence in their occurrences. In other words, ecological data can be used "priori to, during, or subsequent to" species classification. It is worth mentioning here that in his stress on the significance of the ESC, Shaw did not exclude other characteristics, particularly morphological characteristics.

Thus, given the importance of the ecological data for bryophytes classification, Shaw claimed that "infragenetic groups are sometimes well-defined ecologically."[237] He cites the example of the genus *Pholia*, a cosmopolitan genus in the family of *Mniaceae* in which four infragenetic groups of species can be distinguished both morphologically and ecologically. In addition, the availability of abundant ecological data may be influenced by whether bryophytes were included in the studies of ecology. For species which are ecologically well-known, ecological data can be used to differentiate species. For instance, in wetland ecology, studies of

[236] Jonathan Shaw, 1985, "The relevance of ecology to species concepts in bryophytes," *Bryologist* 88(3), 199-206, p. 199.

[237] Ibid., p. 200.

the genus *Drepanocladus* have produced abundant data which was used to support the discovery of new species. For many other bryophytes, the limitations of applying ecological species concept were apparent, at least in the 1980s, because of the paucity of ecological data on bryophytes. Thus, Shaw claimed,

> When using field collected data on ecological difference between species to support their taxonomic separation, it is of obvious importance to determine whether the habitat correlated variation is induced by the environmental conditions or is genetically based.[238]

Based on what Shaw claimed, morphological or other phenotypic differences associated with habitat variation are highly likely to occur in populations without underlying genetic variation. This possibility reflects the limitation of applying ecological species concept to bryophytes classification. On the other hand, this may also lead to genetic differentiation when populations of a species are geographically separated or isolated to different ecological islands, in other words, when gene exchange is prevented. This may raise the question, to what extent will this genetic differentiation support the formation of new species and the subsequent invention of an entirely new scientific name?

Considering this genetic variation among isolated populations, Robert Wyatt made a "radical" proposal for bryophytes taxonomists to take studies of population biology into account. His investigation of the genetic structure of bryophytes populations led to two distinct models. One population structure, which he called "the *Conocephalum conicum* model," presents low levels of genetic variation within separate biological species, weak interpopulation differentiation, and no microscope heterogeneity. The other, "the *Plagiomnium ciliare* model,"

[238] Ibid., p. 201.

presents the opposite characteristics, showing high level of genetic variation, strong interpopulation differentiation, and microscope heterogeneity.[239] *Conocephalum concium*, as a widely distributed thalloid liverwort in the Northern Hemisphere, shows uniform morphological features with genetic and biochemical variety. Within the species, segregated populations have shown high levels of genetic similarity, regardless of their geographic distribution and ecological conditions. The dioicous moss, *Plagiomnium ciliare*, on the other hand, shows a high level of genetic heterogeneity. Although Wyatt realized that the meager data available in the 1980s could not lead to any generalization about the population structure of bryophytes, he claimed that the two different population structures indicated the relevance between gene flow and population differentiation. What he was emphasizing is that bryophytes that appear morphologically uniform may contain high levels of genetic diversity, which in turn constitute "sibling species," i.e., different species that are morphologically indistinguishable.

For taxonomists, this would pose the question of whether a "proper name" should be assigned to each sibling species, especially in some cases where there is no correlation between morphology and genetic variation. According to Wyatt, "most bryologists would agree that the naming of any and all genetic variants as species should be avoided."[240] My understanding is that there is some degree of genetic variation even within populations of the same species. The question is to what extent is this variation sufficient to indicate the formation of a new species? Alternatively, genetic variation affects the delimitation of species, but the role it plays does not

[239] Robert Wyatt, 1985, "Species concepts in bryophytes: input from population biology," *Bryologist* 88(3), 182-189.

[240] See Wyatt, 1985, "Species concepts in bryophytes: input from population biology," p. 187.

seem to be decisive. This is a contradiction and reflection arising from the ecological species concept.

4.3.3 Bryophytes and Phylogenetic Species Concept

As described in 3.2.3, phylogenetic species concept focuses on the concept and investigation of monophyly or common ancestry as the criterion for species grouping. In bryology, the phylogenetic species concept became progressively more prominent in the 1980s. Specifically in bryology, bryologists noted that bryophytes were particularly valuable in addressing the phylogenetic basis of the species concept. As I mentioned earlier, Mishler has pointed out several common attributes of bryophytes, such as the simplicity of manipulation under experimental conditions, the strategies of sexual and asexual reproduction they possess, and the diversity of ecological and geographical distribution.[241] Similarly, Shaw and Renzaglia referred to the unique vegetative and reproductive innovations of bryophytes, the unparalleled differentiation and complexity, and their key position in the evolution of embryophytes, which are vital for understanding the monophyletic and phylogenetic relationships of plants.[242] As a result, those qualities have led to a boom in research on the phylogenetic relationships of bryophytes. In the preface of *Bryophyte Biology*, bryologists also highlighted the significance of bryophytes for understanding the earliest history of plants in terrestrial environment.

Mishler and Churchill highlighted the importance of phylogenetic systematics to reconstruct the relationships of the three groups of bryophytes, namely, liverworts

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[241] Brent D. Mishler, 1985, "The morphological, developmental, and phylogenetic basis of species concepts in bryophytes," *Bryologist*, 207-214.

[242] Jonathan Shaw and Karen Renzaglia, 2004, "Phylogeny and diversification of bryophytes," *American Journal of Botany* 91(10), 1557-1581.

(*Marchantiophyta*), mosses (*Bryophyta*), and hornworts (*Anthocerotophyta*).[243] Based on the fifty-one characters derived from bryological literature, mostly morphological, anatomical, physiological characters, or biochemical mechanisms, these characters were used as indicators to determine whether groups of liverworts, hornworts, mosses, and tracheophytes (vascular plants) share common ancestry to formulate phylogenetic analysis. Although researchers were aware that some factors could affect the reliability of the analysis, such as inadequate sampling, influence of anagenesis and extinction, and general trends in the reduction or loss of characters, leading to inaccurate lineage result, they still considered some conclusions appropriate.[244] They considered bryophytes to be paraphyletic groups that should not be classified into one group. To be specific, "mosses share a more recent common ancestor with the tracheophytes than do the liverworts and hornworts."[245] In addition to the benefits of examining the phylogenetic relationships among bryophytes and vascular plants, Mishler also praised Hennigian phylogenetic systematics and advocated phylogenetic species concept since it guarantees consistency and predictability theoretically and practically, which is not possible with the morphology-based species concept,[246] particularly about complex relationships of gene flow, ecological niche, morphological coherence of species, etc. For Mishler, monophyly lineage in phylogenetic species concept seems to guarantee consistency due to unique characteristics shared by members and allows for fuzzy edges, such as genetic discontinuities or

[243] Brendt D Mishler and Steven Churchill, 1984, "A cladistic approach to the phylogeny of the 'bryophytes'," *Brittonia* 36(4), 406-424.

[244] Ibid., pp. 417-418.

[245] Ibid., p. 406.

[246] Mishler, 1985, "The morphological, developmental, and phylogenetic basis of species concepts in bryophytes," p. 213.

phenotypic plasticity, which were regarded as hallmarks of predictability.

As examined in 4.3.2, Shaw advocated ESC in the 1980s. In recent years, he has steered toward PSC in light of molecular studies that have facilitated scrutinizing phylogenetic relationships among the three monophyletic lineages of bryophytes. Recent debates among bryologists have focused on whether mosses or hornworts are closest to vascular plants. Despite this controversy, Shaw examined the phylogenetic relationships within the three lineages. From his point of view, molecular investigations have revolutionized the interpretation of genetic and morphological diversification.[247] Molecular investigations also have been elevated to the level of using "single plastid gene, multigene, or multigenomic data sets"[248] to address whether groups of mosses are monophyletic or not. Relationships based on ancestors and descendants have provided the feasibility of mapping genealogical trees of families and species. Contemporarily, bryologists also speculate that some bryophyte families have undergone and are still actively diversifying, suggesting the formation of new lineage. This also suggests that new bifurcations of the tree of life are growing. Thus, DNA bar-coding has developed rapidly in recent years for species identification, where the sequences of an unknow species are compared to the database of known taxa. Shaw cautioned the widespread strategy of DAN bar-coding, as the sequence (usually a short gene fragment) of an unknown species may provide little information about the unknow species.[249] That is, there also seems to be an inadequacy in mapping the phylogenetic tree of life based on information from gene fragments

[247] Shaw and Renzaglia, 2004, "Phylogeny and diversification of bryophytes," p. 1558.

[248] Shaw and Renzaglia, 2004, "Phylogeny and diversification of bryophytes," p. 1571.

[249] Shaw, 2009, "Bryophyte species and speciation," in *Bryophyte Biology* (2nd edition), p. 450.

alone. However, to be sure at least, discussions among bryologists about genetic information and variation, species delimitation, and phylogenetic tree of life have demonstrated the magnitude of the phylogenetic species concept in the last forty years.

4.4 Multi-Linguistic Bryophytes

In this section I employ a multi-linguistic approach to explore the traditional nomenclature of bryophytes-related plants in China.[250] Before non-vascular plants received their scientific names, they were named as if they were in the same group. The English word *Bryophytes* comes from the modern Latin word *Bryophyta*, which can be traced back to Greek word *βρύον* (bryon-, moss) and *φυτόν* (-plant). The Chinese word for bryophytes is 苔藓 (tái xiǎn). The oldest glyphs of the two first appeared on stone carvings from Qin Dynasty (BC 221-BC 207). The short-lived Qin dynasty terminated the Warrior States period (BC 475-BC 221) and unified China's territory, characters, roads, writing, currency, and many other social aspects. As shown in figure 4.5, the left character 苔(tái) was collected in *Qin-Han-Wei-Jin Seal and Clerical Script Glyphs*;[251] and the right character 藓(xiǎn) appeared on *Yunmeng Qin Bamboo Slips*, which were unearthed in 1975 in Hubei Province, China.[252] These two characters show how people named bryophyte-related plants based on their appearance and habitats. The character on the left contains elements such as water, grass, and a person or building, which can be

[250] The reason why it is bryophyte-related plants instead of bryophytes is that the traditional Chinese system of recognizing and naming plants is incommensurable to the species concept, neither Linnaeus' system nor the modern phylogenetic system.

[251] Wuwen Xu, 1985, *Qin-Han-Wei-Jin Seal and Clerical Script Glyphs* (《秦漢魏晉篆隸字形表》) (Chengdu, Sichuang: Sichuang Dictionary Press), p. 44.

[252] Shouzhong Zhang, 1994, *Collection of Shuihudi Qin Slips Characters* (《睡虎地秦簡文字編》) (Beijing: Cultural Relic Publishing Housing), p.9; see also Xu, 1985, p. 65.

interpreted as the co-occurrence of moss and humans. The character on the right combines grass, fish, and sheep. It is hard to tell whether the glyph on the right mimics morphological features of mosses, or indicates that mosses co-inhabit with other animals, or has some other intentions, since the lower part of the character also delivers meanings such as “bright-colored,” “fresh,” and “delicious.”

Figure 4.5: The oldest glyphs of Chinese Character of bryophytes. [253]

Mosses also have formed a unique theme in writing, associated with diversified meanings. Based on scholars’ research on mosses in Japanese and English literatures, Glime claims that there are similarities on how people from different culture associate mosses with meanings. In Ando’ study of Japanese literature, “koke” (コケ, moss in Japanese) is ordinarily associated with four types of meanings, (1) old age, antiquity, solemnity, (2) beauty, quiet, elegance, (3) seclusion, simplicity, loneliness, and (4) desolation, retrospection, mutability, death.[254] In English literature, moss has represented a variety of themes, from the maligned,

[253] They are illustrated with modern glyph and their English counterparts. In modern Chinese, the left character represents liverworts, and the right represents mosses. Combined these two characters represent bryophytes in modern bryology.

[254] Janice M Glime, 2017, *Bryophytes Ecology* (digital edition), 5-3-3-4. Accessible through https://digitalcommons.mtu.edu/bryophyte-ecology/

death, stagnation, barrenness, solitude, to the benign, accumulation of time, spark of green, and haunting.[255] Studies of Chinese literature, particularly Tang poems (唐詩, *Tang Shi*), also show that mosses were associated with different scenes of life, ranging from palace mourning, wistfulness of unrecognized talent, nostalgia, contemplation of death, and sighs over antiquity-now vicissitude, to pastoral serenity, elegant landscape, seclusion, and Zen.[256]

The names of bryophytes-related plants scattered in traditional Chinese literature and writings appear to be quite captivating and expressive. This is related to the traditional way of naming plants. Before Linnaeus's binomial nomenclature was introduced into China along with modern bryology in the early twentieth century, scholars within China had developed a traditional method of naming bryophytes-related plants based on appearance and habitats. This traditional approach can be exemplified by two works. One is the *Compendium of Materia Medica*, or *Běncǎo Gāngmù* (*Pen-ts'ao Kan-mu*, 本草綱目), and the other is the *Collection of Tái*, or *Tái Pǔ* (苔譜). *Běncǎo Gāngmù* is a representative work on the study of traditional Chinese herbology and medicine, describing the habits, habitats, and odors of more than a thousand plants, introducing their medical uses, explaining their therapeutic effects, and also containing illustrations of the plants (Figure 4.6). The work was completed between 1552 and 1578, and it had been revised three times before the final edition. The author, Li Shizhen (1518-1593), recorded sixteen different types of bryophytes-related plants.

[255] Ibid.

[256] Xiaotong Li, 2017, "The Study of the Moss Image in Tang Poems" (《唐诗苔藓意象研究》), Master Thesis: Inner Mongolia University.

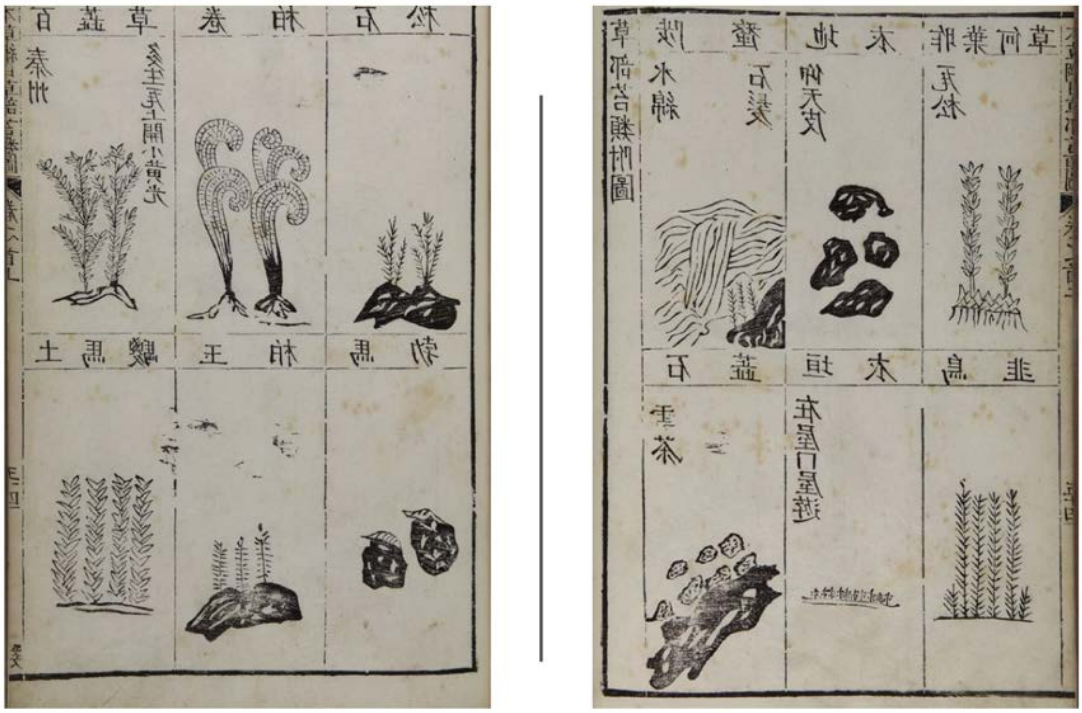

Figure 4.6: The illustration of bryophytes-related small plants in *Běncǎo Gāngmù* (1603). [257]

From the column of habitats, the habitats of bryophytes-related plants are quite diverse. Moreover, their usage in traditional medicine reveals complex interactions between humans and bryophytes-related small plants. For instance, the author of *Běncǎo Gāngmù* explained that the therapeutic effect of *Chuán-dǐ-tái* (moss at the bottom of the boat) of fever lied in its attributes of *Qi*, i.e., the capacity to divide Yin and Yang. It was believed that *Chuán-dǐ-tái* was produced by the essence of water. Its capacity to divide *Yin* and *Yang* was generated by its living habit, that is, the moss must live in two extreme conditions during its life cycle, enduring both the long-term saturation of water (*Yin*) and exposure to the sun (*Yang*). Fever was interpreted as a symptom of the human body due to the disorder between *Yin* and *Yang*,

[257] Hard copy collected in Shanghai Library, digital copy of the 1603 version available in World Digital Library (https://www.wdl.org/zh/item/13551/, accessed on May 25, 2021), inscribed into UNSECO Memory of the World Register in 2011.

the underlying cause of which is the excess heat within the body. [258] By taking a decoction of *Chuán-dǐ-tái*, it not only helps the body to divide *Yin* and *Yang*, but also allows the removal of excess heat, i.e., *Yang* energy in the body. This example shows that bryophytes-related plants and their names were embedded in a panorama of correlative cosmology and the concept of the human body.

The second book, *Tái Pǔ*, compiled by the bibliophile Wang Xian (1721-1771), is a genealogical record of bryophytes-related plants. The compiler owned a private library with a large number of rare books and enjoyed a good reputation for collecting books. The six chapters of *Tái Pǔ* collected literatures regarding the traditional nomenclature of bryophytes-related plants, their medical usage, papermaking, habitat categories (particularly focused on their appearance in human dwelling places), and a collection of nineteen odes and 249 poems about bryophytes-related plants. For the traditional nomenclature, it apparently shows a divergent thinking from the scientific naming system. It does not classify organisms into different species but into kinds dwelling in different *chù-suǒ* (Chinese word "處所," meaning "dwelling places," or habitats). Bryophytes-related plants thus were classified into kinds via places, such as palaces, abandoned rooms, soil, steps, bricks, trails, walls, wells, stone couches, temples, rocks, valleys, ponds, creeks, woods, tree trunks, steles, drum-shaped stones, age-old graves, etc.[259]

[258] See Shizhen Li, translated by Yumin Rong, 2022, *Ben Cao Gang Mu: Creeping Herbs, Water Herbs, Herbs Growing on Stones, Mosses, Cereals* (《本草綱目》) (Oakland, CA: University of California Press), Volume V, section Herbs, chapter 21, Moss group, 16 kinds. Original Chinese text: "時珍曰：案方賢《奇效方》雲：水之精氣，漬船板木中，累見風日，久則變為青色，蓋因太陽曬之，中感陰陽之氣。故服之能分陰陽，去邪熱，調臟腑。物之氣味所宜也。"

[259] See Lan Zhou, 2019, "A Study on the Mossy Culture in Ancient China: Focused on Tái Pǔ by Wang Xian," Master thesis: Hunan Normal University.

Table 4.1: Bryophytes-related plants: their names, alternative names, and habitats, extracted from *Běncǎo Gāngmù*.

Names	Alternative names	Habit/habitat	Therapeutic effects (extracted)
Zhi li (陟釐)	Water tai, rock hair, rock clothe, water clothe, water cotton/silk;	Grow on the surface of rock in water; fine and soft like hair;	Strengthen stomach, stop dysentery, cure depression;
Gan tai (干苔)	Ocean rock hair, ocean tai,		Stop Vomiting Ping
Lan (萳藍)	Tai in the well;	Abandoned well;	Heal sores caused by poison ivy, edema, burn;
Chuan di tai (船底苔)	The essence of water, moss from the bottom of a boat;	The bottom of the boat;	Cure fever;
Shi rui (石蕊)	Rock tuft, rock tea, rock moistener;	Rock surface;	Improve eyesight, antipyretic, dissolve phlegm
Di yi cao (地衣草)	Wet land moss;	Shaded wet land;	Heal heartache;
Yuan yi (垣衣)	Wall surplus, heven onion, mice onion, xi xie (昔邪),	Grow on the shady side of abandoned short wall;	
Wu you (屋游）	Tiles cloth, tile moss, roof drift, tile loose;	Old tile on roof;	Cure child epilepsy, dog bite;
Zuo ye he cao (昨叶何草)	Tile loose, tile flower;	Grow on roof, or rock crevice in remote mountains, tall as grass, hair on leaf back, poison eye to blind;	Heal swelling and aching gum, burn, dog bite;
Wu jiu (乌韭)	Rock hair, rock clothes, rock moss, rock flower, shi ma zong (石马鬃)	Rock surface in mountains;	Promote lactation;
Tu ma zong (土马鬃)	Wu jiu	Grow on the top of abandoned short wall ；	Excretion disorder, nose bleeding;
Juan bai (卷柏)	Long live, immortal grass, leopard foot;	Rocks in mountains;	Dystocia;
Yu bai (玉柏)		Rock surface;	
Shi song (石松)		Rock surface;	
Sang hua (桑花)	Mulberry moss, mulberry coin;	Mulberry tree;	Nose bleeding, cough;
Ma bo (马脖)		Rotten place in gardens;	Sore throat, aphonia, cough;

Each kind possesses a name. For instance, some tiny plants inhabiting steles were named "Stele Tai" (碑上苔); those growing on old tombs were named "Old Tomb Tai" (古冢苔); and those occupying the trails were named "Trail Tai" (徑中苔).[260] The reason for this classification rests with not the fact that the author himself observed bryophytes-related plants in these places, but that the voluminousness of writings of the traditional literati class included bryophytes-related plants as a part of their physical living surroundings and life scenes.

Based on the above classification of habitats, the traditional nomenclature of naming bryophytes-related plants does not seem to sort plants according to any scientific category. As far as these traditional names are concerned, Zhou investigated all plant names recorded in *Tái Pǔ* and classified bryophytes-related plants into algae, mosses, lichens, ferns, and other small plants, but did not determine their modern species names.[261] The difficulty of classification to the species level is obviously due to the incommensurability between classical Chinese literatures and modern bryology, which were implicitly mentioned by Zhou. Research from the field of ethno-bryology claimed that only the names of higher plants with strong morphological features have the potential to "reach the exactitude of our modern species."[262] Hunn proposed four factors which govern the cultural recognition of biological taxa, namely, phenotypic salience, ecological salience, the size factor, and cultural salience.[263] In Hunn's quantitative investigation, the size factor plays the most dramatic impact on whether different cultures

[260] Ibid.

[261] Ibid.

[262] Seville Flowers, 1957, "Ethnobryology of the Gosuite Indians of Utah," *The Bryologist* 60(1), 11-14, p. 13.

[263] Eugene Hunn, 1999, "Size as limiting the recognition of biodiversity in folkbiological classifications: One of four factors governing the cultural recognition of biological taxa," in *Folkbiology* (Cambridge, Mass: MIT Press), 47-69.

recognized traditional biodiversity.

According to Harris, the visibility of small plants in global indigenous cultures were constrained by technology, especially in the absence of microscopes.[264] The same was true of modern taxonomy before the invention of the microscope in Europe. Johann Dillenius (1684-1747), for example, in his *Historia Muscorum* (1768) also "followed folk classification by including lichens, algae, lycophytes and bryophytes in his treatment of 'moss'."[265] Even the Old English word *moss* was employed to designate entirely different types of plants, as shown by names such as *cup-moss* (a lichen), *Irish moss* (an algae), *Spanish moss* (a lichen), and *club moss* (a vascular plant), etc.[266]

Like ancient Chinese literati and herbalists, the Gosuite Indians also name bryophytes-related plants by habitats. For example, moss growing on wet rocks were named as *Tim-pin-pá-bo-i-ûp*, meaning with roots on wet rocks; or *Tim-pin-so-kûp*, meaning lichens that cling to rocks; or *So-go-ba-gwip*, meaning a small earth plant with seeds.[267] In chapter 3, the nomenclature of bryophytes and lichens invented by southern American indigenous people echoes Flowers' conclusion that only plants with strong morphological features can match modern species, as exemplified in the case of *Protousnea Magallanica*, the hair-like lichen. The metaphoric and perplexing names recorded in Chinese literatures have also elicited some researchers to classify those small plants and compare them with plants recorded in the

[264] See Eric SJ Harris, 2008, "Ethnobryology: traditional uses and folk classification of bryophytes," *The Bryologist* 111(2), 169-217, p. 171.

[265] Ibid.

[266] Ibid.

[267] Flowers, 1957, "Ethnobryology of the Gosuite Indians of Utah," p. 13.

modern system. For example, Harris listed about 150 ethnobotanical species of bryophytes recorded in Traditional Chinese Medicine and Native North Americans, and the former-mentioned plant with the name *Tǔ-mǎ-zōng* (土马鬃, Horse-mane of the Earth) was identified as *Polytrichum commune* and used as a diuretic.[268]

The worldview of the medical usage of these small plants, such as the correlative cosmology and the concept of the body, was generally related to Traditional Chinese Medicine (TCM), one of the oldest and still operative healing systems which combines herbal medicine, acupuncture, moxibustion, massage, food therapy, and systematic physical exercises. The correlative cosmology of TCM has been illustrated widely by both domestic and international researchers,[269] via themes such as *Qi (*氣), complementary and exchangeable *Yin-Yang (*陰陽), five elements (五行), the dynamic balance or harmony between the body and nature. In this correlative world, the human body was conceived not as separate from the rest of the world, but as forming a continuum with the rest, with rich interactions between the body, the atmosphere, the seasons of nature, and other aspects of the other-than-human world. According to the interpretation of British sinologist A. C. Graham (1919-1991),

> Man is in spontaneous interaction with things, but responds differently according to the degree of his understanding of their similarities and contrasts, connexion[sic.] or isolation. The "ought" then finally detaches-itself in an imperative to know how things compare and connect, and in particular whether in connecting they support or interfere with each other, which is to know their "patterns" (Li, 理) and the "Way" (Tao, 道) behind them all; to know what to do is to know what one would be moved to do in the

[268] Harris, 2008, "Ethnobryology: traditional uses and folk classification of bryophytes."

[269] See Changlin Liu, 1982, *The Philosophy of Neijing and the Method of Chinese Medicine* (《內經的哲學與中醫學的方法》) (Beijing: Science and Technology Press); see also Angus Charles Graham, 1986, *Yin-Yang and The Nature of Correlative Thinking* (Vol. 6) (Singapore: Institute of East Asian Philosophies).

> sage's full knowledge of how things are related in fact. Value separates from fact as the value of wisdom itself.[270]

Following what Graham says about the interaction, it not only applies to the sage's knowledge and practice, but also to an herbalist while applying Traditional Chinese Medicine. In the case of using bryophytes-related plants to cure, the knowledge of how small plants interact with the schematized world generates and explains therapeutic methods. Only based on knowing how things are interconnected, such as mutually generating or mutually restraining, does one know how to deal with other things and how to live with oneself in a complex world. This is true for a Traditional Chinese Medicine practitioner as well as an intellectual. Value is being what it is. Habitat as a part of "being what it is" is thus included in the traditional nomenclature.

4.5 Chinese Modern Nomenclature of Bryophytes

As explained in the previous section, the ancient Chinese named bryophytes-related plants by focusing on appearance and habitats. I also showed in the previous section the link between the traditional way of naming bryophytes-related plants and the medical usage of the plants, showing the correlative cosmology and the concept of the body. In this section, I handle the Chinese modern nomenclature of bryophytes, which differs radically from the traditional nomenclature.

Modern bryology was introduced to China by Bangjie Chen (Pan-chich Chen, 陳邦傑, 1907-1970), the founder of China's bryology. Internationally, he was venerated as "the Father

[270] See Angus Charles Graham, 1986, *Yin-Yang and The Nature of Correlative Thinking* (Singapore: Institute of East Asian Philosophies), p. 65.

of Chinese Bryology."[271] Chen graduated from the Department of Botany of the National Central University. He went to Berlin University to study botany in 1936. Before travelling to Berlin, he had collected thousands of species of bryophytes from various locations in China, and none of the bryophytes collected at that time had Chinese species names. Nor were mosses and liverworts distinguished from each other in their names during field surveys. Carrying with him thousands of specimens of bryophytes he had collected,[272] Chen went to Berlin to seek answers regarding bryophytes nomenclature, taxonomy, and distribution. In 1939, he defended his dissertation, "Studien über die Ostasiatischen Arten der Pottiaceae (Studies on the East Asian species of the Pottiaceae)" and received his doctorate. In 1940, he returned to China and initiated modern bryology in China. During his career, he had collected a total of 40,000 bryophyte specimens across China's main mountainous areas, including 46 families, 130 genera, and 654 species of liverworts, and 62 families, 354 genera, and 1,675 species of mosses.[273]

In 1954, Chen established the first bryophytes herbarium at Nanjing Normal University, where other universities would send their junior botanists to receive training.[274] Chen also remained in communication with international bryologists until the domestic turmoil of the

[271] Xingjiang Li, Renliang Hu, Mu Zang, 2010, "In memory of our mentor Prof. Pan-Chich Chen," *International Bryological Symposium for Pro. Pan-Chich Chen's Centennial Birthday* (《陳邦傑先生國際學術紀念文集》, Nanjing: Nanjing Normal University Press).

[272] Hua Zuo, Ping Zuo, Fen Zuo, et al., 1979, "The pioneer of China's bryological research: Memorial to our father Prof. Pan-Chich Chen (《我國苔蘚研究的拓荒者: 悼念我們的父親陳邦傑教授》)," *Journal of Nanjing Normal University* (Natural Science Edition), 1, 94-96.

[273] Xingjiang Li, Renliang Hu, Mu Zang, 2010, "In memory of our mentor Prof. Pan-Chich Chen."

[274] Hua Zuo, Ping Zuo, Fen Zuo, et al., 1979, "The pioneer of China's bryological research: Memorial to our father Prof. Pan-Chich Chen."

Cultural Revolution. However, political chaos quickly interrupted and disrupted the normal development of the academia and educational community in China. The field of bryology was no exception. Chen had been physically and mentally persecuted until his death in 1970. In their memorial essay, Chen's children recollected his suffering during the chaotic period and honored their father as "the pioneer of Chinese bryological research,"[275] rivaling the most profound work of bryophytes on the surface of the Earth. In 1989, Richard H. Zander, an American bryologist then working at Clinton Herbarium of the Buffalo Museum of Science, combined Chen's first name and his own name into "Chenia R. H. Zander" to name a newly discovered genus in the family of Pottiaceae to commemorate Chen's contribution in the field of Pottiaceae research. Zander briefly explained that "(the genus) named as a tribute to Pan-Chieh Chen, whose 1941 'Studien über die Ostasiatischen Arten der Pottiaceae' remains a superb treatment of the Chinese representation of the family."[276] The genus now has three species, and in 1993, the Botanical Society of China created the biennial journal "Chenia: Contributions to Cryptogamic Biology" in Chen's honor. Since then, the journal has published articles particularly related to non-vascular plants like bryophytes and lichens and vascular plants pteridophyte. From the above historical description, it is irrefutable that without Chen's contribution, Chinese bryology would not have come into being.

In the course of his research, Chen accumulated various bryological problems relating to the translation between Latin scientific names and Chinese names. In 1952, he argued that the

[275] Ibid.

[276] Zander, 1989, "Seven New Genera in Pottiaceae (Musci) and A Lectotype for Syntrichia," *Phytologia* 65(6), 424-436, p. 425.

Chinese character “蘚” should be used to designate mosses and the character “苔” for Hepaticae (liverworts).[277] In 1953, he published an article entitled 《葫蘆蘚》(hú-lú-xiǎn, *Funaria hygrometria Hedw.),* literally “calabash moss,” which marked his recommendation of the Chinese name of the species *Funaria hygrometria Hedw.* to the Chinese bryological society. In this article, he also made the case for using Funaria hygrometria Hedw. instead of *Polytrichum commune* (土馬鬃, pronounced as tǔ-mǎ-zōng) to represent mosses in middle school botany textbooks.

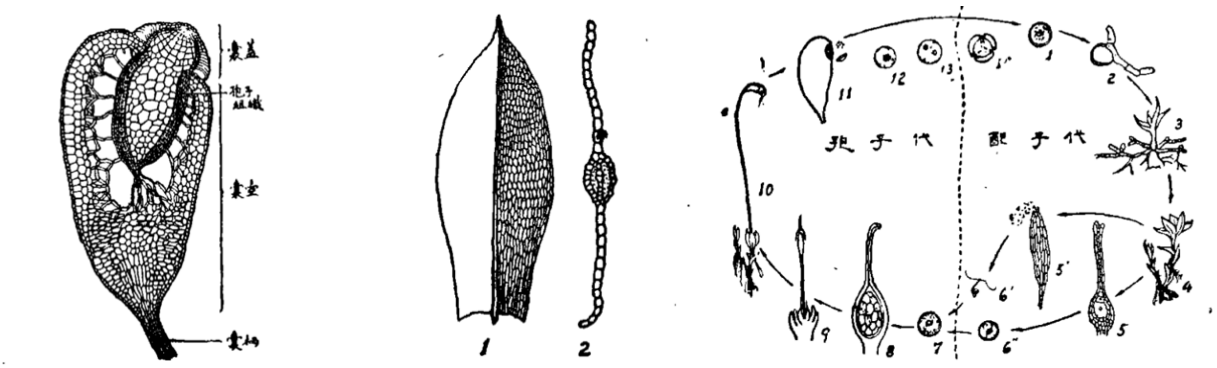

Figure 4.7: Chen’s hand-drawings of *Funaria hygrometria* Hedw. (葫蘆蘚, 1953). [278]

One reason for this change is that, although the name “tǔ-mǎ-zōng” frequently appeared in classical literature, its corresponding species and its scientific name needed to be further examined. Besides, the multilayer cellular leaf-structure of Polytrichum commune does not represent the typical feature of moss, as most mosses have monolayer cellular leaf structure.[279] The Chinese name of the species *Funaria hygrometria Hedw.* (葫蘆蘚) was

[277] Wu, 1992, “Chen Bangjie’s pioneering research in the field of bryophytes science” (《陳邦傑在苔蘚科學領域的開拓性研究》), *Journal of Nanjing Normal University* (Social Science Edition), 3, 39-43.

[278] The left, middle, and right drawings show respectively the capsule with calyptra, a leaf with a monolayer cell illustration, and the life-circle of sporophyte and gametophyte. See Chen, 1953.

[279] Bangjie Chen, 1953, “Funaria hygrometria Hedw.《葫蘆蘚》,” *Biology Bulletin* (10), 370-373, 381.

invented based on the morphological similarity between the capsule of the moss and a calabash (figure 4.7, left). He also included eight hand-drawings to illustrate its life circle and anatomical features of the leaves, sporophyte, and leaf teeth, etc.

This analogous association of bryophytes with other plants or animals is common in the modern Chinese nomenclature of bryophytes. Other distinctive examples include all species in the family of *Fissidentaceae* (鳳尾蘚科, pronounced in Pinyin as "fèng-wěi-xiǎn-kē"), literally "Phoenix tail moss family." The Chinese name of this family speaks for the morphological features of the mosses, the leaves of which are alternately arranged into two flat rows, as if mimicking the feathers of a male phoenix tail (Figure 4.8). The sacred bird phoenix was regarded by the ancient Chinese as the chief of feathered animals whose appearance was a symbol of blessings from the Heaven.[280] The bird frequently appears in classical literature and cultural relics (Figure 4.9). Other bryophytes that evidently employ analogical thinking in nomenclature include, but are not limited to, *Hypopterygium japonicum Mitt.* (東亞孔雀蘚, Eastern-Asian peacock moss, Figure 4.10), *Hypopterygium flavolimbatum* (黃邊孔雀蘚, Yellow-edge peacock moss), *Atrichum angustatum (Brid.) Bruch & Schimp* (狹葉仙鶴蘚, Slender-leaf crane moss), *Conocephalum conicum (L.) Underw.* (蛇苔, Snake liverwort), *Cratoneuron filicinum* (牛角蘚, Ox horn moss), *Hedwigia ciliata* (虎尾蘚, Tiger tail moss), etc.

[280] See *Da Dai Li Ji* (《大戴禮記·易本命》), which says, "There are 360 feathered-chóng and the phoenix the oldest ... Thus, if the emperor is fond of destroying the nests and eggs, the phoenix would not fly," original Chinese text, "有羽之蟲三百六十，而鳳皇為之長 ..... 故帝王好壞巢破卵，則鳳凰不翔焉."

Figure 4.8: Illustration to Fissidentaceae. Left: A photo of a species in the family of Fissidentaceae. Photo credit belongs to Liu Ang, open access via Plant Photo Bank of China (PPBC). Right: Photo credit belongs to Guangmin Li, open access via PPBC.

Figure 4.9: Silk Painting with Female Figure, Dragon, and Phoenix Patterns (《人物龍鳳帛畫 , 12.2*8.6 inches). [281]

[281] The painting was excavated in 1949, from Tomb of Chu State during the Warrior States (BC 475-221), Changsha, Hunan Province, China. Open access at Hunan Museum through http://www.hnmuseum.com/en/content/silk-

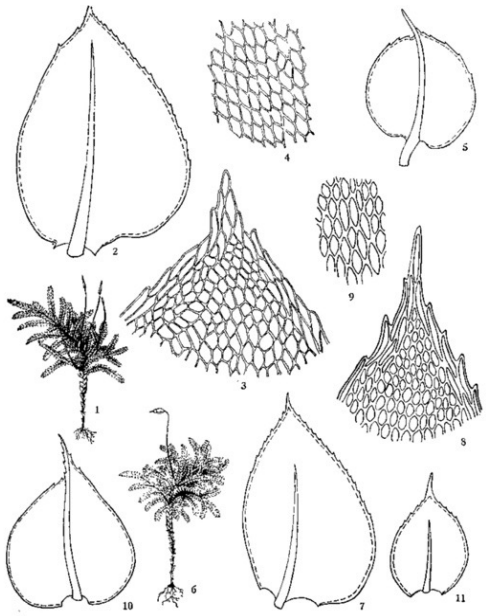

Figure 4.10: Illustration of *Hypopterygium japonicum* Mitt. (東亞孔雀蘚, Eastern-Asian peacock moss).[282]

Figure 4.11: Photograph of *Hypopterygium arbuscula* Brid. [283]

painting-female-figure-dragon-and-phoenix-patterns. The tail feathers of the Phoenix were oppositely rather than alternatively arranged in the painting.

[282] Chen first identified this species in 1935 and the specimen (00360355) was stored at the Herbarium of the institute of Botany of Chinese Academy of Sciences. The illustration was drawn by Zhongyuan Feng (冯钟元, 1917-), who is specialized in botanical scientific illustration. Number 1 and 6 in the illustration are the drawings of the whole plant which tell the reason for naming the species in this family as peacock moss. In the illustration of the peacock moss family, it also mentions, "the branches and leaves are unipennate, bipinnate, and seldomly tripinnate, resembling a fan or peacock while spreading its tail." See Xingjiang Li, 1985, *Bryoflora of Xizang* (《西藏苔蘚植物志》) (Beijing: Science Pres), p. 292.

[283] This species is a cosmopolitan species of the family *Hypopterygium*. Photo was taken by the author at the Senda Darwin Biological Station, Chiloé, Chile.

Table 4.2: Species in the family of Fissidentaceae and their Chinese names[284]

Scientifics names	Chinese names	Literal meaning of the Chinese names
Fissidens bryoides Hedw.	小鳳尾蘚	Little phoenix tail moss
Fissidens crenulatus Mitt.	齒葉鳳尾蘚	Tooth-leaf phoenix tail moss
Fissidens Cripulus Bird.	黃葉鳳尾蘚	Yellow-leaf phoenix tail moss
Fissidens diversifolius Mitt.	多形鳳尾蘚	Multi-shape phoenix tail moss
Fissidens dubius P. Beauv	卷葉鳳尾蘚	Curled-leaf phoenix tail moss
Fissidens flaccidius Mitt.	暖地鳳尾蘚	Warm-land phoenix tail moss
Fissidens grandifrons Bird.	大葉鳳尾蘚	Large-leaf phoenix tail moss
Fissidens javanicus Dozy & Molk.	爪哇鳳尾蘚	Java phoenix tail moss
Fissidens macaoensis L. Zhang	澳門鳳尾蘚	Macao phoenix tail moss
Fissidens minutus Thwaites & Mitt.	微鳳尾蘚	Mini phoenix tail moss
Fissidens pellucidus Hornsch	粗肋鳳尾蘚	Coarse-rib phoenix tail moss
Fissidens polypodioides Hedw.	網孔鳳尾蘚	Mesh phoenix tail moss

To further determine the Chinese name of a species, if the name of the family of the species has already been determined, the full name of the species can be determined by adding some unique morphological features, or geographical distribution of the species to the family name. In other words, if a family already has a Chinese name, then basically all species of the same family will share the family name. This is consistent with the nomenclature of Latin scientific names. For example, since the family *Fissidentaceae* has been named as "鳳尾蘚" (Phoenix tail moss), indicating the specific morphological feature or geographical distribution of the species, then combining the word with the family name could determine the modern Chinese name of the species. The following table shows some species in *Fissidentaceae* family

[284] Chinese names were cited from *The Miniature Angels in the Plant Kingdom*, 2015.

are named through analogical thinking with additional morphological features particular to each species to differentiate them from one another (Table 4.2). In Chen's field work, he had identified around twenty species of this family and reported them in 1963,[285] which basically informs us that the bryophyte names in Chinese had been formulated during this period. In 1959, Chen Bangjie and Li Zhengli translated Gilbert M. Smith's book *Cryptogamic Botany* (1955, 2nd edition) into Chinese. The second volume of this book introduced bryophytes and pteridophytes, of which the scientific names of bryophytes had also been translated into Chinese.

4.6 Conclusion

In general, in this chapter I attempt to examine the linguistic-cultural dimension of biocultural conservation. When we consider this dimension, it is evident that it often exhibits more complexity than can be presented in a single case study. Bryophyte nomenclature was deliberately chosen for this chapter with the initial intention that encounters with mosses in field activities always seem to be encounters with species. However, by reflecting on its nomenclature, I find it impossible to avoid not only the question of what a species is, but even more so, how the term species is employed in biological research, biological conservation, ecological education, and communication. The species that people encounter in field activities always have some unique morphological characteristics, occupy a specific geographical environment, exhibit certain habits, and co-inhabit with other species. Inter-species encounters always occur in such concrete contexts. Moreover, people's encounter with a specific other-

[285] Qian Gao, 1996, *Flora Bryophytarum Sinicorum: Fissidentales & Pottiales* (《中國苔藓志： 鳳尾藓目 叢藓目》) (Beijing: Science Press).

than-human being is always a concrete and uneven encounter at the species level. That is, one cannot encounter the other species as an abstract *Homo sapiens*; one always carries some degree of individuality (e.g., knowledge, culture, religious complex, personal experience, etc.) to encounter an *other-than-human being* which is abstracted as a species. The unevenness lies in the fact that humans cannot abstract the *I* as merely a member of *Homo Sapiens* but must abstract *other-than-human beings* as species. Otherwise, the fecundity and infinite succession of existence would be more than a person can bear.

Most of the time, this abstraction of other-than-human beings is taken for granted. However, when it comes back to *species* as an academic term and discourse, as the reflections on the three major species concepts in this chapter show, "species" seem to manifest itself as a kind of wandering state, wandering in quadrants with fuzzy boundaries. As I will show in later chapters, this fuzziness and ambiguity did not impede the extensive use of the term *species* in mass ecological and environmental communication. Undeniably, despite the gap between the popular perception of the "species" and the frontiers of taxonomy, the targets of biodiversity conservation in term of "species" does point to what exists in a specific geographical environment or ecological region. As sections 3.2 and 3.3 show, whatever the controversy remains about what a species is and how a species is delimited, it is remarkable that in the absence of uniformity, the knowledge about species and their delineation is flourishing. This sounds like a thunderbolt out of a clear sky to those who seek scientific certainty and shun ambiguity, mind-boggling. It is worth mentioning that both the Linnaean nomenclature and the subsequent phylogenetic nomenclature do reflect the debates about realism versus nominalism, creation versus evolution in heterogeneous Western thinking. For that matter, the

species problem is a Western problem.

In contrast, traditional Chinese and some indigenous ways of naming moss-related plants seems to be scientifically irrelevant, displaying a particular concern for the complex connections between humans and other-than-human beings, whether expressed through literature, herbology, or traditional medicine. It also seems inappropriate to me to evaluate these connections in terms of environmental philosophical discourses such as instrumental versus intrinsic values, interspecies injustice, or epistemic injustice, etc. Because the cognitive ambiguity shown by traditional nomenclature is not identical to the ambiguity shown by the species problem. In traditional nomenclature, all beings, including human beings, are encompassed in an awareness of the connectedness of all things. It is assumed that this universal connectedness indicates that humans cannot be isolated from the Other in biophysical, linguistic-cultural, and spiritual dimensions. On the other hand, the ambiguity in the species problem is particular to the evolutionary relations of some species, which does not exclude how the connectedness of all beings is revealed by modern ecological research.

This view of universal connectedness is certainly not immune to Levinas' criticism of totality. What I take from the above examination of bryophytes nomenclature is that, although cultures may not avoid the problem of totality, in the encounter and meeting between cultures, reflecting on one's own totality and being receptive to the totality of others is the opportunity to face infinity. In other words, Levinas' criticism of totality calls on biocultural conservation and asks the "I" to receive the opportunity of contemplating, caring, and facing the Other. This is shown in the shifting of bryophytes nomenclature in China. Modern Chinese nomenclature accepts and incorporates the scientific law of binomial nomenclature. It is possible that the

implementation of modern nomenclature will lead to the situation where traditional nomenclature and its corresponding practices will eventually become a spiritual relic, or even vanish. Without biocultural conservation, human activities in the field and their connection to bryophytes will become increasingly homogenized. There is the concern that the connectedness to bryophytes and many other beings is only interpreted ecologically today. When others are assimilated or made extinct because of biocultural homogenization, with whom will the "I" meet? This may appear as the problem of a worrywart. Perhaps in a metaphysical sense, alterity or heterogeneity is infinitely becoming.[286]

[286] See Karen Barad, "On Touching."

CHAPTER 5

MOSSY EXPRESIVENESS: ARTS AND GARDENS FOR CONSERVATION

The garden contains all that exceeds what literally meets the eye.
—Robert Pogue Harrison

In this chapter I employ the word *expressiveness* to designate the power of art works and gardens to convey ideas, thoughts, or feelings in the context of biocultural conservation. It starts with Ernest Haeckel's drawings of bryophytes in his *Art Forms in Nature*, followed by an analysis of three large-scale paintings of bryophytes by two female artists at the Shenzhen Fairy Lake Botanical Garden. These art works have advanced bryophytes conservation and ecological communication. The third section categorizes various types of moss gardening in terms of the scales of gardening. As a result of this categorization, ethical questions emerge, and gardening proves to be essential for understanding human-moss interactions and delineating human conditions.

5.1 Ernst Haeckel: Mosses in *Art Forms in Nature*

5.1.1 Haeckel and His Monism

To appreciate Haeckel's moss painting, it would be instructive to acknowledge his rank as a scientist and an artist. In 2004, Night Fire Films released "Proteus: A Nineteen Century Vision,"[287] a documentary that reveals the worldview of contemporary intellectuals based exclusively on the images of nineteenth century painters, artists, photographers, etc. The documentary itself is a work over more than twenty years. At its core is Ernst Haeckel's (1834-1919) drawings of Radiolaria, his prominent one-celled organisms. Filled with the stunning

[287] Accessible through https://nightfirefilms.org/films/proteus/.

beauty and numerous forms of Radiolaria, "Proteus" conveys a sense of strong encounters, as if seeking the reconcilability between the world of scientists and of artists, or questing the unity of nature and God, or ascertaining the harmony between a visible world with fabulous forms and shapes versus an invisible world of the spirit.

As the narrator of "Proteus" notes, through the tiny Radiolaria, Haeckel's two worlds meet. Robert J. Richards, Haeckel's definitive biographer, who has undertaken a laborious task of correcting the distortive profile of Haeckel, also captures a similar sense of encounters. By refusing to label Haeckel as a scientific charlatan, embryonic liar, or proto-Nazi, Richards restores Haeckel's reputation as a scientific and artistic genius. His comment that Haeckel was "torn by the two souls in his breast – the deeply feeling spirit and the aggressively rational mind"[288] also discloses the base of Western thought, which was proposed by Miguel de Unamuno (1864-1936), saying that the tragic sense is generated by "the desire for immortality, the longing to unite with eternal, divine nature" and "the skepticism of grounded reason."[289] If Richards and Unamuno were right about Haeckel's torn and unsettled situation, then Haeckel's efforts in sciences and art can be interpreted as striving for unity. It is based on this unity or totality that minor organisms such as mosses, liverworts, lichens, and even Radiolaria are incorporated in the whole view.

The endeavor for unity can also be explained by the concept of *ecology* invented by Haeckel and his general monistic philosophy. As a pioneering scientist, Haeckel coined several

[288] See Robert J Richards, 2008, *The Tragic Sense of Life: Ernst Haeckel and the struggle over evolutionary thought* (Chicago, IL: The University of Chicago Press), p. 454. Miguel de Unamuno wrote his philosophical essay Del Sentimiento Trágico De La Vida (The Tragic Sence of Life) in 1912, which according to the author is a book dedicated to all civilizations and Christians, and an unquenchable thirst for the Truth.

[289] Ibid., pp. 453-454.

influential concepts including phylogeny, ontogeny, and ecology. The former two concepts are dedicated to understanding life at the species and individual levels. As I have shown in chapter 4, the position of bryophytes in the nomenclature debate mirrors how bryologists are situated within various definitions of species. The concept of *ecology* was dedicated to understanding the relationship between organisms and their physical environment. Etymologically, it is well-known that the word *ecology* originates from Greek word *οἶκος*, meaning "household," "housekeeping," or "living relations."[290] It was introduced by Haeckel through his book *Generelle Morphologie der Organismen* (*General Morphology of Organisms*) in 1866.

After examining the conceptual relation between Darwin's concept of "the economy of nature" or "polity of nature" in the *Origin of Species* (1859) and Haeckel's concept of *ecology*, Robert Stauffer concluded that Haeckel's definition and concept of *ecology* was too close to Darwin's description of "the economy of nature" to be original. In Darwin's terms, "the economy of nature" designated "the mutual relations of all organic beings to each other and to their environment,"[291] as infinitely complex. Stauffer's favoritism to Darwin biased him against Haeckel's contribution to the conception of *ecology*. Another more apposite evaluation traces Haeckel's trajectory of inspirations back to Alexander von Humboldt (1769-1859). Haeckel's original writing in his 1866 work shows Humboldt's contribution to his concept of *ecology*.[292]

Indeed, Haeckel defined *ecology* as "the whole science of the relations of the organism

[290] Ernst Haeckel, 1866, quote from Robert C Stauffer 1957, "Haeckel, Darwin, and ecology," *The Quarterly Review of Biology* 32(2), 138-144.

[291] See Stauffer, 1957, p. 140.

[292] Frank N Egerton, 2013, "History of ecological sciences, part 47: Ernst Haeckel's ecology," *Bulletin of the Ecological Society of America* 94(3), 222-244.

to the environment including, in the broad sense, all the 'conditions of existence'."[293] He further clarified the relations into organic and inorganic types, and the latter refers to "the physical and chemical properties of its habitat, the climate (light, warmth, atmospheric conditions of humidity and electricity), the inorganic nutrients, nature of the water and of the soil, etc."[294] Years later, in his 1904 book, *Die Lebenswunder* (*The Wonders of Life*) Haeckel proposed to demarcate disciplinary boundaries among sciences, define the place of biology, and clarify its relations to other sciences and philosophy. Particularly, he reiterated the significance of differentiating ecology from biology. As he wrote,

> I proposed long ago to call this special part of biology ækology (the science of home-relations) [sic.], or bionomy. Twenty years later others suggested the name of ethology. To call this special study any longer biology in the narrower sense is very undesirable, because it is the only name we have for the totality of the organic sciences. [295]

From the above quote, Haeckel apparently considered the new discipline of ecology would link all branches of life science and construct a cohesive image of all life forms, "the totality of the organic sciences." In other words, through his proposal of the discipline of ecology or "bionomy," his ambition was to offer a monistic vision of the world or to seek unity was achievable.

Haeckel's monistic philosophy demonstrated his life-long aspiration. In the preface of his *Der Monismus als Band zwischen Religion und Wissenschaft* (*Monism as Connecting Religion and Science: The Confession of Faith of a Man of Science*, English translation, 1894), he

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[293] Haeckel, 1866, quoted from Egerton, 2013, "History of ecological sciences, part 47: Ernst Haeckel's ecology," p. 226.

[294] Ibid.

[295] Ernst Haeckel, 1904, *The Wonders of Life: A Popular Study of Biological Philosophy* (No. 23) (Harper and brothers), pp. 78-79.

mentioned that he had been occupied by problems regarding the integration between science and religion for over thirty years antecedent to his commitment to monism.[296] Monism is a revolutionary belief in contrast to Western dualism, for Haeckel believes that God/the world, creator/creature, and spirit/matter, etc. are separate substances. Haeckel's monism not only assured the union between these dichotomized substances, but also united faith and knowledge. It further offered a firm basis and consistent explanation to various topics in scientific studies toward the end of the nineteenth century, including consciousness and human soul as evolutionary result,[297] the immortality of the cosmos in terms of matter, energy, and motion conversions, etc.[298] This monistic philosophy is of critical importance to understanding Haeckel's efforts in the fields of art and science, particularly his remarkable drawings in *Kunstformen der Natur* (*Art Forms in Nature*, 1899 - 1904). Based on Haeckel's monism, nature is no longer just an assemblage of organic or inorganic elements. Nature is Divine.

Hence, all organisms and creatures in nature are also sacred. From the perspective of art, since the Divine Nature can "open to us an inexhaustible fountain of aesthetic enjoyment,"[299] a monistic investigation of *It* sought the union among the sciences, ethics, and aesthetics, through which the scientific understanding of nature, aesthetic pursuing of the beautiful, and ethic training for the good, were one. Haeckel's conclusive and last sentence in his book *Monism*, "May God, the Spirit of the Good, the Beautiful, and the True, be with us,"[300]

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[296] Ernst Haeckel, 1894, *Der Monismus als Band zwischen Religion und Wissenschaft (Monism as Connecting Religion and Science: The Confession of Faith of a Man of Science*, English translation, UK: A and C Black).

[297] Haeckel, 1894, *The Wonders of Life: A Popular Study of Biological Philosophy*, pp. 45-48.

[298] Ibid., pp. 46-51.

[299] Ibid., p. 85.

[300] Ibid., p. 89.

reiterated this unity. Richards believes that this vision of scientific pantheism can be traced back to German pantheistic belief of the sameness of God and nature, represented especially by Spinozism and Goetheism.[301]

Haeckel's contribution to the concept of *ecology* and his commitment to monism, proves that the complexity of Haeckel's art works shows his delicate and subjective efforts to convey the message of the unity of knowledge, faith, art practices, and many other aspects of an intellectual lived in his time. According to Richards, who has offered lots of valuable insights into Haeckel's academic accomplishments, to understand Haeckel's practices in sciences and arts, one must attend to three principles that guided him. To be specific, these three principles are "the morphological tradition," his understanding of the object of biological and artistic comprehension, and "his deeper evolutionary and metaphysical convictions."[302]

5.1.2 Haeckel's Moss Art

Haeckel's painting of Muscinae (Mosses) depicts sixteen species (Figure 5.1). The species names are listed in the drawing on the right, as a line drawing of the image on the left. Although merely sixteen species are included, morphological characteristics of each species are detectable. For example, *Rhodobryum roseum* (7), commonly known as rose moss, is characterized by its large leaves that resemble roses. Other species in this drawing also are characterized by their distinctive features, such as *Sphagnum medium* (creeping at the bottom like hydrangea, 11), *Andreaea Thedenii* (peculiar hollow mature capsule like Chinese lanterns, 12), and *Hypnum*

[301] Richards, 2009, "The tragic sense of Ernst Haeckel: his scientific and artistic struggles," pp. 100-102.

[302] Ibid., p. 100.

castrense (feather-like leaves, 13), etc. In addition to the morphological features of the sixteen species shown in this painting, there are some other commendable aspects of this painting, particularly the way that the drawing integrates diverse species in one habitat, resembling a "miniature forest" or "miniature jungle" of mosses. The overall image conveys the message that mosses of all kinds co-inhabit, and that the lush, jagged miniature forests shine with energy and vitality. Most of Haeckel's artworks were dedicated to depicting the order and beauty of the divine nature. It is quite clear that he was also obsessed with the geometric structure of various creatures, as he demonstrated in his numerous drawings in *Art Forms in Nature* (Kunstformen der Natur, 1904).

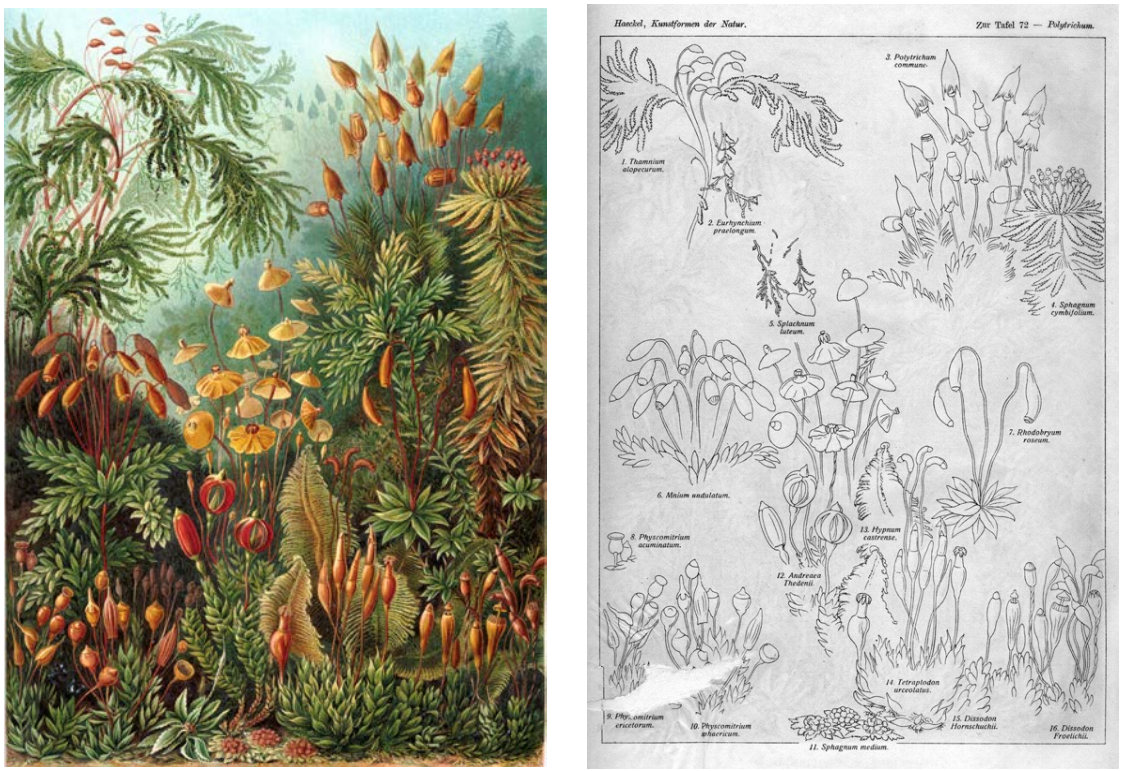

Figure 5.1: "Muscinae" from Ernst Haeckel's *Art Forms in Nature*. The right drawing illustrates "Muscinae" with species names. Photo credit: Ernst Haeckel, Public domain, via Wikimedia Commons.

The most frequent structures are exhibited as radiative and spherical (as shown by *Haeckeliana porcellana, Phaeodaria*, 3), spiral (as displayed by *Polystomella venusta,*

Thalamophora, 8), symmetrical (exemplified by *Surirella Macraeana, Diatomea*, 14), fractal patterns (*Parmelia olivacea*, *Lichenes,* 9), or the amalgamation of various patterns, etc.[303] Haeckel's drawings are presented in two types. One type (see figure 5.2) is simple organisms, typically displaying those striking patterns; and the other type (see figure 5.3) is complex creatures, correspondingly with a combination of various patterns and landscapes, such as the drawings of *Coniferae* (the family of cone-bearing trees like cedars, firs, and pines), *Trochilidea* (the family of Hummingbirds), *Chelonia* (the family of turtles), or *Lacertilia* (the family of reptiles), etc.[304] Usually, the second type of drawing shows various species of the same family in one habitat or landscape. The drawing of mosses, "Muscinae," belongs to the second type.

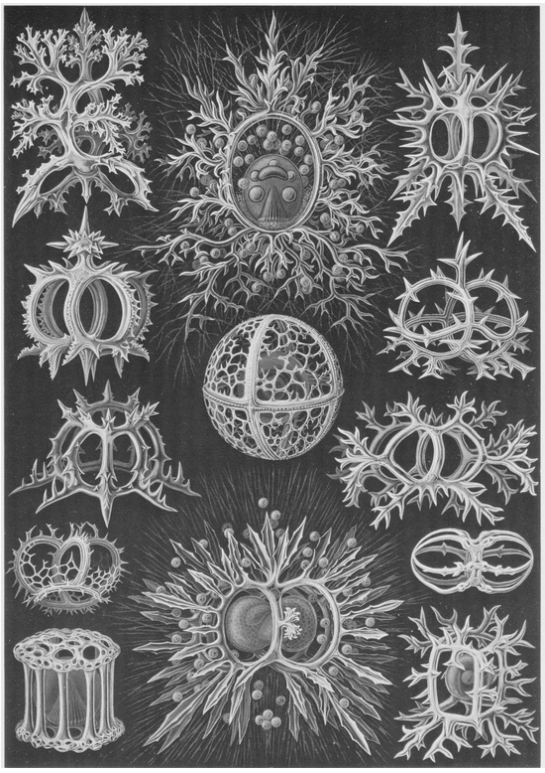

Figure 5.2: Striking patterns in Haeckel's drawings. The drawing is from *Art Forms in Nature* (Dover Publications, Inc., 1974), plate 70: "Various species of Gorgon-headed starfishes."

[303] Ernst Haeckel, 1974, *Art Forms in Nature* (New York, NY: Dover Publications).

[304] Ibid.

Figure 5.3: The family of Trochilidea. All hummingbirds are in one habitat, see plate 99: "Various species of hummingbirds."

The idea behind these arduous artistic and scientific endeavors is either to emphasize repetitive patterns or to locate different species within a habitat. Whether he meant that all organisms and living things, regardless of their position on the genealogical tree of life, share basic geometric patterns, or whether observing these patterns can open doors to the divine order remains a question. But he did place more emphasis on painting than the black-and-white photographic technique of his time. As he wrote in the foreword to the *Art Forms in Nature*,

> Indeed, a crude color sketch (if it conveys the landscape in a vivid fashion) has a deeper and more stimulating effect than the best black-and-white illustration or photographic representation. This distinction lies not only in the effect of color itself - since different individuals are sensitive in different measures - but also because the painter, as thoughtful artist, reproduces in his subjective image the conceptually articulated character of the landscape and emphasizes its essential features. The objective image of the photograph, by contrast, reproduces equally all parts of the view, the interesting and the mundane, the essential and the inessential. Thus, the colored photograph, if it

> should be brought to perfection, will indeed never be able to replace the individually conceived and deeply felt image of the painter. [305]

As the above quotation explains, Haeckel argued that painting would be superior to photographic representations because in painting the subjective involvement of the artist played an important role in expressing the essential characteristics of the artist's conception. In this sense, a drawing of a species is no longer just a copy, reproduction, or representation of those species in a habitat. Subjective value is irreplaceable. Photographic representation, as a totality of "what is there," may be authentic, but it lacks subjectivity. In Haeckel's moss painting, the subjective message is that even small plants like mosses and other tiny creatures are sacred.

5.2 A Tribute to Ernst Haeckel from China

In chapter 4, I have argued that bryophyte nomenclature was embedded in different cultures. In the scenario of the Chinese way of naming bryophytes, apparently, there are two different systems for how to name a moss. One is the traditional way, which contains much ambiguity and attends to habitat, medical use, and the connection of moss to the human body. The other is the modern way of naming bryophytes, which involves greater accuracy and endeavors to establish a scientific Chinese name for each species. In 4.5, academic lineage also shows that modern bryology and nomenclature in China have only flourished for about eight decades. The tribute to Haeckel stems out of this academic lineage and can be seen as a capsule of eight decades of growth. It is surprising that bryophytes have played such an invaluable role in connecting the Chinese and West.

[305] Cited from Robert J Richards, 2009, "The tragic sense of Ernst Haeckel: his scientific and artistic struggles," p. 98.

"Tribute to Ernst Haeckel" is a section of the Chinese-English bilingual book, 《苔藓之美》 (*The Magic and Enchantment of Bryophytes*). Indeed, not only is this specific section dedicated to Haeckel, but the entire book could also be viewed as an elucidation of Haeckel's conception that biological and artistic comprehension of plants and animals should converge at a certain point. The book contains collections of paintings, photographs, and Chinese calligraphies of bryophytes. The vital bryological information of each species, such as growth form, habitat, distribution, habits, relationships to other species, etc., is displayed with authentic photographs, with the following page showing an artwork, in the form of watercolor, acrylic, or gouache paintings. As a collective exertion from bryologists, artists, and calligraphers, the bryological discernment, artistic dexterity, and calligraphic mastery in the book deliver to the audience a message that the cosmos of bryophytes contributes tremendously to the ecological and aesthetic world. According to Alison Downing from the Department of Biological Science, Macquarie University, Australia, who wrote a forward for the book,

> ... Zhang Li and his colleagues delight us with yet more superb illustrations ...To my great delight, some wonderful large-scale paintings that include multiple bryophyte species have been included to pay tribute to Professor Ernst Haeckel (1834-1919), a German biologist, naturalist, philosopher and artist who described thousands of new species in many fields. I never cease to admire the skill of the artists ...Three calligraphy works of famous classical poems have also been included ... Not only does the calligraphy delight our eyes but the poetry reminds us that bryophytes have been observed and much treasured for aeons. I have always thought that Zhang Li and all his colleagues who contributed to The Magic and Enchantment of Bryophytes were artists in different ways. The new edition reminds me that they are also poets, historians and philosophers and I thank them for using bryophytes to give me a unique insight into Chinese culture. [306]

The millennium tradition of observing mosses has been traced back to the etymological

[306] Alison Downing, "Forward I," in Li Zhang, Qin Zuo, Lihui Mao, 2019, *The Magic and Enchantment of Bryophytes* (《苔藓之美》) (Nanjing, China: Phoenix Science Press), p. 5.

development of the Chinese word *mosses* in chapter 4.4. In the above quote, Downing mentions “some wonderful large-scale paintings” that pay tribute to Haeckel. “Some” are exactly three, namely, *Impression, Eastern Himalayas* (印象·東喜馬拉雅， Figure 5.4), *Becoming Alice* (成為愛麗絲， Figure 5.5), and *Autumn in Western Yunnan* (滇西秋色， Figure 5.6).

Figure 5.4*: Impression, Eastern Himalayas.* It was drawn by Shihua Li, acrylic on canvas, 75 cm (29.5 inches) by 100 cm (39.3 inches), 2017. The description tells that the painting “reflects the diversity of bryophytes in the Eastern Himalayas, with a galaxy of 37 bryophyte species, including 5 liverworts, 31 mosses and one hornwort.” As depicted in the painting, various species were located in their habitual surroundings with the sizes scaled so that multiple species could cluster around each other. Copyright: Shihua Li.

Figure 5.5*: Becoming Alice.* It was drawn by Lili Xu, acrylic on canvas, 80 cm (31.5 inches) by 80 cm (31.5 inches), 2017. The creativity of *Becoming Alice* integrates several elements, namely, the household story of Alice's Adventures in Wonderland, 32 species of bryophytes, the painter's daughter (the baby girl in the painting), and a springtime atmosphere. In this painting, bryophytes not only embosom the baby girl but also decorate her garland. Copyright: Lili Xu.

Figure 5.6*: Autumn in Western Yunnan.* It was drawn by Lili Xu, acrylic on canvas, 80 cm (31.5 inches) by 80 cm (31.5 inches), 2017. This painting shows an image of autumn bryophytes. When temperature and rainfall drop with the season, the air contains less moisture and bryophytes take turn to present vivid autumn colors. Copyright: Lili Xu.

As the title "Tribute to Ernst Haeckel" indicates, these three large-scale paintings resonate with Haeckel's painting "Muscinae." First, they follow the pursuit of the "Muscinae" to combine artistic representation with biological accuracy. Just as Haeckel left clues in the paintings for the audience to look out for all sixteen species in "Muscinae," for each of the three large paintings, the artists also used partial close-up images to show species identification information and numbered the species so that admirers of the paintings could easily identify the moss species within them.

Haeckel is extraordinarily adept at both bryological identification and artistic creation, and for the Chinese artists who are neither bryologists nor botanists, they have been working closely, frequently, and diligently with bryologists in Shenzhen Fairy Lake Botanical Garden to accomplish what Haeckel has achieved, to depict the morphological features of each species with great accuracy. In that regard, although these artworks were drawn by the two female artists, they were primarily a collective achievement of the bryologists and artists in Shenzhen Fairy Lake. Together, the bryologists and artists encourage the audience to play a treasure hunt game, to closely observe and identify the bryophytes exhibited in the paintings.

Second, as mentioned in 4.1, Haeckel's "Muscinae" conveys a message of co-inhabitance of various mosses: the three large-scale paintings also convey their message of co-inhabitance to the audience. The *Impression* and the *Autumn* display the co-inhabitance of diversified bryophytes, while *Becoming Alice* carries a meaning of "harmony that can exist between human beings and nature."[307] The word *harmony* represents the antique vision of

[307] See Zhang, 2019, *The Magic and Enchantment of Bryophytes*, p. 194.

traditional Chinese culture that "harmony in diversity" (和而不同) is much more valued than "homogenization in disharmony" (同而不和), as Confucius expresses in *Analects* 13:23.[308] In *Becoming Alice*, the artist deliberately painted bryophytes not only from Asia, but also from other continents, with the intention of showing that Planet Earth is our only habitat and that all continents should strive for harmony between humans and nature. When Haeckel venerates nature and its elements as divine, the annotator of "Becoming Alice" invokes the Chinese vision of "harmony," or at least an ideal of ethical co-inhabitance, building a bridge between Haeckel's divine nature and Chinese "harmony." It is promising to have this biocultural conversation and meaningful for meeting others.

Third, although Haeckel's "Muscinae" does not designate an exact location, habitat, or region, it does suggest that 16 species inhabit a "place" given the relationship between near and distant perspectives throughout "Muscinae." The artists of the three large-scale paintings considerately specified the "places" in both *Impression* and *Autumn*. These two places, Eastern Himalayas and Western Yunnan, are two ecological zones recognized as two of the most globally renowned biodiversity hotspots. East Himalayas harbors iconic species like "Tibetan antelope, snow leopard, red panda and Tibetan sand fox," "at least 8,000 species of vascular plants," and "700 species of bryophytes."[309] The other biodiversity hotspot, Western Yunnan, houses around 17,000 vascular plants and 1,600 bryophytes. A bryophyte, *Takakia ceratophylla*, listed on the IUCN Red List of Threatened Species, is sheltered in this region.[310] Globally, the

[308] *Analects* 13:23.

[309] Zhang, 2019, *The Magic and Enchantment of Bryophytes*, p. 174.

[310] Ibid., p. 212.

biodiversity hotspots are usually cultural-and-ethnic-and-linguistic diversity hotspots.[311] The fact that the Eastern Himalayas and Western Yunnan harbor ethnic, cultural, and linguistic diversity[312] marks these paintings as carrying significant message of biocultural ethic and conservation. In this regard, these paintings in turn rediscovered Haeckel's "Muscinae" as biocultural heritage and enriched the significance of both Haeckel and his paintings for contemporary global socio-ecological-cultural crisis.

Since their completion, these artworks have fascinated domestic and international audiences. From July 23 to 29, 2017, these three large-scale paintings were exhibited in the nineteenth International Botanical Congress, along with approximately other eighty bryophyte artworks from Shenzhen Fairy Lake Botanical Garden. The congress, which is held every five years, registered 6,850 attendees from 109 countries and regions in 2017.[313] The moss art exhibition was also open to the public through WeChat registration to maximize the impacts of ecological communication between academia and society. Since the publication of *The Magic and Enchantment of Bryophytes*, more audiences have accessed the artworks and received the messages of co-inhabitance and harmony between human and nature conveyed by the enchanted moss-cosmos. On July 23, Peter H. Haven, a notable and distinguished American botanist and environmentalist, also the President Emeritus of the Missouri Botanical Garden,

[311] See Jules Pretty, Bill Adams, Fikret Berkes, et. al, 2009, "The intersections of biological diversity and cultural diversity: towards integration," *Conservation and Society* 7(2), 100-112; see also Luisa Maffi, 2005, "Linguistic, cultural, and biological diversity," *Annual Review of Anthropology* 34, 599-617.

[312] See Shengji Pei, 2004, "Ethnic cultural diversity and nature conservation in Yunnan," *Acta Botanica Yunnanica* (SUPPL. 15), 1-11; Hillman, 2003; Ben Turin, 2005, "Paradise under construction: minorities, myths and modernity in northwest Yunnan," *Asian Ethnicity* 4(2), 175-188; and Veena Bhasin, 2011, "Pastoralists of Himalayas," *Journal of Human Ecology* 33(3), 147-177.

[313] "Closure of the Nineteenth International Botanical Congress," *Shenzhen Special Zone Daily*（《深圳特区报》）, July 30, 2017.

reported on “Saving Plants to Save Ourselves: The Shenzhen Declaration,” which later was published as “The Shenzhen Declaration on Plant Sciences - Uniting plant sciences and society to build a green, sustainable Earth.”[314] Faced with the global situation of socio-ecological crisis, the Shenzhen Declaration calls for an integrated and collaborative solution which prioritizes seven actions. I have listed them below,

- To become responsible scientists and research communities who pursue plant sciences in the context of a changing world;
- To enhance support for the plant sciences to achieve global sustainability;
- To cooperate and integrate across nations and regions and to work together across disciplines and cultures to address common goals;
- To build and use new technologies and big data plat forms to increase exploration and understanding of nature;
- To accelerate the inventory of life on Earth for the wise use of nature and the benefit of humankind;
- To value, document, and protect indigenous, traditional, and local knowledge about plants and nature;
- To engage the power of the public with the power of plants through greater participation and outreach, innovative education, and citizen science.[315]

In terms of the three large-scale moss paintings and other artworks presented in the book of *The Magic and Enchantment of Bryophytes*, these efforts at least echo the above calls. Although the declaration does not rule out utilitarian and anthropocentric thinking, a calling of “the power of plants” and “the power pf the public” does echo the core values of Michael Marder’s

[314] See Peter R Crane, Song Ge, De-Yuan Hong, et al, 2017, “The Shenzhen Declaration on Plant Sciences-Uniting plant sciences and society to build a green, sustainable Earth,” *Journal of Systematics and Evolution* 55(5): 415-416.

[315] Ibid.

vegetal democracy.[316]

5.3 Moss Gardening: Affinity and Companion

In the last two sections I have discussed the ethical teachings in the moss artworks of Ernst Haeckel and Chinese artists, particularly the divine nature of mosses and the necessity of co-inhabitance. The power of artworks to carry ethical teachings is so massive that citizens form a deep affinity for the miniature cosmos of moss. When I tried to trace the sources of this affinity beyond the paintings, I came across various types of ways for people to immerse themselves and indulge in this affinity for moss, such as gardening, landscape designing, indoor decoration, stylish T-shirt, etc. How astonishing and delightful it is that mosses are even more accepted than some flowering plants in some communities and social clubs. In this section, I describe various types of moss-gardening to inquire how people connect with mosses in everyday life. In the next section, I examine the ethical concerns of human-moss interactions in moss gardening.

Generally, I clarify moss-gardening into three types based on scales. The largest scales of moss gardens are found in botanical gardens, temples, antique academy, and designed landscapes. Such moss gardens usually bear some cultural or religious significance. Some places

[316] According to Marder, "vegetal democracy is open not only to Homo sapiens but to all species without exception. Like the plant-soul itself, consonant with life's hospitality, it stands for that which is most common and most inclusive, not by formally enveloping its contents but conversely by bringing into relief differences and divisions without which no "sharing," no participation, no "being-with" is possible. Far from furnishing a natural or a naturalized foundation for actual and ideal democratic regimes, it is a paradigm of sharing more basic than any exchanges between "autonomous" individuals. The non-economic generosity of plant-soul, giving itself without reserve to everything and everyone that lives, transcribes vegetal democracy into an ethical politics, free of any expectations of returns from the other. Its divisibility renders irrelevant the task of reconciling particular, individual interests and the universal Good, since what happens below individual unities bears directly upon common well-being." See Michael Marder, *Plant-thinking: A philosophy of vegetal life*, p. 52.

convey a rich and meaningful biocultural message in the sense that biological diversity and cultural heritage co-exist and add radiance to each other. For example, the Moss Garden of Bloedel Reserve in the Bainbridge Island, Washington, not only enjoys its reputation of more than forty species of bryophytes in the area, but also is recognized as a resurgence of moss gardening, the most notable of which can be traced back to Japan's Saiho-ji Temple (西芳寺, Figure 5.7 left). Saiho-ji demonstrates the most naturalistic practice of moss gardening. Built 1,300 years ago in the Nara Period, it has more than 120 species of bryophytes thriving on a surface of 35,000 square meters (around 8.6 acres) and is internationally recognized as the "Koke-dera Temple" or "Moss Temple." As early as the 1960s, Japanese bryologists have identified the scientific names of bryophytes species in Saiho-ji Temple.[317] A recent study of the bryophyte biodiversity and the microclimates in the garden shows that bryological conservation in Japanese temples may contribute to the "functional diversity and ecological resilience of urban biodiversity."[318] Besides the Japanese garden, in the Lost Gardens of Heligan (UK), artists Sue Hill and Pete Hill created two sculptures in 1997, Mud Maid and The Giant's Head, which revitalized the abandoned garden and became iconic sculptures of the garden.[319] The two sculptures emerge from the land, conveying a sense of vicissitude, as if the Lost Garden has survived several hundred years of construction, plantation, abandonment, and revitalization.

Similar to the Lost Garden of Heligan, the Wansong Academy (萬松書院, Myriad Pines

[317] Zennoske Iwatsuki, and Tsutomu Kodama, 1961, "Mosses in Japanese gardens," *Economic Botany* 15(3), 264-269.

[318] Oishi, 2019, "The influence of microclimate on bryophyte diversity in an urban Japanese garden landscape," *Landscape and Ecological Engineering* 15(2), 167-176.

[319] See https://www.heligan.com/explore/estate/woodland. With her face covered by bryophytes in summer, Mud Maid was also known as "Moss Maiden."

Academy) in Hangzhou (China) is also a symbol of historical deposits and bryological fondness. The Academy, which initially had been constructed as a Buddhist Temple during the Zhenyuan Period of Tang Dynasty (785-804), was remodeled in 1498 into a Confucian Academy for scholars and students.[320] Bryophytes in the Academy have attracted many visitors since 2017 when the Academy co-hosted an annual exhibition of bryophytes with Hangzhou Botanical Garden and Hangzhou West Lake Academy of Landscape Science. The moss gardens in the Academy, featuring both planted moss garden and naturally grown mosses, symbolize human-moss interactions in cultural relics. In contrast to the well-maintained moss garden in the Saiho-ji Temple, the sculptures in the Lost Garden of Heligan were an outcome of planting mosses and then allowing them to grow. In the case of the naturally grown garden in the Wansong Academy, it involves entirely letting mosses grow without even plantation. Figure 5.7 (right) shows how mosses have thrived on the roof of the Wansong Academy, a vivid presentation of the name "wū-yóu" (屋游, roof drift, tile clothe, tile moss, tile loose, etc., ref. chapter 4.3). This enduring tradition of moss-gardening has steered modern moss-gardeners like George Schenk and Annie Martin, who are passionate about designing moss gardens.[321] Additionally, moss gardening has become an applicable and effective way to shake off the grass lawn obsession. Grass lawn is notorious for the chemicals and toxins they import to urban ecosystems,[322] not to

[320] In the narrative of the Chinese Romeo and Juliet, known as "the Butterfly Lovers" or "Liang Shanbo and Zhu Yintai" (梁山伯與祝英台), the two met at the Academy as fellow students. See Qun Shao, 2019, "Hanzhou Wansong Academy" (《杭州萬松書院》), *Xin Yue Du* (《新閱讀》), 3, 21-23.

[321] Modern moss gardeners value the ecological service and environmental benefits offered by bryophytes, such as water conservation, erosion control, flood mitigation, filtration, phytoremediation, and carbon sequestration. See Martin, 2016, *The Magical World of Moss Gardening* (Portland, OR: Timber Press).

[322] Paul Robbins, Annemarie Polderman, and Trevor Birkenholtz, 2001, "Lawns and toxins: An ecology of the city," *Cities* 18(6), 369-380.

mention the energy consumption and other problems caused by lawn mowers. Roofs covered with moss and lichen may have different meanings in Asia, Europe, and North America. For Asian and European societies with centuries of histories and cultural immersion, it may mean harmony between human spirit and buildings, antiquity, and funniness; for North American cultures dedicated to the forging of a new world, it may mean roof cleaning service.[323] Of course, that has not prevented some wealthy North Americans from finding ways to transplant mosses to deliberately pursue a sense of antiquity or to replicate a particular eco-region in their modernized manors（ref. 5.4）.

Figure 5.7*:* Moss Gardens. [324]

The second popular type of moss-gardening is moss graffiti and its derivative, moss wall. The two forms are placed together partly because both are vertical and partly because both are of medium scale. Moss graffiti as an art form initially appeared in Europe in the 1970s.

[323] See George Schenk, 1997, *Moss Gardening: Including lichens, liverworts, and other miniatures* (Portland, OR: Timber Press).

[324] The left photo shows moss garden in Saiho-ji Temple, open access through http://saihoji-kokedera.com/top.html, accessed on Feb. 1, 2022. The right shows mosses on the roof of Wansong Academy, photo taken by Ji Fou ( ).

Figure 5.8*:* Moss graffiti and moss wall. [325]

The most archetypal moss graffiti is the Big Bang (Figure 5.8, left), created by artist Anna Garforth. She assembled hundreds of moss tufts collected from stones walls around Hackney to express "Mother Earth as a seed shattering explosion."[326] Garforth's idea also attracted architects and she was invited to install another object "The King's Cross Picnic" in the London Festival of Architecture in 2012.[327] For some architects, vertical moss graffitis and walls are useful tools and solutions for urban transformation.[328] In New York City, the studio "Mosstika" also gathers some artists to incorporate local plants into art works. This studio is not exclusively focused on moss graffiti, but they have installed moss artworks on the street walls in New York City. Moss graffiti on urban walls usually convey some ideas about green living or the adoration of nature, just like the Big Bang displays the image of an "explosion" as if life is exploded on

[325] The left photo shows "The Big Bang," created by Anna Garforth, collected in the Russian Club, East London, open access through https://www.floelondon.com/the-big-bang, accessed on Feb. 2, 2022. The right photo shows moss wall in a commercial space, designed and installed by Artisan Moss, open access through https://www.artisanmoss.com/gallery-commercial/, accessed on Feb. 1, 2022.

[326] Accessed through https://www.floelondon.com/the-big-bang on Feb.1, 2022.

[327] Accessed through https://archello.com/project/the-kings-cross-picnic on Feb. 1, 2022.

[328] Rafał Zieliński, 2015, "Importance of sketches, graphics and computer in designing green walls," *Czasopismo Techniczne* (Technical Transaction) 4-A, pp. 293-299.

Earth. The founder of the studio "Mosstika," Edina Tokodi also states that "my installation works dissolve the barriers between private and public space, between the organic and inorganic elements of the urban landscape, and between nature and art."[329]

Contrary to moss graffiti that conveys the idea of green living, moss walls are rapidly being commercialized with the slogan of enriching indoor living spaces. U. S. companies like "Artisan Moss," "the Good Earth Plant Company," "Moss Pure," "Bemoss," the German company "Freund," and the U. K. company "Preserved Moss" are proud of the features and values created by their moss walls, such as biophilic design, bringing nature indoors, maintenance-free, stabilizing moisture, absorbing noise, botanical art, and aesthetic appeal, etc. Designers and artists understand how important it is for people to connect with nature, and they bring nature to them. Artisan Moss in Northern California states its mission as "we want to create green, botanical art at any scale; and it had to be stunning, unique and easy to care for."[330] The Good Earth Plant Company calls for a workspace revolution, to create the post-pandemic workplace where mosses and many other plants could contribute to the health and well-being of people in the building environment. The company organized the Silverado Roundtable and published a white paper for professional designers, which announces "American business must embrace workplace design supporting comfort, safety, and the human need to be part of a collaborative culture to remain competitive and to retain its top

[329] Accessed through http://www.mosstika.com/about on Feb. 1, 2022.

[330] Accessed through https://www.artisanmoss.com/how-we-began/ on Feb. 1, 2022.

talent."[331] Who would have thought that moss could comfort people to continue human productivity and creativity after the COVID pandemic? Once these mosses were alive, and now they are preserved with glycerin and non-toxic resins for the rejuvenation of human vigor and vitality.

Besides moss gardening on the scale of yard and wall, the smallest popular moss gardening practice, known as "miniature landscape" or "moss terrarium," is widespread despite socio-cultural variances. People from diverse cultural backgrounds have cultivated this taste of appreciating the vitality, vigor, and beauty of the miniature landscape. These mosses are removed from their original habitat and relocated in glass containers or other types of vessels. In the recent decade, internet technology and social media have allowed people to communicate about their affinity for moss terrarium. For instance, "Giant Moss Dripwall Terrarium with a Pond," one of the most visited videos from the YouTube channel "SerpaDesign," has been visited more than two million times since April 4, 2020. The audience employ terms such as *paradise, biosphere community, beautiful, stunning, gorgeous, amazing, awesome, brilliant, incredible, work of art*, etc. to express their appreciation. Some audiences imagine that they are tiny people dwelling in glass vessels. Another video from a different channel "苔テラリウム専門-道草ちゃんねる- (Moss Terrarium - Michikusa Channel)," "苔むす石段の作り方 (How to Make Mossy Stone Steps)," has been visited more than 700 thousand times since it was uploaded on September 25, 2020. What is particular about this video is that the video producer has listed the scientific species names of all bryophytes in the terrarium.

[331] The Silverado Roundtable, 2021, "White Paper: The nature of the post-pandemic workplace," accessible through https://www.goodearthplants.com/wp-content/uploads/2021/01/Silverado-Roundtable-Whitepaper-NaturOfPostPandemicWorkplace-v1.0-WEB.pdf.

Visitors appraise this video as a masterpiece for its beautiful and therapeutic design. International audience from Canada, Germany, America, Sweden, Poland, Sri Lanka, Czech Republic, Spain, England, etc. beg for English subtitles. It is such a delightful experience that mosses bond people from various geographical locations and socio-cultural backgrounds.

Besides YouTube, social media such as Facebook and Instagram also offer platforms for moss terrarium enthusiasts and business owners to communicate, commercialize, and commune. Instagram has gathered members such as "moss-connect あなたと苔を繋げる" (Osaka, Japan), "mossarium_kl" (Selangor, Malaysia), "mosslight1955" (Hyogo, Japan), "theframeterrariums" (Dubai, UAE), "Terrariumtribe" (London, UK), "Glassgardenslondon" (London, UK), "dartfrogterra" (Germany), etc. and these members upload numerous photographs of their work. Chinese moss terrarium enthusiasts such as "毛野家" (Mao-ye home), "岫草微景" (Tranquil herbs for mini landscape), "一葉一植苔蘚手作" (One leaf, one plant, bryophytes handicrafts), "蘚然" (Moss-so), "子航的微型世界" (Zihang's miniature world), "幾何自然" (Geonature), etc. gather at Xiaohongshu (Little Red Book) to communicate and share. To a certain extent, this modern trend of "miniature landscapes" or "terrariums" is a remnant of traditional practices like "Penjing" or "Bonsai." A moss terrarium is like a miniature garden on the desk. Some moss terrariums have combined narratives to set up the tone and link the terrarium to cultural tradition or contemporary cultural penchant (Figure 5.9). These devotees usually run local businesses, offer terrarium classes, and organize other activities such as moss tours, moss photograph contest, moss exhibition, etc. Mosses used by terrarium producers are either gathered from the local environment or purchased from supplies of cultivated mosses.

In terms of these three kinds of moss gardening, it can be said that people desire mosses as companions. The diverse human-moss linkages displayed by moss gardening seem to reveal the vicissitude of the times. Old temples and traditional schools that have survived for centuries often provide excellent habitats for mosses, where people can visit mosses, navigate the ever-changing times, and embrace what moss can teach about people's life. Moss graffiti and commercial moss walls seem to indicate that street artists and design professionals strive to bring moss into urban environments and living spaces. Through them these phenomena and the ethical issues behind them are worth pondering. The smallest scale of moss gardening seems to be a spontaneous act of people who, because of their fondness for mosses, bring them into their daily lives. Moss terrariums are placed in people's daily living spaces both as an aesthetic element and as cultural symbols that suggest narratives, stories, and other meanings. All three of these different scales of moss gardening demonstrate that some people enjoy intimacy with moss.

Figure 5.9: Moss terrariums and cultural narratives.[332]

[332] The left photo is a moss terrarium with a Totoro, designed and created by mossarium_kl, photo accessible through Instagram of "mossarium_kl." Totoro is a woodland creature in Hayao Miyazaki's animated film *My*

I would argue that in some scenarios, human-moss interactions show that humans care about mosses. But in some other scenarios, mosses seem to be more generous than humans, with humans becoming the ones being nourished and cared for. Humans' modern adoration of moss is focused directly on the garden, a garden where moss and other species are kept in confinement and designed to be viewed, gazed at, and contemplated as objects.

5.4 Conviviality: Meeting Mosses in Gardening

As described in 5.3, the three types of moss gardening, namely, the horizontal garden, the vertical wall, and the container garden, demonstrate that human-moss interactions are quite complicated. Now in terms of human-moss interactions in moss-gardening, there seems to exist a spectrum from totally human-dominated to moss-dominated interaction. In traditional moss gardens such as temples, antique academies, and other human-dwelling places which have survived centuries of socio-environmental changes without dramatical transformation, mosses seem to dominate the interaction. In those places, the ethical code is moderately solid, to sustain mosses and not to step on them. That is why Saiho-ji only opens to the public in certain periods and visitors must make reservations before they go to worship or visit mosses.

The cases of vertical moss walls and miniature terrarium are different. The ethical codes are vague as some human-moss interactions are hidden from what people can observe. When companies install moss walls, mosses have gone through the preserved process. For those who

Neighbor Totoro. The right photo is a moss terrarium with the four main characters in the novel *Journey to the West* (《西遊記》), designed and created by "畑草微景" (Tranquil herbs for mini landscape). As one of the Four Classical Sagas*, Journey to the West* was published in the 16th century which narrates the pilgrimage journey of Monk Xuan Zang and his disciples, Monkey King, Monk Ba Jie, and Monk Sha.

create moss terrariums, mosses have been removed from their microclimate and relocated in glass containers. The price for the benefits or pleasure generated by using moss to enhance a workspace or creating a moss terrarium is the complete industrialization or privatization of moss. Moss must first be appropriated, or rather, moss must first be completely objectified, materialized, managed, and manipulated. Because of this appropriation in which humans dominate the interspecies interactions in absolute terms, conviviality has been lost when humans dominate interspecies interactions in absolute terms, because conviviality, the quality of being friendly, carrying meanings such as "relating to," "occupied with," or "good company," must welcome the presence of others and their speech. When Illich argues that contemporary modern society has deprived people of conviviality and reduced them to consumers,[333] an analogical relationship can be made to interspecies encounters when humans dominate the relationship. In domination there is the absence of conviviality.

In scenarios in which humans attempt to dictate interspecies interaction, human zeal to manipulate and control other species can be flawed, as Kimmerer shows in her book. She was invited to help a wealthy owner "create an exact replica of the flora of the Appalachians, in a native plant garden" and ensure the authenticity of the replica that "mosses were included in the restoration."[334] The divergence between "the owner wants mosses to grow on all these rocks" and "you cannot move mosses just like rearrange furniture" demonstrates that "mosses have an intense bond to their places that few contemporary humans can understand."[335]

[333] Illich, 1973, *Tools for Conviviality*, pp. 11-12.

[334] Kimmerer, 2003, *Gathering Moss*, p. 125.

[335] Ibid., p. 131.

Biologists fathom that successful moss gardening must not only consider the microenvironmental factors under which each species can grow, but also wisely select the right species. More importantly, moss cannot grow instantly, and as I mention in chapter 2, the time scale of moss is not the same as the time scale of humans. Not to mention, the human time scale has been completely changed since the introduction of the industrial ethical principle mostly based on cost-benefit control, seeking efficiency, and immediate availability.

In addition to the differences in the degree of human domination of the moss gardening types described in 4.3, the attitudes toward mosses in interspecies encounters also differ. For instance, some moss gardening is exclusively about exploiting moss for commercial purposes, while some moss gardening is simply about living delightfully with the companion of moss. In this regard, modern moss gardening seems to have gone through a process of moving from instrumental exploitation to appreciation of the intrinsic value of mosses. When people recognize the intrinsic value of mosses, they acknowledge that these tiny species are valuable for their own sake, rather than for any human ends, be it for ecological services, economic value, or aesthetic value. Since the 1930s, American bryologists have appreciated the prominence of moss in gardening. According to Grout, "The soft beauty of coloring imparted to a landscape or a roof by a covering of variously shaded mosses has always been appreciated by artists and other lovers of beauty."[336] Besides the beauty, artificially cultivated mosses on new buildings also enhance "the charm of antiquity."[337] It was a common idea in gardening that

[336] Abel Joel Grout, 1931, "Mosses in landscape gardening," *The Bryologist* 34(5), 64-64.

[337] Ibid.

bryophytes were tools for creating a sense of antiquity. Bryologist Walter Gerritson contrasted gardens of flowering plants and of mosses, and he claims,

> We see and admire gardens of flowering plants with their bright, beautiful blossoms. What a contrast is a garden of mosses with their soft velvety forms and varying shades of green, some with mats of fern-like growth, some with up-right stems, and others with rounded bosses. Yet when these are well arranged, they make another garden of true beauty.[338]

It thus appears that the garden composed of diversified miniature bryophytes is no less beautiful to Gerritson than a garden of angiosperms. "The charm of antiquity," "soft velvety," and "true beauty" are captured by Japanese bryologist, expressed as "a feeling of tranquility of mind," and Japanese bryologists are particularly fond of bryophytes "because they tend to create such an atmosphere."[339] Bryophytes have been planted and employed to invent antiquity, velvety, tranquility, and true beauty. Although the appreciation of mosses from an aesthetic perspective seems tainted with instrumentalism, at least they are not deprived of life, thus leaving the opportunity for meeting to fulfill conviviality.

Conversely, in the eyes of a person who is truly prepared to meet bryophytes in gardening, there is considerable difference he or she can show. Kimmerer reflects the ethical issues in human-moss interactions through the wealthy owner's invisibility, his power of facelessness, purposeless possession, control, and his capricious loyalty and betrayal to mosses. Being anonymous and faceless allows the wealthy owner unethical manipulation of both mosses and humans. How could the wealthy owner free himself from this bondage by copying the flora of the Appalachians and ordering professional support of a bryologist to manipulate

[338] Walter Gerritson, 1937, "A garden of mosses," *The Bryologist* 40(2), 39-40.

[339] See Iwatsuki & Kodama, 1961, "Mosses in Japanese gardens."

mosses? Does he even care?

Professional moss garden designers such as Annie Martin, George Schenk, Sue Hill, Helen Yoest, and David Spain might know how to become free from the bondage, and they enjoy good reputations in creating steady conviviality of meeting mosses. For those moss gardeners, mosses are mesmerizing, and they are generous and hospitable when talking about their obsession with mosses. As Annie Martin writes,

> The magic of moss gardening may start with the way it makes me feel, but many other aspects of moss fuel my love affair. Mosses offer visual delights and tactile pleasures; they stoke our imagination and our memories; they connect us to earlier peoples and moss gardeners around the globe; they have countless environmental advantages and medicinal uses; and they are simply a joy to garden with. [340]

She has categorized the benefits of moss gardening into many categories and has accumulated a cornucopia of experience, stories, and narratives in numerous workshops and lectures to convey these benefits to other humans in vibrant forms. She values how individual experiences from others are intertwined with mosses. Furthermore, who could have imagined that her first step into a moss cosmos and professional moss gardening started with her first terrarium at the age of ten? Who could have imagined that her intertwining with moss led to majestic grandeur? I believe when she writes the following, she is ready for a meeting,

> Every time I walk out of my front door, my mosses greet me, triggering a smile in my heart. The magic of my garden engulfs my spirit, and that internal smile instantaneously moves to my face. As I gaze at the dazzling mosaic of mosses in my garden, I feel immense joy and pride juxtaposed with calm. Throughout all seasons, my mosses have a magnetic quality that engulfs me. Most often, I am catching a quick glimpse for an infusion of moss magic as I head out into the world as a moss landscape designer and moss farmer. What a divine way to start a day! [341]

[340] Annie Martin, 2016, *The Magical World of Moss Gardening* (Portland, OR: Timber Press), p. 10.

[341] Ibid., p. 10.

The overwhelming power and enchantment of mosses sublimate the human-moss interaction in Martin's case. She shows generosity in eulogizing mosses. The "my" in the phrase "my mosses" in her case is no longer an assertion or statement of ownership or possession, but an expression of affinity, kinship, companion, co-inhabitance, and a way to the transcendent. Furthermore, as she states, in the being of mosses is the presence of the divine. In this regard, Martin forms a deep connection and "an alliance" with the Japanese gardeners who have dedicated themselves to mosses in the temples.[342] Similar to Japanese gardeners' spiritual inspiration of moss, in Martin's meeting with moss, she meets the transcendent and the divine.

Another renowned and erudite moss gardener, George Schenk, who has created moss gardens for various purposes like entertainment, enjoyment, and education, has brought moss gardens to cities such as Seattle, Vancouver, Auckland, Manila, etc. In his meeting with various miniature plants while transplanting mossy rocks, he profoundly captures the deep connection between mosses and humans. As he writes,

> In the rock itself we perceive the world raw and uninhabitable. In the moss on the rock, we see the world breathing greenly and preparing for our habitation. Moss on stone is as a comforting hand on a human shoulder.[343]

Just because moss prepares for "our" habitation, one need not reject one's appreciation of moss on rocks as anthropocentrism or instrumental rationality. Rather, it is the most glorious generosity of moss that colonizes rocks, makes them alive, prepares "our habitation," and gives us things without which we could not inhabit the Earth. Thus, a mossy rock is "a comforting hand on a human shoulder," reminding that rather than being alone on the planet, humans co-

[342] Ibid., p. 19.

[343] Schenk, 1997, *Moss Gardening: Including lichens, liverworts, and other miniatures*, p. 56.

inhabit with mosses and myriads of other-than-human species. This consolation won't vanish if we always keep in mind the dignified colonization of mosses on rocks. Therefore, while *Sphagnum* mosses and limestone were constructed into a natural and self-perpetuating system for acid mine drainage,[344] we should be mindful and grateful for the efforts of *Sphagnum* mosses, namely, the fact that they have strived to live and reduce the acidity and metal concentration of the drainage. In this case, abandoned mines become deserted landscapes, and once again, mosses prepare us for habitation, reclaiming and revitalizing deserted landscapes. For moss gardeners and those who fix the landscape with *Sphagnum* mosses, the colonization of rocks and the restoration of abandoned mines by mosses are signs of the triumph of life.

Moss gardeners such as Annie Martin and George Schenk are sages wise about understanding (bryology and ecology), appreciating (the enchanted beauty), venerating (the presence of mosses in biosphere), and cultivating (mosses, themselves, and ethical human-moss interactions). Martin refers to the ethical code people should follow while gathering mosses, and she admonishes people attending to "the distinctions among rescuing, harvesting, and stealing mosses."[345] Wild moss gathering for distribution apparently is detrimental to conservation. When harvesters in the United States have gathered wild mosses as much as seventeen million pounds in a single year, and most of them are from the Pacific Northwest and Appalachia,[346] ecologists have enough reason to be apprehensive about moss gathering. It

[344] Robert LP Kleinmann, Thomas O Tiernan, Joseph G Solch, et al., 1983, "A low-cost, low-maintenance treatment system for acid mine drainage using sphagnum moss and limestone," in *Proceedings of the 1983 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation* (Lexington, KY: University of Kentucky), pp. 241-245.

[345] Martin, 2016, *The Magical World of Moss Gardening*, p. 169.

[346] Joshua Tompkins, 2004, "Moss hunters roll away nature's carpet, and some ecologists worry," *New York Times* November 30.

takes only one year to collect seventeen million pounds of moss, but it can take more than a hundred years for moss to recover. Years of gathering added up to exponential moss decline.

Moss farms or nurseries that grow mosses for gardening and landscaping also need to follow ethical codes in their harvesting and farming practices if they want to avoid ecological degeneration. If one wants the everlasting companionship of mosses in the fields, perpetual availability for collection, readily accessibility for people to express their aspirations, even if only observe them from a distance or play with them with a hand-lens, then the first step toward the aspiration for moss companions should be ethical reflection, that is, to remember the true meaning of conviviality when encountering mosses. Doing so requires eliminating human dominance, contemplating their otherness, appeals, time scales, and caring for them when encountering mosses. Just as Illich envisions a convivial society in which tools serve everyone and allow their values to be realized, convivial biocultural interactions in which interspecies relationships, intercultural relationships, can and are oriented toward the other. The ethics of conviviality is not exactly about altruism, but simply about the proper handling of the relationship with the others, without depriving them of their existence. Their presence is already a gift, already a care shown by the Other.

5.5 The Human Condition in Moss Gardening

The simple ethical codes like “don’t step on mosses,” “sweep away debris,” “weed the mosses” in Saiho-ji Temple present a call for meeting mosses with a moral appeal to not disturb the moss.[347] Unethical gathering of moss has gone to extreme vices that go far beyond

[347] Schenk, 1997, *Moss Gardening: Including lichens, liverworts, and other miniatures*, p. 34.

disturbance. It is the absence of meeting, but taking, possessing, appropriating, and privatizing. Where do those mosses end their journey? When I see products preserved Mixed mosses, moss milkshake, moss balls, or dried mountain mosses for gardening sold on Amazon, SuperMoss, Hobby Lobby, Dollar Tree, etc., I keep imagining the journey they have gone through and questioning events behind the scenes. Have they gone through unethical moss gathering, harvesting, or poaching which would indeed corrupt the efforts of gardening itself? So, what is the human yearning for gardening? Is it the expectation that mosses settle on rocks, crawl in the soil, or cluster in containers in our living or working spaces?

Moss gardeners usually talk about the benefits of planting and growing moss, such as restore the soul, feed the spirit, and provide a sense of peace and serenity.[348] Thinkers such as Karel Čapek (1890-1938), Pablo Neruda (1904-1973), and Robert Pogue Harrison uplift the philosophical meaning of gardening from different perspectives. In The Gardener's Year (1984, originally published in 1929), Čapek imagines the scene that a gardener comes into the Garden of Eden, "he would sniff excitedly and say: 'Good Lord, what humus!' I would think that he would forget to eat the fruit of the tree of knowledge of good and evil."[349] Čapek's witticism implies that if Adam had not yet taken care of the humus in the Garden of Eden, he could not yet be called a gardener. The several words in *Genesis* 2 about what Adam did in the Garden of Eden are clearly not focused on what he did, and we cannot conceive of whether Adam ever labored in the garden as a gardener. At least Čapek imagined that all gardeners should have

[348] See Martin, 2016, *The Magical World of Moss Gardening,* for example, p. 93.

[349] Karel Čapek, 1984, *The Gardener's Year* (Madison, WI: University of Wisconsin Press), p. 34.

evolved into “some kinds of invertebrate” to avoid back ache,[350] probably like a frog without vertebral columns, because the gardener squatted and labored like a frog sitting on the ground. Čapek believes that gardeners had to dig themselves into the earth in order to become gardeners, rather than just sitting back and reaping all the fruit that the garden produced, as Adam did.

Neruda, in his poem “Oda a la jardinera” (Girl Gardening, or Ode to the Gardener), eulogizes humans’ terrestrial love perpetuated in gardening, “the dust of your heart, bring us word of fecundity, love, and summon the strength of my songs ... and my heart works below in the roots.”[351] Harrison connects Neruda’s poem to Eve’s primordial role as gardener, in tasting the fruit, “human vision was born” and death is not the price but matrix of life’s vitality.[352] Harrison has assumed that in Eden “there was no fecundity of generations,” “no death,” “no birth,” and the fall, as a preference of mortality over immortality, is the seeking of self-fulfillment over everything provided.[353] Following the thread of Eve’s burning desire of self-fulfillment, Harrison discovers care, which presents as “a constant, interminable condition for human beings.”[354] The Fall is in turn interpreted as a step to maturity, to become a gardener, as Harrison writes,

> It was only by leaving the Garden of Eden behind that they could realize their potential to become cultivators and givers, instead of mere consumers and receivers. Regarding that potential, we must not forget that Adam, like *homo* in the Cura fable, was made out of clay, out of earth, out of humus. It’s doubtful whether any creature

[350] Ibid., p. 35.

[351] Neruda, 1961, *Selected Poems of Pablo Neruda* (New York, NY: Grove Press), p. 257.

[352] Robert P Harrison, 2008, *Gardens: An essay on the human condition* (Chicago, IL: University of Chicago Press), pp. 17-19.

[353] Ibid., p. 14.

[354] Ibid., p. 7.

> made of such matter could ever, in his deeper nature, be at home in a garden where everything is provided. Someone of Adam's constitution cannot help but hear in the earth a call to self-realization through the activation of care. His need to engage the earth, to make it his place of habitation, if only by submitting himself to its laws—this need would explain why Adam's sojourn in Eden was at bottom a form of exile and why the expulsion was a form of repatriation. [355]

Gardening in this sense is not about restoring a lost paradise, but rather about taking care of the mortal human world, where the earth is "the matrix of pain, death, corruption, and tragedy."[356] From Harrison's interpretation of the Fall, I have been questioning, in terms of humanity, what forms the continuum of being created humans, sojourning in Eden, the Fall, the expulsion, and "hard labor to eat"?

The answer seems to be "dust" and "in the image of God." [357] The inconsistency between unethical moss gathering and the true meaning of gardening makes moss gardening without care and ethical concerns futile. When Harrison claims that "(T)he more we succeed in turning the Earth into an inexhaustible inventory for human consumption, the more we abandon the postlapsarian vocation of care that turned human beings into cultivators of the mortal Earth, as well as cultivators of our mortal modes of being on the Earth,"[358] he is right. But while assuming Adam and Eve are immature human beings incapable of gardening or excusing their bite, he may not have been justified. As in *Genesis* 2, Adam is intellectually mature enough to name all the species in the Garden of Eden. The desire to bite and taste is better to interpret as a covet of more wisdom and maturity rather than just a desire of self-

[355] Ibid., p. 10.

[356] Ibid., p. 12.

[357] Genesis 3:17, NIV.

[358] Harrison, 2008, *Gardens: An essay on the human condition*, p. 166.

fulfillment. It was a rational and mature choice. For Eve, she forms judgments quite assertively and logically, "the tree was good for food," "pleasing to the eyes," and "desirable for gaining knowledge."[359] Probably, the desire to bite and taste is the same as the desire today that we turn earth into "an inexhaustible inventory for human consumption."[360] From productivity to consumption, instant availability is what we desire, like all the provisions in the Garden of Eden. Mosses are no exception. When mosses were preserved and relocated for gardening, the genuineness and authenticity of gardening were lost.

However, the profound meaning of horticulture seems to go far beyond the biophysical level. Under Harrison's argument, any affairs involving care are indeed a kind of gardening, or rather, any genuine gardening must embrace care. Thus, for him, city-polis, traditions, modern technology, democracy, language and culture, education, and even entire human cultures are gardens to be cultivated and cared for. In this sense, Čapek's cultivation of the Czech language and its national literature is invaluable to Harrison, who believes that it was Čapek's deep appreciation of the proximity between cultivation of the soil and nurturing the spirit/culture, that is, his gardening ethics which displays unconditional generosity and the necessity of giving the land more than a person takes, that made it possible for him to nourish Czech national literature and to defy the greatest threat to the European humanist tradition, totalitarianism, on his own.[361] Čapek believes that modern technology is impotent to contemporary social crises because a gardener's "humility, devotion, and curatorial vocation" are completely

[359] Genesis, 3:6, NIV.

[360] Harrison, 2008, *Gardens: An essay on the human condition*, p. 166.

[361] Ibid., chapter 3.

missing in the midst of modern technology.[362] Čapek's concerns about modern technology in the 1920s and 1930s are not assuaged in the mind of Harrison in the twenty-first century. In Harrison's view, although modern technology seems to be unrivaled, it cannot be the guardian of the future, which also shapes his view on modernism, as he claims,

> I believe that modernism, for lack of a better term, has been mostly a story of combating and denouncing history, rather than cultivating, in sheltered places, counterforces to history's deleterious forces.[363]

This concern for modernity may not seem relevant to moss gardening, but this relevance becomes apparent when we correlate it with the different patterns and attitudes of moss gardening. I believe the reader has already discerned the types of moss gardening in which human humility, care, and devotion are constantly present, and in which moss gardening are completely absent. Harrison's book concludes with Malcolm Lowry's *Under the Volcano*, in which the decay of a garden, as described, symbolizes the human condition, "in the grip of destructive and self-intoxicating passions," and "repeat our expulsion and tumble into our self-chosen inferno."[364]

5.6 Conclusion

In this chapter I have considered the mossy expressivity based on their presentation in artworks and gardening. In the artworks of Haeckel and the two Chinese moss artists, moss, an unremarkable group of plants, becomes the main theme of painting. Although moss become an effective means of conveying messages to audiences, which makes all artistic creation suspect

[362] Ibid., p. 37.

[363] Ibid., p. 159.

[364] Ibid., p. 175.

of instrumentalism, the artists' realistic and detailed depiction of moss plants and the resulting appreciation open a charismatic world of human-moss interactions. Among these interactions, whether it is Haeckel's struggle with regard to the unity of science and religion, or the harmony between humans and mosses, or the calling of the preservation of biocultural diversity conveyed by the paintings, all suggest a certain unique interspecies relationship. As I have mentioned in this chapter, one of the understandings that needs to be shattered when experiencing these interspecies relationships is the understanding that humans are the solo caretakers and stewards of the planet. On the surface, it seems that the human species is guarding, managing, and stewarding the whole planet, but in reality, it is not. Mosses carry out their care with their own presence in the ecosystem and gardens. This is self-evident to moss gardeners and ecologists.

In reflecting on moss gardening, I have shown the significance of moss to gardeners. For Western gardeners, mosses are the link between the human and the divine world, and for Eastern moss gardeners, mosses are the elves that allow people to experience spiritual transcendence and self-reliance. It is important to stress that in gardening, mosses are not immune to the trap of commercialization. The ethical code behind the commercialization of moss is clearly based on an anthropocentric, economic purpose-driven, cost-benefit analysis-based ethical framework involving only technological solutions to environmental problems. The problem with this approach is that in addition to the complete objectification of mosses, the time scale of industrialization to degrade the moss world is so disproportionate to the time scale of moss growth and restoration that the end is almost written if regeneration is not fulfilled.

The unethical gathering, hunting, and poaching of mosses is the greatest attack on the fecundity of Life on the Earth and on mosses' guardianship in the true sense. It is the deprivation of the capacity of mosses to guard the Earth, as well as humans, plants, soil, and so on. In the deprivation is the absence of meeting, a totalization of mosses. The deprivation of mosses as guardians or the deprivation of the condition of their possibility to be good, should have political-ethical implications here. Moss conservation is thus of great weight, and I explore this topic in chapter 6.

CHAPTER 6

MEETING THE INVISIBLE IN CONVIVIAL MOSSY CONSERVATION

Invisibility does not denote an absence of relation; it implies relations with what is not given, of which there is no idea.
Emmanuel Levinas

The discussion of moss art and gardening in chapter 5 seems to present an enchanted and prevalent moss-cosmos in which people are absorbed in the companionship of mosses. However, among art works from Art for Conservation (AFC), mosses seldom become the subject. In Matt Pattson's acrylic *Bog Turtle* (2021) and Ute Bartels' watercolor *Himalaya Moments* (2011), mosses are backgrounding elements, and the main subject in these paintings are a turtle and a snow leopard. The inconspicuousness of mosses proves the absence and invisibility in the mainstream of AFC. In other words, the subjects in AFC reflect charming animals and plants which are regarded as important targets of conservation. Most of them are flagship species, charismatic, well-known, and beneficial for raising funds and public awareness. The ethical concern is that many non-vascular plants and invertebrates were excluded in the mainstream of biological conservation and ecological communication. In this chapter, I discuss and assess flagship-centered conservation and mosses-centered conservation to portray convivial biocultural conservation.

6.1 Exclusive Conservation and Communication

Botanical gardens can play a fundamental role in cultivating "field environmental philosophy" and other forms of environmental education.[365] These gardens connect the public

[365] See Ricardo Rozzi, Francisca Massardo, Christopher B. Anderson et al., 2006, "Ten principles for biocultural conservation at the southern tip of the Americas: the approach of the Omora Ethnobotanical Park," *Ecology and*

with biodiversity through recreation and participatory educational activities.[366] Additionally, they have a part in research and *ex-situ* conservation, as well as in sharing scientific information with citizens.[367] Today, it is particularly important to address the contemporary global socio-environmental crisis in the Anthropocene, we need an awareness of the severity of the crisis as well as an understanding about the need for taxonomic inclusivity in conservation efforts to save planetary biodiversity. However, in global conservation and communication this inclusivity has not been achieved due to exclusiveness in two senses. First, global citizens are excluded from the massive information and data produced by scientists. Without citizens' participation, ecological restoration and conservation are tepid; hence, science research and education need to be more broadly communicated and shared. The second sense of exclusiveness is that many co-inhabitants are excluded from consideration, either as target species of conservation or as educational tools to inform global citizens.[368]

Regarding the first problem of exclusiveness, in global society the attitude toward conservation is lukewarm, with little identifiable success. For example, Lera Miles and

Society 11(1), 43; and Tetsuya Kono, 2018, "The garden as a representation of nature: a space to overcome biocultural homogenization?" in *From Biocultural Homogenization to Biocultural Conservation* (Ecology and ethics, vol 3, Springer, Dordrecht), pp 459–474.

[366] See He He and Jin Chen 2012, "Educational and enjoyment benefits of visitor education centers at botanical gardens," *Biological Conservation* 149 (1), 103-112; Nalini Nadkarni, 2013, "Not such strange bedfellows: underserved public audiences as collaborators for ecologists," in *Linking Ecology and Ethics for A Changing World* (Ecology and ethics, vol 1, Springer, Dordrecht), pp 333–342; and Alexandria K Poole, Eugene C Hargrove, Philip Day et al., 2013, "A call for ethics literacy in environmental education," in *Linking Ecology and Ethics for A Changing World* (Ecology and ethics, vol 1, Springer, Dordrecht), pp. 349–372.

[367] Gao Chen and Weibang Sun, 2018, "The role of botanical gardens in scientific research, conservation, and citizen science," *Plant Diversity* 40(4), 181-188; Leila Faraji and Mojtaba Karimi, 2020, "Botanical gardens as valuable resources in plant sciences," *Biodiversity and Conservation* (Jan 02), 1-22.

[368] Ricardo Rozzi, 2019, "Taxonomic Chauvinism, No More! Antidotes from Hume, Darwin, and Biocultural Ethics," *Environmental Ethics* 41(3), 249-282.

collaborators found that tropical dry forests are critically threatened, but they are not in the forefront of public concerns.[369] John Croxall and his team discovered that commercial fisheries and pollution, alien invasive predators, habitat degradation, and human disturbance continually and increasingly threaten seabird conservation.[370] In many protected areas and biodiversity hotspots, human activities continue to endanger ecosystems and biological conservation. Megha Verma and collaborators used the most recent human footprint dataset to demonstrate increasing impacts on crops, pastureland, roads, and infrastructures on biodiversity in Southeast Asia, which in turn reduces the efficacy of conservation.[371]

Apparently, without efforts by global citizens, biological conservation cannot succeed. Hence, it is necessary that the public has access to data regarding human pressure and how it continually endangers global and local biodiversity. Even if big data is accessible to global citizens, how to communicate such information meaningfully is a problem. The inaccessibility of affluent ecological information and the lack of effective communication produced the first sense of exclusiveness. Global citizens are excluded from massive amounts of information. A bridge between the ecological academy and global citizens is necessary to connect the two sides. Indeed, when environmental awareness emerged, early pioneering environmentalists such as Aldo Leopold (1949) or Rachel Carson (1962) deliberately wrote for the public *A Sand County Almanac* and *Silent Spring*, and their works continue to inspire young generations.

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[369] See Lera Miles, Adrian C. Newton, Ruth S. DeFries, et al., 2006, "A global overview of the conservation status of tropical dry forests," *Journal of Biogeography* 33(3), 491-505.

[370] John P Croxall, Stuart HM Butchart, Ben Lascelles, et al., 2012, "Seabird conservation status, threats and priority actions: a global assessment," *Bird Conservation International* 22(1), 1-34.

[371] Megha Verma, William S. Symes, James EM Watson, 2020, "Severe human pressures in the Sundaland biodiversity hotspot," *Conservation Science and Practice* 2(3), e169.

Regarding the second problem of exclusiveness, many conservation researchers and organizations have focused on flagship species.[372] The organisms chosen as flagship species commonly are "charming species," which are privileged because they trigger greater concerns than "not-so-charming" species. Rozzi has criticized this approach taxonomically speaking, because flagship species are usually vertebrates like mammals and birds, or vascular plants like gymnosperms and angiosperms.[373] This taxonomic bias leads to the exclusion of small animals and plants, which is deeply associated with global biocultural homogenization and a "taxonomic chauvinism."[374] Barbara Clucas and her team expressed alarm that mammals and bird species -- rather than invertebrates, fish, and amphibians -- are prioritized for conservation, thus exposing the public to only a few flagship species.[375] Greogor Kalinkat and his collaborators also are concerned that aquatic biodiversity is overlooked in conservation. In other words, numerous invertebrates and nonvascular plants are invisible to the public.[376] Therefore, it is crucial to educate global citizens to "open their eyes" to see these marginalized organisms.

These two senses of exclusiveness compel me to undertake the dual task of (i) bridging the scientific academy and global citizens who are situated in different local cultures and contexts, and (ii) including a more comprehensive taxonomic diversity of the co-inhabitants in

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[372] See Matthew J Walpole and Nigel Leader-Williams, 2002, "Tourism and flagship species in conservation," *Biodiversity and Conservation* 11(3), 543-547; see also Jennifer McGowan, Linda J Beaumont, Robert J Smith, et al. 2020, "Conservation prioritization can resolve the flagship species conundrum," *Nature Communications* 11(1), 1-7.

[373] Ricardo Rozzi, 2013, "Biocultural ethics: from biocultural homogenization toward biocultural conservation," in *Linking Ecology and Ethics for A Changing World* (Ecology and ethics, vol 1, Springer, Dordrecht), pp 9–32.

[374] See Rozzi, 2019.

[375] Barbara Clucas, Katherine McHugh, and Tim Caro, 2008, "Flagship species on covers of US conservation and nature magazines," *Biodiversity and Conservation* 17(6), 1517-1528.

[376] Greogor Kalinkat, Juliano S Cabral, William Darwall, et al., 2016, "Flagship umbrella species needed for the conservation of overlooked aquatic biodiversity," *Conservation Biology* 31(2), 481-485.

conservation. In this chapter, I examine traditional charismatic flagship species-centered and lesser-known moss-centered conservation initiatives in Chile and China. Based on this analysis, I explore promising ways to bridge the distance between the ecological sciences and global citizens and enhance taxonomic inclusivity. In Chile and China, moss-centered conservation and communication with citizens have succeeded through implementing multiple activities and projects that display the possibility and necessity of including invertebrates and nonvascular plants in conservation and education. These initiatives highlighted the ecological, aesthetic, cultural, and ethical values of those marginalized organisms, and stated that an understanding of these values is essential to foster global biocultural conservation in order to secure the future of the planet.[377]

6.2 Flagship Species Centered Conservation

In conservation biology, flagship species usually represent those charming species that can attract public attention. The World Wide Fund for Nature (WWF), formerly World Wildlife Fund, defines the interrelated concepts of flagship, keystone, and indicator species. Flagship species "act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause; are usually relatively large, and considered to be 'charismatic' in western cultures; may or may not be keystone species and may or may not be good indicators of biological process."[378]

[377] Ricardo Rozzi, Ximena Arango, Francisca Massardo, et al., 2008, "Field environmental philosophy and biocultural conservation: the Omora Ethnobotanical Park educational program," *Environmental Ethics* 30(3), 325–336; and Ricardo Rozzi, Lily Lewis, Francisca Massardo, et al., 2012, *Ecotourism with a Hand-Lens at Omora Park* (Punta Arenas, Chile: Ediciones Universidad de Magallanes).

[378] WWF, 2020, https://wwf.panda.org/our_work/wildlife/flagship_keystone_indicator_definition/, accessed on July 13, 2020.

From the angle of ethics, it is odd that the definition of *flagship species* is both anthropocentric (as humans decide which species are charismatic) and non-anthropocentric (as other-than-human species are valued). This definition is not ecocentric (as flagship species might or might not be keystone species), but biocentric (as one particular species becomes the conservation target). In terms of values, the focus is on the "charming" features of the species, and therefore aesthetic or socio-economic values outweigh ecological and ethical values. In this section I briefly review the use of flagship species as conservation targets in Chile and China, particularly with regard to China's Giant Panda (*Ailuropoda melanoleuca*) and Chile's Magellanic Woodpecker (*Campephilus magellanicus*). From the perspective of ecosystem management, Daniel Simberloff cautioned about the risks of focusing on single-species management, and using conservation strategies based on flagship, umbrella, and/or endangered species, because they overlook ecological interactions and the relevance of conserving biotic communities.[379] From a philosophical perspective, the implications of a narrow focus on flagship species are probably greater than the ecological ones.

6.2.1 The Magellanic Woodpecker conservation in Cape Horn Biosphere Reserve, Chile

To create the Cape Horn Biosphere Reserve, it was not coincidental that the Magellanic Woodpecker was chosen as the flagship species. The creation of this biosphere reserve was led by the interdisciplinary research team of the Omora Ethnobotanical Park, a biocultural garden established in 2000. It covers an area of 1,100 hectares near Puerto Williams, the capital of the

[379] Daniel Simberloff, 1998, "Flagships, umbrellas, and keystones: is single-species management passé in the landscape era?" *Biological Conservation* 83 (3), 247-257.

Chilean Antarctic Province.[380] A lot of research and efforts disclosed the ecological and cultural significance of this woodpecker. Early in the 1870s, a Yahgan-English dictionary compiled by the Anglican missionary Thomas Bridges included the word *lana* as the Yahgan name for the Magellanic Woodpecker.[381] Úrsula Calderón, one of the last two Yahgan people who at that time spoke her native language, explained to Ricardo Rozzi that *lan* in Yahgan means "tongue."[382] Hence, the bird's name *lana* could be associated with the skillful habit of extracting larvae from tree trunks.[383] It is notable that the scientific name *Campephilus*, means "caterpillar-lover."[384]

Woodpeckers of the genus *Campephilus*, a genus that is found only in the Americas.[385] The close phylogenetic relationship between the Magellanic Woodpecker and the North American Ivory-billed and Imperial Woodpeckers (*Campephilus principalis* and *C. imperialis*) attracted United States ornithologist Lester L. Short to study Magellanic Woodpeckers in the 1970s. His research disclosed valuable information regarding distribution, foraging behavior, sounds produced by bills, vocalizations, and morphology of the Magellanic Woodpecker, and

[380] Ricardo Rozzi, Francisca Massardo, Christopher Anderson, et al., 2006, "Ten principles for biocultural conservation at the southern tip of the Americas: the approach of the Omora Ethnobotanical Park," *Ecology and Society* 11(1), 43.

[381] See Ricardo Rozzi, Francisca Massardo, Christopher Anderson, et al., 2010, *Multi-Ethnic Bird Guide of the Sub-Antarctic Forests of South America* (Denton, TX: University of North Texas Press).

[382] Ricardo Rozzi and Francisca Massardo, 2011, "The road to biocultural ethics," *Frontiers in Ecology and the Environment* 9(4), 246-247.

[383] Ibid.

[384] Ibid.

[385] Ricardo Rozzi, Juan M Draguicevic, Ximena Arango, et al., 2014, "From science towards conservation: the education and environmental ethics program of the mora Ethnobotanical Park," in *Magellanic Sub-Antarctic Ornithology: first decade of long-term bird studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve, Chile* (Denton, TX: University of North Texas Press), pp 295-302.

compared it with other woodpeckers of the genus Campephilus.[386]

Before the establishment of the Cape Horn Biosphere Reserve, researchers investigated the ecology of Magellanic Woodpeckers, discovering a close relationship for foraging and cavity-nesting with trees of the genus Nothofagus (i.e., the beeches of the "South").[387] Magellanic Woodpeckers may play a key ecological role because in the harsh climatic conditions of Cape Horn their cavities are used by other birds.[388] In 2005, to implement sustainable economic activities, and avoid negative environmental and social impacts, Omora Park researchers suggested identifying a flagship or charismatic species in order to enhance the participation of the local community. Questionnaires and interviews of members of the indigenous Yahgan community, teachers, students, Navy personnel, and authorities showed a marked preference for the Magellanic Woodpecker.[389] The Omora Park study included not only the preference of local communities but also ecological attributes for conservation, ethical values, endemic geographical distribution, conservation status, and biocultural or ethnobiological values. This research provided a theoretical foundation for designing a practical

[386] Lester L Short 1970, "The Habits and Relationships of the Magellanic Woodpecker," *The Wilson Bulletin* 82(2), 115-129.

[387] See Ricardo Rozzi, Francisca Massardo, Christopher Anderson, et al., 2010; see also Ricardo Rozzi, Juan M Draguicevic, Ximena Arango, et al., 2014, "From science towards conservation: the education and environmental ethics program of the mora Ethnobotanical Park," in *Magellanic Sub-Antarctic Ornithology: first decade of long-term bird studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve, Chile* (Denton, TX: University of North Texas Press), pp 295-302; and Quiterie Duron, Jaime E Jiménez, Pablo M Vergara, et al. 2018, "Intersexual segregation in foraging microhabitat use by Magellanic Woodpeckers (Campephilus magellanicus): Seasonal and habitat effects at the world's southernmost forests," *Austral Ecology* 43(1), 25-34.

[388] Pablo Vergara and Roberto P Schlatter 2004, "Magellanic woodpecker (Campephilus magellanicus) abundance and foraging in Tierra del Fuego, Chile," *Journal of Ornithology* 145(4), 343-351.

[389] Ximena Arango, Ricardo Rozzi, Francisca Massardo, et al., 2014, "Discovery and implementation of the Magellanic Woodpecker (Campephilus magellanicus) as a charismatic species: a biocultural approach for conservation in the Cape Horn Biosphere Reserve," in *Magellanic Sub-Antarctic Ornithology: first decade of long-term bird studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve, Chile* (Denton, TX: University of North Texas Press), pp. 302-316.

program to implement the Magellanic Woodpecker as a flagship species. Copious activities with the local community raised awareness about the need to conserve this species and its forest habitats.[390]

The recognition of the Magellanic Woodpecker as a flagship species, fueled by theoretical contribution and practical efforts, eventually had a profound regional and international influence. At the theoretical level, the "3Hs" (Habitats, Habits, and co-in-Habitants) framework of the biocultural ethic linked this species with its ecological roles and value for the conservation of Nothofagus forests.[391] At the practical level the methodology of "Field Environmental Philosophy" (FEP) oriented the creation of conservation narratives and the design of participatory field activities.[392] Combined, these theoretical and practical frameworks exhibited their potential for both education and conservation. Additionally, a multi-scale institutional structure brought together local, national, and international private and public organizations, and universities.[393] The set of charismatic features, the endangered conservation status, the key ecological role, and rich traditional ecological knowledge linked to the Magellanic Woodpecker successfully grabbed the public's attention.[394] *In April 2007, in*

[390] Ibid.

[391] Ricardo Rozzi, 2018, "Biocultural homogenization: a wicked problem in the Anthropocene," in *From Biocultural Homogenization to Biocultural Conservation* (Ecology and ethics, vol 3, Springer, Dordrecht), pp 21–47.

[392] Ricardo Rozzi, Christopher B Anderson, J Cristóbal Pizarro, et al. 2010, "Field environmental philosophy and biocultural conservation at the Omora Ethnobotanical Park: Methodological approaches to broaden the ways of integrating the social component ("S") in Long-Term Socio-Ecological Research (LTSER) Sites," *Revista Chilena de Historia Natural* 83(1), 27-68.

[393] Ricardo Rozzi, Francisca Massardo, Christopher B Anderson, et al. 2006, "Ten principles for biocultural conservation at the southern tip of the Americas: the approach of the Omora Ethnobotanical Park," *Ecology and Society* 11(1), 43.

[394] Ximena Arango, Ricardo Rozzi, Francisca Massardo, et al., 2014, "Discovery and implementation of the Magellanic Woodpecker (Campephilus magellanicus) as a charismatic species: a biocultural approach for conservation in the Cape Horn Biosphere Reserve."

coordination with the Municipality of Cape Horn, the Omora Park team celebrated the Earth Day at the local school of Puerto Williams by distributing reusable cloth bags printed with the images of the Magellanic Woodpecker drawn by three students that had won a contest called "The Magellanic Woodpecker and its habitat." The cloth bags (Figure 6.2) were given to local families to deter the use of single-use plastic bags and promote the protection the woodpeckers' habitats in the Cape Horn Biosphere Reserve, Chile.

Figure 6.1: Magellanic Woodpecker. Photo was taken in a forest close to Puerto Williams, Chile by the author during her FEP practice at Omora Park.

Figure 6.2: Reusable cloth bags with images of the magellanic woodpecker. Photograph by Ricardo Rozzi.

6.2.2 Panda Conservation in Foping National Natural Reserve, China

Pandas enjoyed their reputation first in Europe, then in North America, lastly in its native land, China. It was discovered in 1869 by a French missionary and naturalist, Armand David, who sent specimens to the Muséum National d'Histoire Naturelle in Paris.[395] The first scientific description of the species was published in the early 1870s. In 1936, the United States fashion designer Ruth Harkness captured a baby panda and took it to Chicago's Brookfield Zoo, which attracted 53,000 visitors on the first day of its exhibition.[396] At the same time, Chinese people were enmeshed in a web of continual domestic wars, the intrusion of Japan, unstable politics, and poverty without attending to the panda's reputation abroad. Even in 1961, when a panda was sent to the London Zoo and the newly founded World Wide Fund for Nature adopted the image of a panda as the logo, Chinese citizens seemed to be absent from this Western panda zeal. Chinese public appreciation was stimulated in 1972 when former China Premier Zhou Enlai presented two giant pandas as a gift to the United States to initiate diplomatic relations. The U. S. - China relationship had a huge domestic and diplomatic impact on the public, and the establishment of Foping National Nature Reserve followed these events.

Giant pandas in the Foping region attracted the attention of biologists after a group of ornithologists conducted fieldwork on birds, and accidentally found incomplete skulls of giant pandas on the south side of Qinling Mountain. In 1964, ornithologists Guangmei Zheng and Xu Pingyu published their discovery. In 1973, the Shaanxi Biological Resources Survey team

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[395] Jennifer S Holland, 2016, "Who discovered the panda?", National Geographic. Accessed through https://www.nationalgeographic.com/magazine/2016/08/explore-panda-mania-history/ on November 15, 2020.

[396] Vicki Croke, 2005, *The Lady and the Panda: the true adventures of the first American explorer to bring back China's most exotic animal* (New York, NY: Random House), p. xv.

conducted large-scale research on Qinling Mountain. They suspected that the population and density of giant pandas in Foping County were the highest in China. In 1978, China's State Council approved the establishment of Shaanxi Foping National Nature Reserve, covering a total area of 350 km2 (app. 86, 487 acres) to conserve giant pandas and their habitats. Roughly during that time, World Wide Fund signed an agreement with China to cooperate on the conservation of giant pandas.

Later in the 1980s, several ecological and biodiversity studies were conducted in Qinling Mountain, and fortunately in the Foping region researchers observed wild giant pandas. Later, researchers began studying pandas without interfering in their life habits. Eventually, a female giant panda became accustomed to the presence of people.[397]

Since the 1970s, China has conducted four national surveys of giant pandas. The most recent survey included quantitative information about population density, genetic diversity, isolated population, quality of habitats, vegetation types, conservation management, and the status of captive populations.[398] The highest wild population was detected in the Foping National Nature Reserve.

In the 1990s, new technologies such as GIS and radiotracking facilitated the ecological surveys, which enhanced investigation about the demography, geographical distribution, seasonal movement, and the relationship between seasonal movement and habitat parameters. From 1991 to 1995, researchers mapped the home range patterns of six radio-

[397] George B Schaller, 1994, *The Last Panda* (Chicago, IL: The University of Chicago Press), p.119.

[398] China State Forestry Administration, 2015, "The Giant Pandas of China: Status Quo." Chinese-English version of the report was accessible through: http://www.forestry.gov.cn/main/69/content-743562.html

collared giant pandas, including three males and three females in the Foping National Nature Reserve. Their results were published years later.[399] Regarding the seasonal vertical movement of the giant pandas and their activity range, the radiotracking data shows that the pandas live in their winter habitats for almost three quarters of the year, and in the summer habitats for only one quarter of the year.[400] The seasonal migration of pandas called attention to their movements for habitat management, particularly to estimate their required protected areas. Pandas select their preferred habitats based on different bamboo species as food. In winter, giant pandas select *Bashaina fargesii*, a bamboo with short and dense culms distributed in middle and southwest China, and in summer *Fargesia qinlingens* with tall and sparse culms.[401] Research on food preferences has provided insights for restoration of panda habitats. This research limited economic activities in some local areas, but also stimulated a paradigm shift in conservation that focused on the nutritional basis of food selection.[402] Differences of seasonal movements between Foping Pandas and Wolong Pandas demonstrated that local habitat conditions play an important role in their behaviors.[403] Hence, reintroducing pandas to wilderness needs to adopt different strategies based on local habitat conditions.

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[399] Yangge Yong, Xuehua Liu, Tiejun Wang, et al. 2004, "Giant pandas migration and habitat utilization," in *Giant Pandas: Biology and Conservation* (Berkeley, CA: University of California Press), pp. 158-169.

[400] See Xuehua Liu, Andrew K Skidmore, Tiejun Wang, et al., 2002, "Giant panda movements in Foping nature reserve, China," *The Journal of Wildlife Management* 1179-1188.

[401] Xuehua Liu, Albertus G Toxopeus, Andrew K Skidmore, et al, 2005, "Giant panda habitat selection in Foping Nature Reserve, China," *The Journal of Wildlife Management* 69(4), 1623-1632.

[402] Yonggang Nie, Zejun Zhang, David Raubenheimer, et al., 2015, "Obligate herbivory in an ancestrally carnivorous lineage: the giant panda and bamboo from the perspective of nutritional geometry," *Functional Ecology* 29(1), 26-34.

[403] Xuehua Liu, Tiejun Wang, Ting Wang, et al., 2015, "How do two giant panda populations adapt to their habitats in the Qinling and Qionglai Mountains, China," *Environmental Science and Pollution Research* 22(2), 1175-1185.

Figure 6.3: Panda Exhibition in Foping Giant Panda Valley Scenic Area. It introduces citizens to the domestic distribution and overseas journeys of the pandas as icons of international friendship. Photo by Meng Jia.

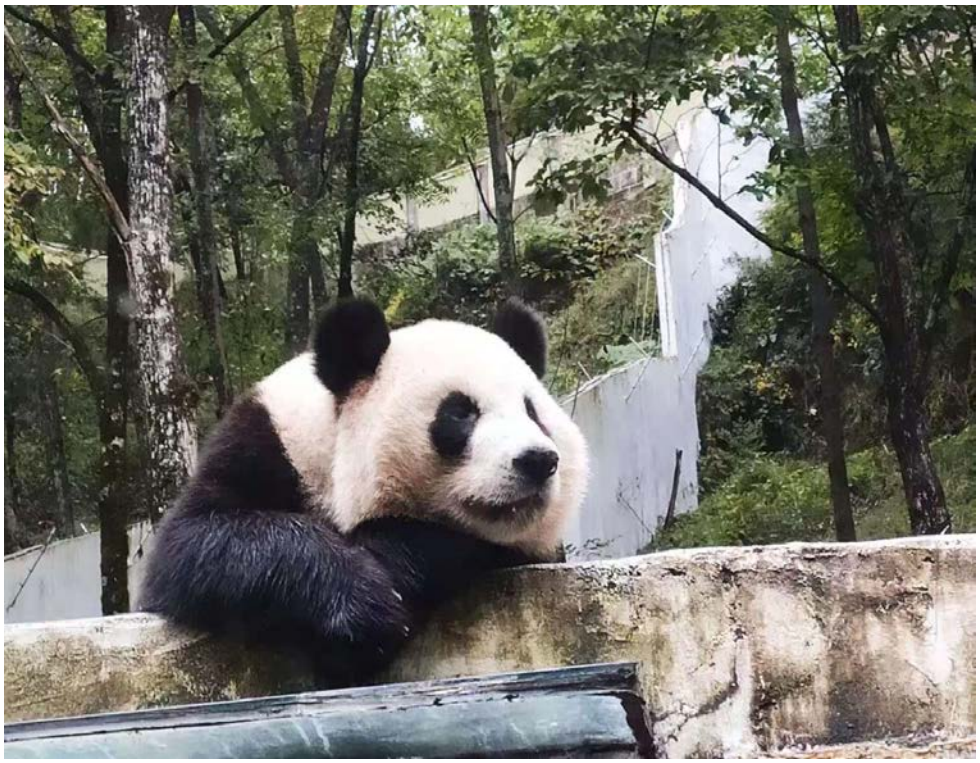

Figure 6.4*: Thinking Panda-life*. This panda in Foping Giant Panda Valley Scenic Area was named as "Thinking Panda-Life" by Zhu's Chinese student. Photo by Chao Gao.

Figure 6.5: Four Treasures of Qinling. [404]

[404] The left, "Four Treasures of Qinling", announced the theme song "The Spirit of the Heaven and Earth" of the animation on April 21, 2020. The animation series tells stories about their habits, unique life-habits that include surviving skills, fighting for their habitats, struggles in everyday life, and their wills to thrive. Source: Sanqin Daily. The right "Four treasures of Qinling" were designed as the mascot of China's 14 National Games which was held in Xi'an, Shaanxi in 2021. Photo credit: Xinhua News, open access.

Five decades of research have enriched ecological information, panda conservation, and public education. The scientific, ecological, and cultural values of giant pandas have become common knowledge among educated Chinese. The panda is also an umbrella species for the protection of habitats and other endangered co-inhabitants.[405] Pandas also became economically important, and in 2010 visits to their reserves yielded US $2.6 - 6.9 billion per year.[406] Chinese citizens were soon informed through multiple channels about the economic success of panda conservation, as the panda was named as one of the "four treasures of Qinling Mountains," along with the Crested Ibis (*Nipponia nippon*), the Snub-nosed Monkey (*Rhinopithecus roxellana qinlingensis*), and the Golden Takin (*Budorcas taxicolor bedfordi*).

6.3 Bryophytes-centered Conservation

Globally the awareness of bryophytes' conservation is novel. Despite the fact that the British Bryological Society, the first organization regarding bryological research and conservation, was founded in 1896, and that the International Association of Bryologists (IAB) was established in 1969, there is still little public awareness about mosses.[407] Nevertheless, earlier taxonomic identification of bryophytes was not exclusive to professional bryologists but also amateurs were very active in the field.[408] Some non-European cultures enjoy ancient

[405] Binbin Li and Stuart L Pimm, 2016, "China's endemic vertebrates sheltering under the protective umbrella of the giant panda," Conservation Biology 30(2), 329-339.

[406] Fuwen Wei, Robert Costanza, Qiang Dai, et.al., 2018, "The Value of Ecosystem Services from Giant Panda Reserves," Current Biology 28(13), 2174-2180.

[407] Tomas Hallingbäck and Nick Hodgetts, 2000, *Mosses, Liverworts, and Hornworts: Status Survey and Conservation Action Plan for Bryophytes* (IUCN, Gland, Switzerland and Cambridge, UK in collaboration with the Swedish Threatened Species Unit).

[408] Mark Lawley, 2019, "A social and biographical history of British and Irish field-bryologists," *The British Bryological Society*, accessible through https://www.britishbryologicalsociety.org.uk/resources/bryohistory/.

traditions appreciating the beauty of mosses. For instance, in Chinese classical literature, mosses comprise a unique topic for generations of writers composing poetry, eulogy, and verses. In Japan, Saihō-ji, monks at the vintage Buddhist temple collected more than 120 species of bryophytes, as I have mentioned in chapter 5.

The exclusion of mosses in global biological conservation might be interpreted as a twentieth-century expression of what Rozzi has called "global biocultural homogenization."[409] Mosses receive much less attention than megafauna and vascular plants in conservation as well as in formal and non-formal education. Consequently, people's perspectives on the taxonomic breath of biodiversity are reduced.[410] To counteract this trend and to invigorate "moss-centered conservation", in this section I review two cases studies. The Omora Ethnobotanical Park in Chile and Shenzhen Fairy Lake Botanical Garden in China exemplify successful moss-centered approaches. Ana analysis of the concepts, methodologies, and activities conducted at these botanical gardens can disclose multiple epistemic, ecological, cultural, and ethical values of mosses.

6.3.1 "Ecotourism with a Hand-lens" (EHL) at the Omora Ethnobotanical Park, Chile

The Omora Ethnobotanical Park, a botanical garden, is the research, education, and conservation center that has led to the creation and implementation of the Cape Horn Biosphere Reserve (CHBR).[411] The historical process of Omora Ethnobotanical Park and the

[409] See Ricardo Rozzi, 2012, "Biocultural ethics: recovering the vital links between the inhabitants, their habits, and habitats," *Environmental Ethics* 34(1), 27-50.

[410] Ricardo Rozzi, 2013, "Biocultural ethics: from biocultural homogenization toward biocultural conservation," in *Linking Ecology and Ethics for A Changing World (*Ecology and Ethics, vol 1, Springer, Dordrecht), pp 9–32.

[411] See Ricardo Rozzi, Francisca Massardo, Christopher B Anderson, et al., 2006; and Andrés Moreira-Muñoz, Francisca Carvajal, Sergio Elórtegui, et al., 2020, "The Chilean Biosphere Reserves network as a model for

creation of Ecotourism with a Hand-lens has been summarized by Rozzi and his collaborators.

In 2001, former president of Chile, Ricardo Lagos, visited Omora Park and experienced the early stage of EHL. As a result, President Lagos supported not only Omora Park but also the creation of the CHBR and stimulated the establishment of the Cape Horn Center to be a world observatory for climate change, and more broadly global socio-environmental change. The mission of the center would be to focus on the "micro-world" represented by mosses and other small organisms, but scaling up to the global biosphere reserve, thereby contributing to planetary sustainability.[412]

In subsequent years, Omora Park researchers discovered a unique and endemic richness of moss species, other bryophytes, and lichens. Cape Horn was identified as a world biodiversity hotspot for bryophytes, and therefore deserved consideration per se in conservation.[413] For the first time in history, a protected area was created based on the diversity of little "non-charismatic" organisms. This changed the perspective that small organisms can be effectively protected only as a consequence of protecting large charming "umbrella species."[414]

For the former achievement, networking and applying the four-step cycle of field environmental philosophy was essential. Field environmental philosophy includes not only

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sustainability?: challenges towards regenerative development, education, biocultural ethics and eco-social peace," in *UNESCO Biosphere Reserves: Supporting Biocultural Diversity, Sustainability and Society* (New York, NY: Routledge), pp. 61-75.

[412] Ricardo Rozzi, María Teresa La Valle, Shaun Russell, et al., 2020, "Ecotourism with a Hand-Lens: A Field Environmental Philosophy Experience from the South of the World," in *Philosophy for the Real World: An Introduction to Field Philosophy* (New York, NY: Taylor & Francis/Routledge), pp. 222-239.

[413] See Ricardo Rozzi, Juan J Armesto, Bernard Goffinet, et al., 2008, "Changing Lenses to Assess Biodiversity: Patterns of Species Richness in Sub-Antarctic Plants and Implications for Global Conservation."

[414] Ricardo Rozzi, Juan J Armesto, Julio R Gutiérrez, et al., 2012, "Integrating ecology and environmental ethics: Earth stewardship in the southern end of the Americas," *BioScience* 62(3), 226–236.

research but also communication, participatory creation of metaphors and narratives. Rozzi has affirmed that metaphors become strong "cultural messengers from science to ethics," and culture.[415] Field environmental philosophy also includes field activities guided with an ecological and ethical orientation to appreciate the biophysical and cultural diversity embedded in ecosystems. Finally, field environmental philosophy asks participants to undertake an *in-situ* conservation action to foster a sense of responsibility among them regarding their links with other co-inhabitants.[416] Through field environmental philosophy's four-step cycle, researchers were themselves stunned by the diverse cornucopia of formerly "invisible" non-vascular plants. Omora Park researchers investigated not only biological diversity, but also the cultural diversity embedded in vernacular names, as well as the etymology of scientific names. Visitors, especially schoolchildren, propose names for moss species that do not have common names. Together with Omora Park researchers, visitors also compose metaphors, including the "Miniature Forests of Cape Horn."[417] This metaphor effectively communicates the richness of tiny organisms that co-inhabit with mosses.

During the following period, Ecotourism with a Hand-lens provided new opportunities for multiple visitors, including tourists, public authorities, philosophers, artists, teachers, and students to have "face-to-face encounters" with mosses, liverworts, hornworts, lichens, and to

[415] Ricardo Rozzi, 1999, "The reciprocal links between evolutionary-ecological sciences and environmental ethics," *BioScience*, 49(11), 911-921.

[416] See Ricardo Rozzi, Juan J Armesto, Julio R Gutiérrez, et al., 2012, "Integrating ecology and environmental ethics: Earth stewardship in the southern end of the Americas."

[417] Ibid.

appreciate their diverse life-habits and habitats.[418] Participants are awed by their direct encounters with non-vascular plants. EHL is a guided field activity that connects people with other co-inhabitants and opens them to unrivalled ecological, aesthetic, and ethical values. These values have remained invisible due to biocultural homogenization.[419] Eventually, *in-situ* conservation led to the creation of the Miniature Forests Interpretive Trail at Omora Park. The trail, in turn, became a platform for research, education, communication, and conservation activities, including new forms of ecotourism. [420]

The Chilean government supported this kind of diversification of tourism. It catalyzed a series of workshops, and published bilingual books in Spanish and English, which included field guides for the bryophytes and lichens of the Miniature Forests of Cape Horn and introduced the Ecotourism with a Hand-lens activity to the general public and tour guides.[421] Rozzi emphasized that "small is diverse, small is beautiful, and small is essential."[422]

In recognition of the importance of bryophyte research, and the creation of the protected area in Cape Horn, and a novel ecotourism activity, the International Association of Bryologists (IAB) held its 2015 IAB Conference at the Omora Ethnobotanical Park, Chile. Participants came from all around the world. A strong delegation from China included

[418] Ricardo Rozzi, 2012, "Introduction to ecotourism with a hand lens," in *The Miniature Forests of Cape Horn: Eco-Tourism with a Hand-lens* (Denton TX: University of North Texas Press), pp. 28-79.

[419] See Ricardo Rozzi, Juan M Draguicevic, Ximena Arango, et al., 2014, "From science towards conservation: the education and environmental ethics program of the mora Ethnobotanical Park."

[420] Ricardo Rozzi, Juan J Armesto, Julio R Gutiérrez, et al., 2012, "Integrating ecology and environmental ethics: Earth stewardship in the southern end of the Americas."

[421] See Ricardo Rozzi, Francisca Massardo, Christopher B Anderson, et al., 2006, "Ten principles for biocultural conservation at the southern tip of the Americas: the approach of the Omora Ethnobotanical Park"; Ricardo Rozzi, Lily Lewis, Francisca Massardo, et al., 2012, *Ecotourism with a Hand-Lens at Omora Park*; and Ricardo Rozzi 2018, "Biocultural homogenization: a wicked problem in the Anthropocene."

[422] See Ricardo Rozzi, 2012, "Introduction to ecotourism with a hand lens," p. 45.

researchers from the Shenzhen Fairy Lake Botanical Garden, China, who remained in contact with Omora Park researchers.

Figure 6.6*: Hypnum skottsbergii.* Photo taken using a hand-lens to observe the feather-like gametophyte and bean-like capsule of Hypnum skottsbergii at one of the stations along the Miniature Forests Interpretative Trail at Omora Ethnobotanical Park.

Figure 6.7: Local people decorate souvenirs with lichens and mosses.

6.3.2 "The Miniature Angels in the Plant Kingdom" at Shenzhen Fairy Lake Botanical Garden, China

The Shenzhen Fairy Lake Botanical Garden (SZBG) is located in the Luohu District, Shenzhen, Guangdong province of southeast China. Founded in 1983, it covers an area of 546 hectares. Renowned as "An Emerald Embedded in the Metropolis," it combines plant collections, scientific research, popular science, recreation, and tourism. A bryophyte research team was formed in 2006 with the initial goals of conducting bryology related research, particularly focusing on taxonomy, diversity cataloging, genealogy, conservation, and horticulture. Zhang Li has provided a historical account of the bryological work at the Shenzhen Fairy Lake Botanical Garden.[423]

In August 2012, bryologists from the Shenzhen Fairy Lake Botanical Garden participated in an expedition to Tibet. In a mountain village at an altitude of 4000 meters, bryologist Li Zhang rediscovered a cluster of bryophytes that they had never observed. After two years of searching records and evidence from the U. S. National Herbarium, they finally identified this species as *Brachymeniopsis gymnostoma*, the only moss species that had been previously announced as extinct. In January 2015, Zhang Li and collaborators reported this rediscovery at the International Association of Bryologists (IAB) Conference held at the Omora Ethnobotanical Park, Chile.

The team at the Shenzhen Fairy Lake Botanical Garden includes bryologists and artists. Science and art play significant roles in conveying scientific information to citizens. Compelling

[423] Li Zhang, 2020, "How to conduct unpopular science education: case studies from Shenzhen Fairy Lake Botanical Garden," in *Education on Biodiversity Conservation: Proceedings of the 4th Luosuo River Forum of Science Education* (Xishuangbanna, Yunnan Province, China), pp. 145-151.

photographs, paintings, and calligraphies are combined with textual representation to convey scientific information to the public, which are detailed in chapter 5.2. With the aid of biocultural ethic's 3Hs conceptual framework, we can understand the diverse life-habits of mosses as well as their various habitats. This achievement eventually developed into a publication in 2019, titled *The Magic and Enchantment of Bryophytes*.[424] This brilliant achievement is a result of more than ten years of efforts to bridge the academy and the public.

Bridging scientific information and citizens was catalyzed by the collaboration between the Shenzhen Fairy Lake Botanical Garden team of bryologists and the Department of Gardens and Green Areas (Civic and Municipal Affairs Bureau of Macau Special Administration Region) to investigate Macau's diversity of bryophytes. This built a foundation for bridging academic research and Macau citizens. The team not only completed a catalogue of the diversity of bryophytes, but also shaped how citizens began to think about mosses. A public exhibition entitled "The Miniature Angels in the Plant Kingdom" was held for Macau citizens in 2007, and in 2009 a book with the same title was published bilingually in Chinese and English.[425] Macau citizens welcomed the book because it introduced them to bryophytes. In 2015, a second edition reached beyond Macau Island to the mainland, hence making possible a larger scope of audience. Furthermore, in 2016, the book *Field Guide to Wild Plants of China: Bryophytes* (《中國野外植物手冊：苔藓卷》) included around 300 species and introduced the method of using

[424] See Li Zhang, Qin Zuo, Lihui Mao, 2019, *The Magic and Enchantment of Bryophytes* (《苔藓之美》, Nanjing, China: Phoenix Science Press).

[425] See Li Zhang, Qin Zuo, Baoying Hong, 2015, *The Miniature Angels in the Plant Kingdom* (《植物王國的小矮人》2nd edition, Macao: Department of Gardens and Green Areas, Civic and Municipal Affairs of Bureau of Macao Special Administrative Region).

a hand-lens to observe bryophytes. This book was rated as one of the most outstanding popular science books by the Chinese Academy of Science.

To introduce knowledge about bryophytes to the general public, SZBG also held exhibitions to communicate via expressive metaphors. In addition to “miniature angels,” other metaphors such as “Adventure to the Green Mini-Cosmos” （綠色小宇宙之奇妙歷程） and “The Plant Elves Who Lighten-up a Barren Land: Bryophytes” （點亮荒蕪的植物小精靈：苔藓）have been constructed. These successful exhibitions have not only been opened to local citizens, but also to those of other cities. For instance, in 2017 and 2018 the exhibition was held at the Shanghai Botanical Festival to show the beauty of the mini landscape of ferns, sorrel plants, and bryophytes. Citizens visit the mosses corridor that displays miniature mosses landscapes as well as moss science paintings, specimens, photographs, poetry, and other cultural representations of mosses at the 2018 Exhibition of Shade Plants, a theme section of Shanghai Botanical Festival. This exhibition was co-organized by the Shanghai Botanical Garden, Shenzhen Fairy Lake Botanical Garden, and Shanghai Normal University. Moreover, the international audience was impressed by the exhibition conducted during the nineteenth International Botanical Congress in 2017. Around 6,000 domestic and international researchers were exposed to eighty paintings of bryophytes and moss flora (ref. chapter 5.2). In 2019, SZBG researchers were invited to the Beijing EXPO to co-organize “The Beauty of Mosses” (苔藓之美) that presented bryology, moss art, photographs, and miniature entities to reveal the aesthetic values of bryophytes. Artists from Shenzhen Fairy Lake Botanical Garden instruct children drawing mosses during the 2019 Beijing World Horticultural Exposition (Figure 6.9). The development of meaningful metaphors encourages the general public to understand the

ecosystem services that bryophytes provide to the functioning of the biosphere. Meaningful metaphors successfully connect the imagination of citizens and open them to a wonderland of mosses, thus echoing the long-standing Chinese tradition of moss appreciation.

Figure 6.8*:* 2018 Exhibition of Shade Plants. Photo credit: Li Zhang.

Figure 6.9*:* 2019 Beijing World Horticultural Exposition. Photo credit: Li Zhang.

6.4 Inclusivity: The Epistemic and Ethical Entanglement

In the introduction, I presented two senses of exclusion in contemporary conservation: (i) exclusion of the public from the plethora of ecological information, and (ii) exclusion of "not-so-charming" species from conservation. In this section, I address the entanglement between epistemic biases and ethical practices in contemporary conservation.

As shown in the above case studies, to overcome the limitations of science

communication and taxonomic biases, flagship species have strengths and limitations. Flagship species-centered conservation approaches focusing on large charismatic organisms display huge advantages in raising the conservation awareness of citizens and facilitating communication with them. The socio-cultural values of flagship species not only bridge the human community and other-than-human co-inhabitants, but also connect diversified cultures. In our case studies, Magellanic Woodpeckers function both as a flagship species and as a biocultural keystone species. In addition, it associates Western ecological science with Yahgan ethno-ornithology. In the case of the Giant Panda, its use as the logo of the World Wide Fund has positioned this mammal as a global conservation icon that grabs attention for wildlife preservation. Giant Panda reserves also enlightened Chinese citizens about conservation needs. In terms of scientific communication, flagship species such as the Magellanic Woodpecker and the Giant Panda are powerful and productive. In southern Chile, the Magellanic Woodpecker's habit of knocking on woods producing drumming sounds characterizes its ecological function that rescues native forests from beetle larvae outbreaks. In the Foping National Nature Reserve, the Giant Pandas' *in-situ* conservation encourages a national upsurge of wildlife conservation that fosters the mandate for an ecological civilization. The efficacy of communication in flagship-species conservation does not exclude citizens from understanding the significance of those species, their rareness, their threatened habitats, and their interactions with other co-inhabitants. There is correspondingly strong proof between direct exposure to charismatic species and citizens' pro-conservation attitudes.[426] However, if citizens

[426] See Jeffrey C Skibins, Robert B Powell, and Jeffery C Hallo, 2013, "Charisma and conservation: charismatic megafauna's influence on safari and zoo tourists' pro-conservation behaviors," *Biodiversity Conservation* 22(4), 959–982.

are only exposed to those charismatic species, cognitive bias might exclude not so-charming species.

The charisma of biological species comprises ecological, aesthetic, and corporeal attributes. These attributes have important ontological, epistemological, and ethical implications, which motivate citizens to participate in biodiversity conservation.[427] Thus, exposed solely to charming species produces epistemic bias. The process of how flagship species are identified in different regions discloses only the tip of the iceberg of epistemic bias. Research in Switzerland demonstrates that arbitrary elements are present in the identification a flagship species.[428] In this research, 415 students participated in questionnaires about their affinity for or antipathy to twenty-seven indigenous wildlife species, including vertebrates and insects. Respondents indicated a higher preference for species that they know rather than species unknown to them. At the species level, respondents showed higher affinity for butterflies, birds, and most mammals than for reptiles and other non-butterfly insects. In other words, the limited ecological information that people receive plays an important role in selecting flagship species. If critical biological or ecological information regarding conservation is absent in citizens' cognition, they seldom will pay attention to unknown species and their habitats. Based on "willingness-to-pay" (WTP) to investigate people's preference for species conservation, another study proved that participants pay higher attention to charismatic

[427] Jamie Lorimer, 2007, "Nonhuman Charisma," *Environment and Planning D: Society and Space* 25(5), 911-932.

[428] Jürg Schlegel and Reto Rupf, 2010, "Attitudes towards potential animal flagship species in nature conservation: A survey among students of different educational institutions," *Journal for Nature Conservation* 18 (4), 278-290.

species rather on their conservation status.[429] People are constrained by what they know. If they merely know a global homogenized biological reality, but do not know about regional biocultural diversity, then their cognition, attitude, and habits will be correspondingly limited. The absence of regionally endemic biodiversity and its inclusivity in our ecological communication drives the exclusive focus on large flagship species. Consequently, a large portion of the globe's biodiversity is excluded, particularly invertebrates and non-vascular plants.

To overcome the former exclusion, it is necessary to adjust scientific communication and increase the spectrum of species, for example by including invertebrates and non-vascular plants. Several reasons compel us to correct epistemic biases and enhance taxonomic inclusivity in ecological communication and conservation.

First, generally, scientific communication can be hindered by taxonomic bias and misrepresentation. "Vertebratism" and "taxonomic chauvinism" are symptoms and drivers of biocultural homogenization in modern philosophy, contemporary sciences, and global cultural representation that have excluded the most diverse groups of animals, i.e., invertebrates.[430] By "symptoms," Rozzi points to the phenomena that our mental images of animals are mostly represented by mammals or vertebrates; thus, making invisible the majority of animals. He proposes that this taxonomic bias is "a driver" of global biocultural homogenization, because citizens feel more connected to a few non-local, iconic mammals (i.e., the panda or Mickey

[429] Agathe Colléony, Susan Clayton, Denis Couvet, et al., 2017, "Human preferences for species conservation: Animal charisma trumps endangered status," *Biological Conservation* 206, 263-269.

[430] See Ricardo Rozzi, 2019, "Taxonomic Chauvinism, No More! Antidotes from Hume, Darwin, and Biocultural Ethics."

Mouse) rather than to their own local biodiversity. In biocultural homogenization, these symptoms and drivers form vicious feedbacks.

Taxonomic chauvinism also permeates conservation terminology. Maan Barua investigated how misrepresentation of conservation terminology and taxonomic bias can hinder public conservation literacy.[431] His analysis shows that terms such as *flagship species*, *keystone species*, and *umbrella species* are used differently by academics than by non-academics. Non-academic communication is less precise than technical academic terminology. This might lead to a stereotype fixation on mammals and birds. This misunderstanding can lead to ethical issues. To counterbalance fixation with vertebrates, Barua and collaborators called for promoting "invertebrate flagship as an invertebrate species or group that resonates with a target audience and stimulates awareness, funding, research and policy support for the conservation of invertebrate diversity."[432] In the sphere of plant conservation, non-vascular plants such as mosses are also underrepresented. Conservation terminology with rich communication about invertebrates and non-vascular plants will bridge the communication channel and improve citizens' conservation literacy.

Second, the limited accessibility of global citizens to ecological information might fall into the "availability heuristic" and provoke the occurrence of "neglected beauty" or "unattended charisma."[433] Hence, the attractive features of the available species known to

[431] Maan Barua, 2011, "Mobilizing metaphors: the popular use of keystone, flagship and umbrella species concepts," *Biodiversity Conservation* 20, 1427-1440.

[432] Maan Barua, Daniel J. Gurdak, Riyaz Akhtar Ahmed, and Jatin Tamuly, 2012, "Selecting flagships for invertebrate conservation," *Biodiversity Conservation* 21,1457-1476, see p. 1458.

[433] Amos Tversky and Daniel Kahneman., 1973, "Availability: A heuristic for judging frequency and probability," *Cognitive Psychology* 5(2), 207-232.

citizens are overestimated and those unknown species are disregarded. The inaccessibility to regional endemic species, such as sub-Antarctic mosses, and the accessibility to homogenized species, such as roses and apples in turn exacerbate global biocultural homogenization.[434] Additionally, in the original Greek *charisma* (*χάρισμα*) means "divine gift." To determine which species are "divine gifts" is arbitrary. Thus, "neglected beauty" or "unattended charisma" is a cognitive bias, an epistemic defect, implying an absence of justice. To a very large extent, our notion of *charisma* is socially and culturally constructed. It is notable that the term *charisma* was applied to animals only in recent decades. Even Giant Pandas were unknown to the Chinese as well as the rest of the world. Therefore, the long journey to recognize the charisma of many neglected species has just begun. Work in the Omora Ethnobotanical Park and the Shenzhen Fairy Lake Botanical Garden represent early stages of correcting these epistemic biases. This work is enhancing the inclusivity of ecological communication and conservation terminology. Due to these mosses-centered research, communication, and conservation, the charisma of bryophytes has been impressed on the public's mindsets. These successes in disclosing the "neglected beauty" of bryophytes indicate the possibility of discovering the charisma of neglected species, enlarging the sphere of ecological and evolutionary understanding, thus enhancing the inclusivity of conservation.

Third, flagship species tend to focus the public's attention on the symbolic and representational value of large charismatic species. This tendency risks overlooking interactions among co-inhabitants in the ecosystem, thereby reducing ecological complexity to a few

[434] See Ricardo Rozzi, 2013, "Biocultural ethics: from biocultural homogenization toward biocultural conservation."

flagship species. Nabhan has cautioned about the danger of reductionism via the shades of meaning between endangered species and biodiversity.[435] The ethical implication here is that taxonomic spectrums ought to be broadened for more inclusive conservation and ethical consideration. Moreover, to avoid extreme reductionism, citizens not only ought to know which entities (individual, species, community, etc.) are present; they also need to understand the interactions among them. These interactions are vital links among co-habitants, their life habits, and shared habitats.[436] Consequently, the Magellanic Woodpecker and the Giant Panda should not be regarded only as flagship species. They also should be understood as being embedded in their complex ecological interactions and valued as umbrella species.

Notably, the mosses-centered conservation initiatives at the Omora Ethnobotanical Park and the Shenzhen Fairy Botanical Garden have emphasized ecological complexity from the beginning. In the case of Omora, citizens attend to the integrity of the habits, habitats, and interactions of bryophytes with other co-inhabitants through Ecotourism with a Hand-lens.[437] In the case of Shenzhen Fairy Lake, citizens are exposed to the diverse habits and delicate structures of bryophytes, their life circles, photosynthesis, participation in geochemical cycles, and their capacity to mold the landscape.[438] Since its creation, Omora Park researchers engaged in integrating environmental philosophy, the arts, and sciences because they thought that an ethical reflection on the relationships of co-inhabitation was essential for systems and for a

[435] Gary Paul Nabhan, 1995, "The Danger of Reductionism in Biodiversity Conservation," *Conservation Biology* 9(3), 479-481.

[436] See Ricardo Rozzi, Juan M Draguicevic, Ximena Arango, et al., 2014, "From science towards conservation: the education and environmental ethics program of the mora Ethnobotanical Park."

[437] Ricardo Rozzi, Lily Lewis, Francisca Massardo, et al., 2012, *Ecotourism with a Hand-Lens at Omora Park*.

[438] Li Zhang, Qin Zuo, Baoying Hong, 2015, *The Miniature Angels in the Plant Kingdom* (《植物王國的小矮人》).

contextual approach to orient biological and cultural conservation.[439] Communication needs to include these dimensions and convey them to the general public and decision makers. Conservation cannot achieve its goals if it excessively focuses on a single flagship species in isolation from their ecological and cultural contexts.

Fourth, the epistemic bias that favors compartmentalization and specialization among disciplines impedes adequate ecological communication. A foundational principle of the biocultural ethic's "3Hs" framework is that conservation takes place in social-cultural-political contexts which are influenced by local ecological and particular cultural conditions.[440] This biocultural heterogeneity clashes with the prevailing narrative of universal, homogeneous, and linear progress.[441] This is analogous to the tension between flagship species and moss-centered conservation approaches. The first expect single-species centered communication to motivate citizens to biodiversity conservation. The second communicates ecological interactions among often overlooked organisms, which are essential components of biodiversity. Saroj Chawla examines the close associations among languages, worldviews, and the ways humans interact with their natural environments.[442] Plumwood attributes the ultimate causes of our contemporary environmental crisis to citizens' failure to identify themselves as ecological

[439] Ricardo Rozzi, Ximena Arango, Francisca Massardo, et al., 2008, "Field environmental philosophy and biocultural conservation: the Omora Ethnobotanical Park educational program."

[440] Ricardo Rozzi, 2015, "Earth stewardship and biocultural ethics: Latin American perspectives," in *Earth Stewardship: linking ecology and ethics in theory and practice* (Ecology and Ethics, vol 2, Springer, Dordrecht), pp. 87–112.

[441] Arran E Gare 1998, "MacIntyre, narratives, and environmental ethics," *Environmental Ethics* 20(1), 3-21.

[442] Saroj Chawla, 1991, "Linguistic and philosophical roots of our environmental crisis," *Environmental Ethics*, 13(3), 253-262.

beings due to a culture that separates humans from nature.[443] Further, global citizens subordinate nature because it is merely understood as an object for exploitation. Rozzi identifies "biocultural homogenization" to be a wicked problem because it involves feedbacks between the homogenization of biota and cultures.[444]

Biocultural homogenization is a fundamental driver of rapid global change. In the case of panda conservation, the international attractiveness of the panda as an icon of Kungfu or the WWF logo did contribute to saving pandas and their habitats in China. However, the panda concentrated more than 50% of conservation research resources at the expense of less charismatic species.[445] For global culture, connecting pandas with people has facilitated local conservation and associated local environmental awareness. On the other hand, it has obscured the need for conservation of less conspicuous species. Additionally, the diversity of society-nature connections among various local communities has been often overlooked in biodiversity conservation. Field environmental philosophy addresses these problems by situating people in their regional and local biocultural complex contexts, and by enhancing communication and enriching people's understanding of native biocultural diversity.

6.5 Final Comments on Field Environmental Philosophy

In this last section, I have addressed how field environmental philosophy suits the remedy of creating a more inclusive and convivial conservation approach through botanical

[443] Val Plumwood, 2005, *Environmental Culture: The Ecological Crisis of Reason*, p. 238.

[444] Ricardo Rozzi, 2018, "Biocultural homogenization: a wicked problem in the Anthropocene."

[445] Zhi-Ning Wang, Li Yang, Peng-Fei Fan, and Lu Zhang, 2021, "Species bias and spillover effects in scientific research on Carnivora in China," *Zoological Research* 42(3), 354.

gardens. Grounded on the entanglement between epistemic biases and ethical practices, viz. (1) taxonomic bias, (2) availability heuristic, (3) overlooking of ecological interactions, and (4) homogenizing society-nature connections, I now explain why field environmental philosophy is capable of countering epistemic biases, assuring meaningful ethical practices, and eventually allowing us to meet others (other-than-human beings, other humans, other cultures) as the *Thou*. As introduced in chapter 3.1, the four steps of field environmental philosophy are, namely, (1) interdisciplinary ecological and philosophical research, (2) the composition of metaphors and communication through narratives, (3) field activities guided with an ecological and ethical orientation, and (4) implementation of areas for *in situ* biocultural conservation form a loop system.

To counter taxonomic bias, field environmental philosophy has successfully shown in both case studies of moss-centered approach that field investigation opens up the chance of face-to-face encounters with many other-than-human co-inhabitants. People not only encounter non-vascular plants but also invertebrates, as shown in another field activity designed by Chilean biologist Jaime Ojeda: "open your eyes to dive."[446] The methodology of field environmental philosophy allows people to become immersed in the local biodiversity rather than few mammals or vertebrates.

In terms of availability heuristic, it is a question of whether the broadest availability (all organisms in an ecosystem) ought to be set as the conservation target. Apparently, given the limited conservation resources, in the current stage, the more urgent task is to make endemic

[446] See Ricardo Rozzi, 2019, "Taxonomic Chauvinism, No More! Antidotes from Hume, Darwin, and Biocultural Ethics."

organisms cognitively available to local communities. Field environmental philosophy has the strength to recruit local communities in attending to the endemic biodiversity, or regional conservation needs to ensure local citizens a larger accessibility to the endemic biodiversity, which in turn enriches meaningful ecological communication in the regional scale.

With regard to ecological interactions among co-inhabitants of the ecosystem, since field environmental philosophy devoted to the educational objective of linking ecology and ethics during field activities, it can locate the framework of 3Hs in the local ecosystems and urge citizens to appreciate the complex interactions in local ecosystems and how local ecosystems are connected to global climate change or environmental degradation. Doing so fosters a culture based on the concept that humans are co-inhabitants and ecological beings. For example, as shown in mosses-centered conservation, citizens could value the co-inhabitance of endemic mosses in Southern Chile and apprehend that with air pollution, some non-vascular species have retreated from Europe, i.e., the genus *Usnea*.[447] This point sends a message regarding ethical dwelling on the globe.

As for the fourth epistemic bias which causes biocultural homogenization, field environmental philosophy actually opens the opportunity for participants to understand how local biological diversity is embedded in local cultural context, an insight into the existing various and diversified biocultural links involving reginal and local scales. In both case studies of the moss-centered approach, I observe a common feature: they acknowledge that they are embedded in a social-cultural-political matrix. This acknowledgement captures the complexity

[447] Ricardo Rozzi, 2012, "Introduction to ecotourism with a hand lens."

among philosophy, language, cultural tradition, ecological science, and politics. In the Shenzhen Fairy Lake Botanical Garden, the "moss team" highlighted Chinese tradition in classical literature and calligraphy through their appreciation of the charisma of mosses. China's contemporary political agenda of Ecological Civilization Construction plays a significant role in encouraging urban citizens to participate in exhibitions, nature experiences, and other types of communication activities. Both the successful cases of Omora Ethnobotanical Park and Shenzhen Friary Lake Botanical Garden have constructed multiple metaphors embedded in their social-cultural-political backgrounds to communicate with citizens. Furthermore, the openness of field environment philosophy to biocultural diversity and contextualization also inspires an embrace of traditional ecological knowledge, decolonial environmentalism, and empowering local communities to create novel conservation strategy.[448]

In conclusion, to counter the two senses of exclusiveness I raise at the beginning of this chapter, namely, the exclusiveness of general citizens from the plethora of ecological information and the exclusiveness of many invertebrates and non-vascular plants from biological conservation, field environmental philosophy can contribute to enhancing the inclusivity by fitting into the local biological and socio-cultural-political contexts. As shown in our case studies, to reconnect global citizens with "invisible" organisms through ecological communication and conservation, non-vascular plants like mosses can provide a miniature but powerful bridge. Botanical gardens and accessible areas in natural reserves offer an ideal field

[448] See Ricardo Rozzi, Ximena Arango, Francisca Massardo, et al., 2008; Gallegos de Castillo, 2015, "Sketch of a Decolonial Environmentalism: Challenging the Colonial Conception of Nature through the Biocultural Perspective," *Inter-American Journal of Philosophy* 6(1), 32–47; and Mitsuyo Toyoda, 2018, "Revitalizing local commons: a democratic approach to collective management."

for global citizens to connect with local co-inhabitants and the remaining native biocultural diversity. At the end of this chapter, I call on botanical gardens, environmental organizations, and other institutions in the field to attend to field environmental philosophy and its merits for more inclusive ecological communication, comprehensive taxonomic diversity, and convivial biocultural conservation.

CHAPTER 7

CONCLUSION: TOWARD A CONVIVIAL BIOCULTURAL CONSERVATION

In this project, it was initially the presence of the issue of injustice at three levels that guided my thinking about meeting mosses, namely, interspecies injustice, colonial injustice, and epistemic injustice. Encountering moss, on the surface, seems to involve only interspecies injustice. Yet, as the project proceeds, it becomes impossible to avoid the other two major issues, whether it is about the history of indigenous people of South America, the heritage of their cultures, their traditional ecological knowledges, and traditional way of being that I encountered in the field, or the introduction, acquisition, and integration of scientific nomenclature/knowledge with traditional discourse/culture by contemporary Chinese bryologists. Threaded through all questions of injustice is the theme of how to confront the Other, including other species, other cultures, other ethnicities, other modes of thinking, other systems of knowledge, to name a few. Levinas is straightforward about the ethical responsibility due to the presented face of the Other and the tension between the metaphysical reticence of the Other and de facto totality leading to such extreme violence to the human others during World War II. The calling of meeting mosses is one of the myriad ways of ethically encountering others, a calling of convivial biocultural conservation.

Convivial biocultural conservation is a term I borrowed from Illich and Rozzi. The convergence between Illich's conviviality and Rozzi's biocultural ethic lies first in the fact that they both identify an ongoing and dominant homogenization, although they may use different terms to describe the nature or mechanism of homogenization. Second, another intersection rests in the solution, particularly the "con-" part of "conviviality" and the "co-" part of "co-

inhabitation," both figuratively describing an image of a joyful, friendly, and hospitable welcoming of the presence of others, a meeting. Meeting in this project is generally defined as the ethical command of welcoming the presence, manifestation, expression of others. Although Levinas particularly focuses on the ethical calling of others' face, this project handles mosses as the radical others whose alterity cannot be reduced to the same. As discussed in chapter 2, Levinas differentiates formal alterity and non-formal alterity. It is the non-formal alterity of the metaphysical other which resists to be totalized and offers a challenge of confronting the egoism of the sameness. A metaphysical other is already an ethical calling. Meeting mosses is to welcome their manifestation and expression in the sense that mosses are hosts and subjects of their life.

The Half-Earth project, convivial conservation, and biocultural conservation are different frameworks of conservation to tackle the contemporary wickedness of the Anthropocene. The former two somehow particularly highlight the ecological or the political aspects of conservation. Biocultural conservation, as demonstrated in this project by biophysical encounters, nomenclatures, gardening, and *in-situ/ex-situ* conservation, offers more explicability and fulfillment for addressing contemporary interspecies injustice, colonial injustice, and epistemic injustice.

According to Robert Pogue Harrison, care is the vocation of humans, the condition for humans to be humans by pouring care into what we care and cultivate in the garden. Harrison states that what makes a person human is the conviviality between a person and what the person cares for, whether it is a species, an ecological system, a garden, the planetary earth, or democracy, technology, economy, cultures, or entangled bio-cultural systems. Oriented by

Rozzi's biocultural ethic, the greatest moral commandment for those who care about mosses is to coinhabit with them, i.e., in my own words, to welcome human-moss conviviality. I propose that in fulfilling the vocation of care, the care-taker steps toward conviviality. In fulfilling rather than being deprived of their ecological roles, mosses can exist, and offer us care, friendship, generosity, and be a part of the meeting/conviviality embedded in relations of co-inhabitation. I have observed that interspecies and intercultural meetings (the convivial) are present in both the *in-situ* moss conservation programs at the Omora Ethnobotanical Park in Chile and the *ex-situ* moss conservation programs at the Shenzhen Fairy Lake Botanical Garden in China.

BIBLIOGRAPHY

Aguirre Sala, J.F. (2015). Hermeneutics and Field Environmental Philosophy: Integrating Ecological Sciences and Ethics into Earth Stewardship. In: Rozzi R. et al. (eds) *Earth Stewardship* (Ecology and Ethics), vol 2. Springer, Cham. https://doi.org/10.1007/978-3-319-12133-8_15

Alagona, P. S., & Simon, G. L. (2010). The role of field study in humanistic and interdisciplinary environmental education. *The Journal of Experiential Education*, 32(3), 191-206.

Arango, X., Rozzi, R., Massardo, F., Anderson, C., Ibarra, T. (2014). Discovery and implementation of the Magellanic Woodpecker (Campephilus magellanicus) as a charismatic species: a biocultural approach for conservation in the Cape Horn Biosphere Reserve. In: Rozzi, R., Jiménez, J. E., (eds). *Magellanic Sub-Antarctic Ornithology: first decade of long-term bird studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve, Chile*, pp 302-316. Denton, TX: University of North Texas, University of Magallanes Press.

Armesto, J., Rozzi, R., & Willson, M. (1996). Bridging Scientific Knowledge, Education, and Application in Temperate Ecosystems of Southern South America. *Bulletin of the Ecological Society of America*, 77(2), 120-122.

Barad, K. (2012). On Touching—The inhuman that therefore I am. *Differences*, 23(3), 206-223.

Barnhardt, R., Oscar Kawagley, A. (2005). Indigenous knowledge systems and Alaska Native ways of knowing. *Anthropology & Education Quarterly*, 36(1), 8-23.

Barua, M. (2011). Mobilizing metaphors: the popular use of keystone, flagship and umbrella species concepts. *Biodiversity Conservation* 20(7), 1427-1440.

Barua, M., Gurdak, D. J., Ahmed, R. A., Tamuly, J. (2012). Selecting flagships for invertebrate conservation. *Biodiversity Conservation* 21,1457-1476.

Bhasin, V. (2011). Pastoralists of Himalayas. *Journal of Human Ecology*, 33(3), 147-177.

Bjerke, J. W., Verbal, A., Quilhot, W. (2003). Distribution and habitat ecology of the sorediate species of Menegazzia (Parmeliaceae, lichenized Ascomycota) in Chile. *Revista Chilena de Historia Natural*, 76, 79-98.

Bookchin, M. (2001). What is social ecology? In Zimmerman, ME., Callicott, JB, Sessions, G, Warren, KJ, & Clark, J. (eds) *Environmental philosophy: From Animal Rights to Radical Ecology* (3rd edition), pp. 436-454. Upper Saddle Rivers, NJ: Prentice Hall.

Boyd, R. (1991). Realism, Anti-Foundationalism and the Enthusiasm for Natural Kinds. *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, 61(1/2), 127-148.

Buber, M., translated by Smith, RG. (1958). *I and Thou*. New York, NY: Scribner.

Buck, W. R. (2007). The history of pleurocarp classification: two steps forward, one step back. In *Pleurocarpous Mosses: Systematics and Evolution*. Boca Raton, FL: CRC Press.

Buckinghamn, K. C., David, J. N., & Jepson, P. (2013). Diplomats and Refugees: Panda Diplomacy, Soft "Cuddly" Power, and the New Trajectory in Panda Conservation. *Environmental Practice*, 15(3), 262-270.

Büscher, B., Fletcher, R. (2019). Towards convivial conservation. *Conservation & Society*, 17(3), 283-296.

Büscher, B., Fletcher, R. (2020). *The Conservation Revolution: Radical Ideas for Saving Nature Beyond the Anthropocene*. New York, NY: Verso.

Büscher, B., Fletcher, R., Brockington, D., et al. (2017). Half-Earth or Whole Earth? Radical ideas for conservation, and their implications. *Oryx*, 51(3), 407-410.

Čapek, K. Illustrated by Čapek, J. (1984). *The Gardener's Year*. Madison, WI: University of Wisconsin Press.

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, 486(7401), 59-67.

Carmona, M. R., Aravena, J. C., Bustamante-Sanchez, M. A. et al. (2010). Senda Darwin Biological Station: Long-term ecological research at the interface between science and society. *Revista Chilena de History Natural* (Santiago, Chile), 83, 113-142.

Carson, R. (1962). *Silent Spring*. New York, NY: Fawcett World Library.

Chawla, S. (1991). Linguistic and philosophical roots of our environmental crisis. *Environmental Ethics*, 13(3), 253-262.

Chen, B. (1953). Funaria hygrometria Hedw.(《葫蘆蘚》). *Biology Bulletin* (10), 370-373, 381.

Chen, G., Sun, W. (2018). The role of botanical gardens in scientific research, conservation, and citizen science. *Plant diversity*, 40(4), 181-188.

Cheney, J., Weston, A. (1999). Environmental ethics as environmental etiquette: Toward an ethics-based epistemology. *Environmental Ethics*, 21(2), 115-134.

Chester, Sharon R. (2008). *A Wildlife Guide to Chile: continental Chile, Chilean Antarctica, Easter Island, Juan Fernández Archipelago*. Princeton, NJ: Princeton University Press.

China State Forestry Administration. (2015). The Giant Pandas of China: Status Quo. Chinese-English version of the report can be accessed online through: http://www.forestry.gov.cn/main/69/content-743562.html

Choné, A., Hajek, I., & Hamman, P. (Eds.). (2017). *Rethinking Nature: Challenging Disciplinary Boundaries.* New York, NY: Routledge.

Clucas, B., McHugh, K., Caro, T. (2008). Flagship species on covers of US conservation and nature magazines. *Biodiversity and Conservation*, 17(6), 1517-1528.

Cocks, S., Simpson, S. (2015). Anthropocentric and ecocentric: An application of environmental philosophy to outdoor recreation and environmental education. *The Journal of Experiential Education*, 38(3), 216-227.

Colléony, A., Clayton, S., Couvet, D., Saint Jalme, M., Prévot, A. C. (2017). Human preferences for species conservation: Animal charisma trumps endangered status. *Biological Conservation*, 206, 263-269.

Crane, P.R., Ge, S., Hong, D., Huang, H., Jiao, G., et al. (2017). The Shenzhen Declaration on Plant Sciences-Uniting plant sciences and society to build a green, sustainable Earth. *Journal of Systematics and Evolution*, 55.

Croke, V. (2005). *The Lady and the Panda: the true adventures of the first American explorer to bring back China's most exotic animal.* New York, NY: Random House.

Croxall, J. P., Butchart, S. H., Lascelles, B. E. N., Stattersfield, A. J., Sullivan, B. E. N., Symes, A., & Taylor, P. H. I. L. (2012). Seabird conservation status, threats and priority actions: a global assessment. *Bird Conservation International*, 22(1), 1-34.

Da Dai Li Ji (《大戴禮記》).

de Queiroz, K. (2007). Species concepts and species delimitation. *Systematic biology*, 56(6), 879-886.

de Queiroz, K. (2012). Biological nomenclature from Linnaeus to the PhyloCode. *Bibliotheca Herpetologica*, 9 (1-2), 135-145.

de Queiroz, K. and Donoghue, M.J. (1988). Phylogenetic systematics and the species problem. *Cladistics*, 4, 317-338. https://doi.org/10.1111/j.1096-0031.1988.tb00518.x

de Queiroz, K., Gauthier, J. (1994). Toward a Phylogenetic System of Biological Nomenclature. *Trends in Ecology and Evolution*, 9 (1): 27–31.

Derrida, J, edited by Mallet, M. L., translated by Wills, D. (2008). *The Animal that Therefore I am*. New York, NY: Fordham University Press.

Dillenius, J. J. (1768). *Historia Muscorum: A General History of Land and Water & Mosses and Corals*. United Kingdom: J. Millan.

Dupré, J. (1981). Natural kinds and biological taxa. *The Philosophical Review*, 90(1), 66-90.

Duron, Q., Jiménez, J. E., Vergara, P. M., Soto, G. E., Lizama, M., & Rozzi, R. (2018). Intersexual segregation in foraging microhabitat use by Magellanic Woodpeckers (Campephilus magellanicus): Seasonal and habitat effects at the world's southernmost forests. *Austral Ecology*, 43(1), 25-34.

EBSD. https://www.sendadarwin.cl/inicio/quienes-somos/

Edelglass, W., Hatley, J., & Diehm, C. (2012). *Facing Nature: Levinas and environmental thought.* Pittsburgh, Penn: Duquesne University Press.

Egerton, F. N. (2013). History of ecological sciences, part 47: Ernst Haeckel's ecology. *Bulletin of the Ecological Society of America*, 94(3), 222-244.

Ellis, E. C., Mehrabi, Z. (2019). Half Earth: promises, pitfalls, and prospects of dedicating Half of Earth's land to conservation. *Current Opinion in Environmental Sustainability*, 38, 22-30.

Ereshefsky, M. (1992). Eliminative Pluralism. *Philosophy of Science*, 59(4), 671-690.

Faraji, L., & Karimi, M. (2020). Botanical gardens as valuable resources in plant sciences. *Biodiversity and Conservation*, Jan 02, 1-22.

Fedorovskaya, N. A., Chernova, A. V., & Kravchenko, I. A. (2021, March). The Planting of Greenery for Retaining Walls as a Direction in the Design of Vladivostok. *In IOP Conference Series: Materials Science and Engineering* (Vol. 1079, No. 5, p. 052054). IOP Publishing.

Flowers, S. (1957). Ethnobryology of the Gosuite Indians of Utah. *The Bryologist*, 60(1), 11-14.

Fricker, M. (2007). *Epistemic Injustice: Power and the Ethics of Knowing*. New York, NY: Oxford University Press.

Friederichs, K. (1958). A definition of ecology and some thoughts about basic concepts. *Ecology*, 39(1), 154-159.

Frodeman, R. (2007). The future of environmental philosophy. *Ethics and the Environment*, 12(2), 117-118.

Gagliano, M., Ryan, J. C., & Vieira, P. (Eds.). (2017). *The Language of Plants: Science, Philosophy, Literature*. Minneapolis, MN: University of Minnesota Press.

Gao, C., Li, X., Li, Z. (1996). *Flora Bryophytarum Sinicorum: Fissidentales Pottiales* (《中國苔藓志： 鳳尾蘚目 叢蘚目》). Beijing: Science Press.

Gare, A. E. (1998). MacIntyre, narratives, and environmental ethics. *Environmental Ethics*, 20(1), 3-21.

Gerritson, W. (1937). A garden of mosses. *The Bryologist*, 40(2), 39-40.

Ghiselin, M. (1974). A Radical Solution to the Species Problem. *Systematic Zoology,* 23(4), 536-544. doi:10.2307/2412471

Gimingham C. H., Robertson, E. T. (1950). Preliminary Investigations on the Structure of Bryophytic Communities. *Transactions of the British Bryological Society* (Currently known as *Journal of Bryology*), 1(4), 330-344. doi:10.1179/006813850804878734

Goffinet, B., Rozzi, R., Lewis, L. et. al. (2012). *Miniature forests of Cape Horn: Ecotourism with a hand lens* (Los bosques en miniatura del Cabo de Hornos: ecoturismo con lupa.) Denton, TX: University of North Texas Press.

Goffinet, B., Shaw, A. J. (2009). *Bryophytes Biology* (2nd edition). New York, NY: Cambridge University Press.

Goralnik, L., & Nelson, M. P. (2014). Field philosophy: Dualism to complexity through the borderland. *Dialectical Anthropology*, 38(4), 447-463.

Goralnik, L., & Nelson, M. P. (2017). Field philosophy: Environmental learning and moral development in isle royale national park. *Environmental Education Research*, 23(5), 687-707.

Graham, A. C. (1986). *Yin-Yang and The Nature of Correlative Thinking* (Vol. 6). Singapore: Institute of East Asian Philosophies.

Grene, M. G., & Mendelsohn, E. (1975). *Topics in the philosophy of biology*. Dordrecht, Holland: D. Reidel Pub. Co.

Griffiths, G. C. D. (1974). On the foundations of biological systematics. *Acta Biotheor* 23, 85–131. https://doi.org/10.1007/BF01556343

Grout, A. J. (1931). Mosses in landscape gardening. *The Bryologist*, 34(5), 64-64.

Hacking, I. (1991). A Tradition of Natural Kinds. *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, 61(1/2), 109-126.

Haeckel, E. (1894). *Monism as Connecting Religion and Science: The confession of faith of a man of science*. UK: A. and C. Black.

Haeckel, E. (1904). *The Wonders of Life: A Popular Study of Biological Philosophy* (No. 23). Harper & brothers.

Haeckel, E. (1974). *Art Forms in Nature.* New York, NY: Dover Publications.

Hall, M. (2011). *Plants as Persons: A philosophical botany*. Albany, NY: Suny Press.

Hallingbäck, T., Hodgetts, N. (2000). *Mosses, Liverworts, and Hornworts: Status Survey and Conservation Action Plan for Bryophytes*. IUCN/SSC Bryophyte Specialist Group.

Haraway, D. J. (2008). *When Species Meet*. Minneapolis and London: University of Minnesota Press.

Haraway, D. J. (2016). *Staying with the Trouble: Making Kin in the Chthulucene*. United Kingdom: Duke University Press.

Harris, E. S. (2008). Ethnobryology: traditional uses and folk classification of bryophytes. *The Bryologist*, 111(2), 169-217.

Harrison, R. P. (2008). *Gardens: An essay on the human condition*. Chicago, IL: University of Chicago Press.

He, H, Chen, J. (2012). Educational and enjoyment benefits of visitor education centers at botanical gardens. *Biological Conservation* 149 (1), 103-112.

Hecht, A. (1953). The Gardens of the Villa D'Este. *The Kenyon Review*, 15(2), 208–212. http://www.jstor.org/stable/4333398

Hedwig, J., Schwagrichen, F. (1801). *Species muscorum frondosorum*. Germany: Sumtu Ioannis Ambrosii Barthii.

Hey, J. (2006). On the failure of modern species concepts. *Trends in Ecology & Evolution*, 21(8), 447-450.

Hillman, B. (2003). Paradise under construction: minorities, myths and modernity in northwest Yunnan. *Asian Ethnicity*, 4(2), 175-188.

Holland, J. S. (2016). Who discovered the panda?, National Geographic. Accessed through https://www.nationalgeographic.com/magazine/2016/08/explore-panda-mania-history/ on November 15, 2020

Huerta, V. A., Santoni, J. C., Zúñiga, F. O. (2008). Briófitas de los bosques templados de Chile: una introducción al mundo de los musgos, hepáticas y antocerotes: guía de campo (Bryophytes of Chile's Temperate Forests: An Introduction to the World of Mosses, Liverworts, and Anthocerotes: A Field Guide). Chile.

Hunn, E. (1999). Size as limiting the recognition of biodiversity in folkbiological classifications: One of four factors governing the cultural recognition of biological taxa. In Medin, D. L. & Atran, S. ed., *Folkbiology*. Cambridge, Mass: MIT Press, 47-69.

Illich, I. (1973). *Tools for Conviviality*. New York, NY: Harper and Row.

Iwatsuki, Z., & Kodama, T. (1961). Mosses in Japanese gardens. *Economic Botany*, 15(3), 264-269.

Jacobs, P. (2004). Learning from Saihô-ji: sustaining a garden tradition. *Studies in the History of Gardens & Designed Landscapes*, 24(1), 1-20.

Kalinkat, G., Cabral, J. S. et al. (2016). Flagship umbrella species needed for the conservation of overlooked aquatic biodiversity. *Conservation Biology* 31(2), 481-485.

Katz, E. (1991). Ethics and Philosophy of the Environment: A Brief Review of the Major Literature. *Environmental History Review*, 15(2), 79-86.

Kelly, J. (2017). In Search of Paradise Lost in Tierra del Fuego. *Earth Island Journal* (Earth Island Institute), retrieved on April 29, 2021 via https://www.earthisland.org/journal/index.php/articles/entry/in_search_of_paradise_lost_in_tierra_del_fuego/

Kimmerer, R. W. (2003). *Gathering Moss: A natural and cultural history of mosses*. Corvallis, OR: Oregon State University Press.

King Jr, M. L. (1992). Letter from Birmingham jail. *UC Davis Law Review*, 26, 835.

Kitts, D., & Kitts, D. (1979). Biological Species as Natural Kinds. *Philosophy of Science*, 46(4), 613-622.

Kleinmann, R. L., Tiernan, T. O., Solch, J. G., et al. (1983). A low-cost, low-maintenance treatment system for acid mine drainage using sphagnum moss and limestone. In *Proceedings of the 1983 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation*, pp. 241-245. University of Kentucky, Lexington, KY.

Klips, R. A. (2018). An Artistic Approach to Bryology. *The Bryologist*, 121(2), 248-249.

Kono, T. (2018). The garden as a representation of nature: a space to overcome biocultural homogenization? In: Rozzi R, May RH Jr, Chapin FS III, Massardo F, Gavin M, Klaver I, Pauchard A, Nuñez MA, Simberloff D (eds) *From biocultural homogenization to biocultural conservation* (Ecology and Ethics), vol 3. Springer, Dordrecht, pp 459–474.

Kopnina, H. (2016). Half the earth for people (or more)? Addressing ethical questions in conservation. *Biological Conservation*, 203, 176-185.

Kutschera, U., Farmer, S. (2020). Ernst Haeckel, ancient forests, and the Anthropocene. *Plant Signaling & Behavior*, 15:2.

Larraín, J. (2007). "Musgos (Bryophyta) de la estación biológica Senda Darwin, Ancud, Isla de Chiloé, Chile. Claves para su identificación y lista de especies" (Mosses (Bryophyta)of Senda Darwin biological station, Ancud, Chiloé Island, Chile: Keys for identification and species list). Accessed on April 20, 2021, from the online library of EBSD at https://www.sendadarwin.cl/inicio/investigacion/biblioteca/.

Lawley, M. (2019). A social and biographical history of British and Irish field-bryologists. *The British Bryological Society*, accessible through https://www.britishbryologicalsociety.org.uk/resources/bryohistory/.

Legg, S., and Hutter, M. (2007). A collection of definitions of intelligence. *Frontiers in Artificial Intelligence and Applications*, 157, 17–24.

Leopold, A. (1949). *A Sand County Almanac and Sketches Here and There*. New York, NY: Oxford University Press.

Levinas, E., translated by Lingis, A. (1969). *Totality and Infinity: An essay on exteriority*. Pittsburgh, Penns: Duquesne University Press.

Li, B. V., & Pimm, S. L. (2016). China's endemic vertebrates sheltering under the protective umbrella of the giant panda. *Conservation Biology,* 30(2), 329-339.

Li, S. Z., Hu, C. L. (2022). *Běncǎo Gāngmù* (《本草綱目》, Vol V). Oakland, CA: University of California Press.

Li, S., McShea, W. J., Wang, D., Gu, X., Zhang, X., Zhang, L., & Shen, X. (2020). Retreat of large carnivores across the giant panda distribution range. *Nature Ecology & Evolution*, 4(10), 1327-1331.

Li, X. T. (2017). The Study of the Moss Image in Tang Poems. Master Thesis: Inner Mongolia University.

Li, X., Hu, R., Zang, M. (2010). in Wu, P., Yuan, S. ed. *International Bryological Symposium for Pro. Pan-Chich Chen's Centennial Birthday* (《陳邦傑先生國際學術紀念文集》). Nanjing: Nanjing Normal University Press.

Li, X., Zang, M., Zeng, S. (1985). *Bryoflora of Xizang* (《西藏苔蘚植物志》). Beijing: Science Press.

Linnaeus, C. v., Smith, J. E. (1785). *Reflections on the Study of Nature*. UK: G. Nicol.

Liu, C. (1982). *Nei Jing de Zhe Xue Yu Zhong Yi Xue de Fang Fa* (《内經的哲學與中醫學的方法》, The Philosophy of Neijing and the Method of Chinese Medicine). Beijing: Science and Technology Press.

Liu, X., Skidmore, A. K., Wang, T., et al. (2002). Giant panda movements in Foping Nature Reserve, China. *The Journal of Wildlife Management*, 1179-1188.

Liu, X., Toxopeus, A. G., Skidmore, A. K., et al. (2005). Giant panda habitat selection in Foping Nature Reserve, China. *The Journal of Wildlife Management*, 69(4), 1623-1632.

Liu, X., Wang, T., Skidmore, A. K., et al. (2015). How do two giant panda populations adapt to their habitats in the Qinling and Qionglai Mountains, China. *Environmental Science and Pollution Research*, 22(2), 1175-1185.

Lorimer, J. (2007). Nonhuman charisma. *Environment and Planning D: Society and Space*, 25(5), 911-932.

Maffi, L. (2005). Linguistic, cultural, and biological diversity. *Annual Review of Anthropology*, 34, 599-617.

Mancilla, V., Henríquez, J. M., & Vera, J. (2008). Biodiversidad de Macrohongos de la Reserva Nacional Magallanes. *Anales del Instituto de la Patagonia*, 36(1), 35-44. https://dx.doi.org/10.4067/S0718-686X2008000100003

Marder, M. (2011). Plant-Soul: The Elusive Meanings of Vegetative Life. *Environmental Philosophy*, 8(1), 83-100.

Marder, M. (2011). Vegetal anti-metaphysics: Learning from plants. *Continental Philosophy Review*, 44(4), 469-489.

Marder, M. (2013). *Plant-Thinking: A philosophy of vegetal life*. New York, NY: Columbia University Press.

Martin, A. (2016). *The Magical World of Moss Gardening*. Portland, Oregon: Timber Press.

May, R. (2015). Dorothy Stang: Monkeys Cry and the Poor Die, Earth Stewardship as Liberation Ecology. In Rozzi, R., Chapin III, F. S., Callicott, J. B., et al. (eds). *Earth Stewardship: Linking ecology and ethics in theory and practice* (Ecology and Ethics, Vol. 2). Springer.

McGowan, J., Beaumont, L. J., Smith, R. J. et al. (2020). Conservation prioritization can resolve the flagship species conundrum. *Nature communications* 11(1), 1-7.

McNeill, J. R. (2016). *The Great Acceleration*. New York, NY: Harvard University Press.

Meagher, D. (2008). Chapter Twenty-one: An Etymology of Australian Bryophyte Genera. 1 – Liverworts and Hornworts. *Fieldiana Botany* 47, 257-269. https://doi.org/10.3158/0015-0746-47.1.257

Meagher, D. (2011). An etymology of Australian bryophyte genera. 2 - Mosses. *Muelleria* 29(1): 33-61

Merchant, C., Merchant, P. C. (1989). *The Death of Nature: Women, ecology, and the scientific revolution.* UK: Harper Collins.

Michael, P. (2013). The Intelligent Plant: Scientists debate a new way of understanding flora. *The New Yorker*, 23, 92-105.

Mignolo, W. D. (2007). Delinking: The rhetoric of modernity, the logic of coloniality and the grammar of de-coloniality. *Cultural Studies*, 21(2-3), 449-514.

Miles, L., Newton, A. C., DeFries, R. S., Ravilious, C., et al. (2006). A global overview of the conservation status of tropical dry forests. *Journal of biogeography*, 33(3), 491-505.

Minteer, B. A., & Pyne, S. J. (2013). Restoring the narrative of American environmentalism. *Restoration Ecology*, 21(1), 6-11.

Mishler, B. D. (1985). The morphological, developmental, and phylogenetic basis of species concepts in bryophytes. *Bryologist*, 207-214.

Mishler, B. D. (2000). The phylogenetic species concept (sensu Mishler and Theriot): monophyly, apomorphy, and phylogenetic species concepts. In Wheeler, Q. D., Meier, R. (eds.). (2000). *Species Concepts and Phylogenetic Theory: A Debate*. New York, NY: Columbia University Press.

Mishler, B. D., Brandon, R. N. (1987). Individuality, pluralism, and the phylogenetic species concept. *Biology and Philosophy*, 2, 397–414.

Mishler, B. D., Churchill, S. P. (1984). A cladistic approach to the phylogeny of the “bryophytes”. *Brittonia*, 36(4), 406-424.

Mishler, B., Lewis, L., Buchheim, M., et al. (1994). Phylogenetic Relationships of the “Green Algae” and “Bryophytes”. *Annals of the Missouri Botanical Garden*, 81(3), 451-483.

Moreira-Muñoz, A., Carvajal, F., Elórtegui, S., Rozzi, R. (2020). The Chilean Biosphere Reserves network as a model for sustainability?: challenges towards regenerative development, education, biocultural ethics and eco-social peace. In: Reed, M. G., Price, M. F. (eds) *UNESCO Biosphere Reserves: Supporting Biocultural Diversity, Sustainability and Society* (Earthscan Studies in Natural Resource Management). New York, NY: Routledge.

Muir, P. S. (2004). An Assessment of Commercial “moss” Harvesting from Forested Lands in the Pacific Northwestern and Appalachian Regions of the United States: How Much Moss is Harvested and Sold Domestically and Internationally and which Species are Involved?: Final Report to US Fish and Wildlife Service and US Geological Survey, Forest and Rangeland Ecosystem Science Center.

Nabhan, G. P. (1995). The Danger of Reductionism in Biodiversity Conservation. *Conservation Biology*, 9(3), 479-481.

Nadkarni, N. M. (2013). Not such strange bedfellows: underserved public audiences as collaborators for ecologists. In: Rozzi, R., Pickett, S. T. A., Palmer, C. et al. (eds) *Linking Ecology and Ethics for A Changing World: Values, philosophy, and action* (Ecology and ethics, vol 1), pp 333–342, Springer, Dordrecht.

Neruda, P., Kerrigan, A., & Tarn, N. (1961). *Selected Poems of Pablo Neruda*. New York, NY: Grove Press.

Newton, A. E., & Tangney, R. S. (2007). *Pleurocarpous Mosses: Systematics and evolution*. Boca Raton, FL: CRC Press.

Nicolson, D. (1991). A History of Botanical Nomenclature. *Annals of the Missouri Botanical Garden*, 78(1), 33-56.

Nie, Y., Zhang, Z., Raubenheimer, D., et al. (2015). Obligate herbivory in an ancestrally carnivorous lineage: the giant panda and bamboo from the perspective of nutritional geometry. *Functional Ecology*, 29(1), 26-34.

NNH. (2021). Official site: https://natureneedshalf.org

Norton, B. G. (2013). Environmental Philosophy: A Fresh Perspective. *BioScience*, 63(5), 404-406. doi:10.1525/bio.2013.63.5.15

Oishi, Y. (2019). The influence of microclimate on bryophyte diversity in an urban Japanese garden landscape. *Landscape and Ecological Engineering*, 15(2), 167-176.

Okasha, S. (2019). *Philosophy of Biology: A very short introduction*. Oxford: Oxford University Press.

Pei, S. (2004). Ethnic cultural diversity and nature conservation in Yunnan. *Acta Botanica Yunnanica*, (SUPPL. 15), 1-11.

Pike, S. M. (2016). Mourning Nature: The Work of Grief in Radical Environmentalism. *Journal for the Study of Religion, Nature & Culture*, 10(4), 419-441.

Plumwood, V. (2005). *Environmental Culture: The Ecological Crisis of Reason*. New York, NY: Routledge.

Pollan, M. (2013). The intelligent plant. *New Yorker*, Dec. 23 & 30, 92-105.

Poole, A. K., Hargrove, E., Day, P. et al. (2013). A call for ethics literacy in environmental education. In: Rozzi, R., Pickett, S. T. A., Palmer, C. et al. (eds) *Linking Ecology and Ethics for A Changing World: Values, philosophy, and action* (Ecology and ethics, vol 1), pp 349–372, Springer, Dordrecht.

Pretty, J., Adams, B., Berkes, F., De Athayde, S. F., Dudley, N., et al. (2009). The intersections of biological diversity and cultural diversity: towards integration. *Conservation and Society*, 7(2), 100-112.

Quijano, A. (2000). Coloniality of power and Eurocentrism in Latin America. *International Sociology*, 15(2), 215-232.

Quijano, A. (2007). Coloniality and Modernity/Rationality. *Cultural Studies*, 21(2), 168-178.

Quilhot, W., Cuellar, M., Díaz, R., Riquelme, F., Rubio, C. (2012). Lichens of Aisen, Southern Chile. Gayana. *Botánica*, 69(1), 57-87.

Renn, J. (2019). *The Evolution of Knowledge: Rethinking science for the Anthropocene*. Princeton & Oxford: Princeton University Press.

Renzaglia, K., Schuette, S., Duff, R., Ligrone, R., Shaw, A., et al. (2007). Bryophyte Phylogeny: Advancing the Molecular and Morphological Frontiers. *The Bryologist*, 110(2), 179-213.

Richards, R. (2020). Ernst Haeckel: A Dream Transformed. In O. Harman & M. Dietrich (Ed.), *Dreamers, Visionaries, and Revolutionaries in the Life Sciences* (pp. 35-50). Chicago: University of Chicago Press.

Richards, R. J. (2008). *The Tragic Sense of Life: Ernst Haeckel and the Struggle Over Evolutionary Thought.* Chicago, IL: University of Chicago Press.

Richards, R. J. (2009). The tragic sense of Ernst Haeckel: His scientific and artistic struggles. Darwin: art and search for origins. *Frankfurt aM: Schirn Kunsthalle*, 92-102.

Ridley, M. (1989). The cladistic solution to the species problem. *Biology and Philosophy*, 4(1), 1-16.

Robbins, P., Polderman, A., & Birkenholtz, T. (2001). Lawns and toxins: An ecology of the city. *Cities,* 18(6), 369-380.

Rochefort, L. (2000). Sphagnum: A Keystone Genus in Habitat Restoration. *The Bryologist,* 103(3), 503-508.

Rozzi, R. (1999). The reciprocal links between evolutionary-ecological sciences and environmental ethics. *BioScience,* 49(11), 911-921.

Rozzi, R. (2012a). Biocultural ethics: recovering the vital links between the inhabitants, their habits, and habitats. *Environmental Ethics*, 34(1), 27-50.

Rozzi, R. (2012b). Serendipity in the origin of ecotourism with a hand lens. In: Goffinet B, Rozzi, R., Lewis, L., Buck, W., Massardo, F. (eds) *The Miniature Forests of Cape Horn: Eco-Tourism with a Hand-lens*, pp. 11-26. Denton, TX: University of North Texas Press.

Rozzi, R. (2012c). Introduction to ecotourism with a hand lens. In: Goffinet, B., Rozzi, R., Lewis, L., Buck, W., Massardo, F. (eds) *The Miniature Forests of Cape Horn: Eco-Tourism with a Hand-lens*, pp. 28-79. Denton TX: University of North Texas Press.

Rozzi, R. (2013). Biocultural ethics: from biocultural homogenization toward biocultural conservation. In: Rozzi, R., Pickett, S. T. A., Palmer, C., Armesto, J. J., Callicott, J. B. (eds) *Linking Ecology and Ethics for A Changing World: Values, philosophy, and action* (Ecology and ethics, vol 1), pp 9–32, Springer, Dordrecht.

Rozzi, R. (2015). Earth stewardship and biocultural ethics: Latin American perspectives. In: Rozzi, R., Chapin III, F. S., Callicott, J. B. et al (eds) *Earth Stewardship: Linking ecology and ethics in theory and practice* (Ecology and ethics, vol 2), pp 87–112, Springer, Dordrecht.

Rozzi, R. (2018). Biocultural homogenization: a wicked problem in the Anthropocene. In: Rozzi, R., May Jr, R. H., Chapin III, F. S. et al. (eds) *From Biocultural Homogenization to Biocultural Conservation* (Ecology and ethics, vol 3), pp 21–47, Springer, Dordrecht.

Rozzi, R. (2019). Taxonomic Chauvinism, No More! Antidotes from Hume, Darwin, and Biocultural Ethics. *Environmental Ethics*, 41(3), 249-282.

Rozzi, R., Anderson, C., Pizarro, C. et al. (2010). Field environmental philosophy and biocultural conservation at the Omora Ethnobotanical Park: Methodological approaches to broaden the ways of integrating the social component (“S”) in Long-Term Socio-Ecological Research (LTSER) Sites. *Revista Chilena de Historia Natural* 83(1), 27-68.

Rozzi, R., Arango, X., Massardo, F. et al. (2008). Field environmental philosophy and biocultural conservation: the Omora Ethnobotanical Park educational program. *Environmental Ethics* 30(3), 325–336.

Rozzi, R., Armesto, J. J., Gutiérrez, J. R. et al. (2012). Integrating ecology and environmental ethics: earth stewardship in the southern end of the Americas. *BioScience*, 62(3), 226-236.

Rozzi, R., Armesto, J., Goffinet, B. et al. (2008). Changing Lenses to Assess Biodiversity: Patterns of Species Richness in Sub-Antarctic Plants and Implications for Global Conservation. *Frontiers in Ecology and the Environment* 6(3), 131-137.

Rozzi, R., Chapin III, F. S., Callicott, et al. (Eds.). (2015). *Earth Stewardship: Linking ecology and ethics in theory and practice* (Vol. 2). New York, NY: Springer.

Rozzi, R., Draguicevic, J. M., Arango, X. et al. (2014). From science towards conservation: the education and environmental ethics program of the mora Ethnobotanical Park. In: Rozzi, R., Jiménez, J. E., (eds) *Magellanic Sub-Antarctic Ornithology: first decade of long-term bird studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve, Chile*, pp. 295-302. Denton, TX: University of North Texas Press.

Rozzi, R., Jiménez, J. E. (Eds.). (2014). *Magellanic sub-Antarctic Ornithology: First decade of long-term bird studies at the Omora ethnobotanical park, Cape Horn Biosphere Reserve, Chile*. Denton, TX: University of North Texas Press.

Rozzi, R., La Valle, M. T., Russell, R., Goffinet, B., Massardo, F. (2020). Ecotourism with a Hand-Lens: A Field Environmental Philosophy Experience from the South of the World. In Brister, E., Frodeman, R. (eds) *Philosophy for the Real World: An Introduction to Field Philosophy*, pp. 222-239, New York, NY: Taylor & Francis/Routledge.

Rozzi, R., La Valle, M. T., Russell, S., et al. (2020). Ecotourism with a Hand-Lens: A Field Environmental Philosophy Experience from the South of the World. In Brister, E., Frodeman, R. (eds)., *A Guide to Field Philosophy*, pp. 222-239. Routledge.

Rozzi, R., Lewis, L., Massardo, F. et al. (2012). *Ecotourism with a Hand-Lens at Omora Park*. Punta Arenas, Chile: Ediciones Universidad de Magallanes.

Rozzi, R., Massardo, F., Anderson, C. et al. (2006). Ten principles for biocultural conservation at the southern tip of the Americas: the approach of the Omora Ethnobotanical Park. *Ecology and Society* 11(1), 43.

Rozzi, R., Massardo, F., Anderson, C. et al. (2010). *Multi-Ethnic Bird Guide of the Sub-Antarctic Forests of South America*. Denton, TX: University of North Texas Press.

Rozzi, R., Massardo., F. (2011). The Road to Biocultural Ethics. *Frontiers in Ecology and the Environment* 9 (4), 246-247.

Rozzi, R., Pickett, S. T., Palmer, C., et al. (2013). *Linking Ecology and Ethics for a Changing World.* New York, NY: Springer.

Rozzi, R., Roy Jr, H., Chapin III, F. S., et al. (Eds.). (2018). *From Biocultural Homogenization to Biocultural Conservation* (Ecology and Ethics, Vol. 3). Dordrecht, Netherland: Springer.

Sala, J. F. A. (2015). Hermeneutics and field environmental philosophy: integrating ecological sciences and ethics into earth stewardship. In *Earth Stewardship* (pp. 235-247). Springer, Cham.

Schaller, G. (1994). *The Last Panda*. Chicago, IL: The University of Chicago Press.

Schenk, G. (1997). *Moss Gardening: Including lichens, liverworts, and other miniatures*. Portland, OR: Timber Press.

Schlegel, J., Rupf, R. (2010). Attitudes towards potential animal flagship species in nature conservation: A survey among students of different educational institutions. *Journal for Nature Conservation* 18 (4), 278-290.

Schofield, W. (1981). Ecological Significance of Morphological Characters in the Moss Gametophyte. *The Bryologist*, 84(2), 149-165. doi:10.2307/3242819

Schröter, M., Van der Zanden, E. H., van Oudenhoven, A. P., et al. (2014). Ecosystem services as a contested concept: a synthesis of critique and counter-arguments. *Conservation Letters*, 7(6), 514-523.

Schuh, R. (2003). The Linnaean System and Its 250-Year Persistence. *Botanical Review*, 69(1), 59-78.

Shao, Q. (2019). Hanzhou Wansong Academy. (《杭州萬松書院》). *Xin Yue Du* (《新閱讀》)，3，21-23.

Shaw, J. (1985). The relevance of ecology to species concepts in bryophytes. *Bryologist*, 199-206.

Shaw, J., Renzaglia, K. (2004). Phylogeny and diversification of bryophytes. *American Journal of Botany*, 91(10), 1557-1581.

Short, L. L. (1970). The Habits and Relationships of the Magellanic Woodpecker. *The Wilson Bulletin* 82(2), 115-129.

Simberloff, D. (1998). Flagships, umbrellas, and keystones: is single-species management passé in the landscape era?. *Biological Conservation* 83 (3), 247-257.

Skibins, J. C, Powell, R. B., Hallo, J. C. (2013). Charisma and conservation: charismatic megafauna's influence on safari and zoo tourists' pro-conservation behaviors. *Biodiversity Conservation* 22(4), 959–982.

Stauffer, R. C. (1957). Haeckel, Darwin, and ecology. *The Quarterly Review of Biology*, 32(2), 138-144.

Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review*, 2(1), 81-98.

Stewart, K. (2015). Mourning Wave: Grieving the Loss of the Natural Environment. MAIS Projects and Theses. 29. https://digitalcommons.tacoma.uw.edu/ias_masters/29.

Tauro, A., Ojeda, J., Caviness, T., Moses, K. P., Moreno-Terrazas, R., et al. (2021). Field Environmental Philosophy: A Biocultural Ethic Approach to Education and Ecotourism

for Sustainability. *Sustainability*, 13(8), 4526. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su13084526

The Silverado Rountable. (2021). White Paper: The nature of the post-pandemic workplace. Accessible through https://www.goodearthplants.com/wp-content/uploads/2021/01/Silverado-Roundtable-Whitepaper-NaturOfPostPandemicWorkplace-v1.0-WEB.pdf

Tompkins, J. (2004). Moss hunters roll away nature's carpet, and some ecologists worry. New York Times, November 30.

Toyoda, M. (2018). Revitalizing local commons: a democratic approach to collective management. In *From Biocultural Homogenization to Biocultural Conservation*, pp. 443-457. Springer, Cham.

Treib, M. (1989). Reduction, Elaboration and Yūgen: The Garden of Saihō-Ji. *The Journal of Garden History*, 9(2), 95-101.

Trewavas, A. (2015). *Plant Behaviour and Intelligence*. United Kingdom: Oxford University Press.

Trewavas, T. (2016). Plant intelligence: an overview. *BioScience*, 66(7), 542-551.

Turin, M. (2005). Language endangerment and linguistic rights in the Himalayas: A case study from Nepal. *Mountain research and development*, 25(1), 4-9.

Tversky, A, Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology* 5(2), 207-232.

Van Valen, L. (1976). Ecological Species, Multispecies, and Oaks. *Taxon*, 25(2/3), 233-239. doi:10.2307/1219444

Vanderpoorten, A., Goffinet, B. (2009). *Introduction to Bryophytes*. New York, NY: Cambridge University Press.

Vergara, P., Schlatter, R. P. (2004). Magellanic woodpecker (Campephilus magellanicus) abundance and foraging in Tierra del Fuego, Chile. *Journal of Ornithology* 145(4), 343-351.

Verma, M., Jones, K.R., Watson, J. E. M. et al. (2020). Severe human pressures in the Sundaland biodiversity hotspot. *Conservation Science and Practice* 2(3), e169.

Villagrán, C., Barrera, E. (2019). Musgos del Archipiélago de Chiloé, Chile (Mosses of the Chiloé Archipelago, Chile, EBSD workshops material). Fundación Senda Darwin (Senda Darwin Foundation).

Vitt, D. H. (2000). The classification of mosses: Two-hundred years after Hedwig. *Nova Hedwigia*, 70(1/2), 25-36.

Walpole, M. J., Leader-Williams, N. (2002). Tourism and flagship species in conservation. *Biodiversity and Conservation* 11(3), 543-547.

Wang, Z. N., Yang, L., Fan, P. F., & Zhang, L. (2021). Species bias and spill over effects in scientific research on Carnivora in China. *Zoological Research*, 42(3), 354.

Wei, F., Costanza, R., Dai, Q. et al. (2018). The Value of Ecosystem Services from Giant Panda Reserves. *Current Biology* 28(13), 2174-2180.

Wheeler, Q. D., & Meier, R. (Eds.). (2000). *Species Concepts and Phylogenetic Theory: A debate*. New York, NY: Columbia University Press.

Wiley, E. O. (1979). An annotated Linnaean Hierarchy, with comments on natural taxa and competing systems. *Systematic Zoology* 28, 308-337.

Willmann, R. (1986). Reproductive isolation and the limits of the species in time. *Cladistics*, 2(3), 356-358.

Wilson, E. O. (2016). *Half-Earth: Our planet's fight for life*. New York, NY: Liveright.

Wilson, R. A. (1999). *Species: New interdisciplinary essays*. Cambridge, Mass: MIT Press.

Wu, J. (1992). Chen Bangjie's pioneering research in the field of bryophytes science (《陳邦傑在苔蘚科學領域的開拓性研究》). *Journal of Nanjing Normal University* (Social Science Edition), 3, 39-43.

WWF. (2020). https://wwf.panda.org/our_work/wildlife/flagship_keystone_indicator_definition/, accessed on July 13, 2020

Xu, W. (1985). *Qin-Han-Wei-Jin Seal and Clerical Script Glyphs* (《秦漢魏晉篆隸字形表》). Chengdu, Sichuang: Sichuang Dictionary Press.

Yong, Y., Liu, X., Wang, T., et al. (2004). Giant pandas migration and habitat utilization. In: Donald Lindburg and Karen Baragona (eds) *Giant Pandas: Biology and Conservation*. Berkeley, CA: University of California Press.

Zander, R. (1989). Seven New Genera in Pottiaceae (Musci) and A Lectotype for Syntrichia. *Phytologia*, 65(6), 424-436.

Zhang, L. (2020). How to conduct unpopular science education: case studies from Shenzhen Fairy Lake Botanical Garden. In Education on Biodiversity Conservation: Proceedings of

the 4th Luosuo River Forum of science education, Xishuangbanna, Yunnan Province, China, pp 145-151. Available via http://www.luosuoriverforum.com/qfycontent/uploads/2020/03/43134bc2cd5d9aafea4f25cca0678303.pdf

Zhang, L., Zuo, Q., Hong, B. (2015). *The Miniature Angels in the Plant Kingdom* (《植物王國的小矮人》). Macao: Department of Gardens and Green Areas, Civic and Municipal Affairs of Bureau of Macao Special Administrative Region.

Zhang, L., Zuo, Q., Mao, L. (2019). *The Magic and Enchantment of Bryophytes* (《苔藓之美》). Nanjing, China: Phoenix Science Press.

Zhang, S. (1994). *Collection of Shuihudi Qin Slips Characters* (《睡虎地秦簡文字編》). Beijing: Cultural Relic Publishing Housing.

Zhao, X., Ma, X., Chen, B., Shang, Y., & Song, M. (2022). Challenges toward carbon neutrality in China: Strategies and countermeasures. *Resources, Conservation and Recycling*, 176, 105959.

Zheng, G., Xu, P. (1964). Giant pandas found at the Southern Foot of the Qinling Mountain. *Chinese Journal of Zoology*, 1, 3.

Zhou, L. (2019). A Study on the Mossy Culture in Ancient China. Master Thesis: Hunan Normal University.

Zieliński, R. (2015). Importance of sketches, graphics and computer in designing green walls. *Czasopismo Techniczne*.

Zuo, H., Zuo, P., Zuo, F., et al. (1979). The Pioneer of China's Bryological Research (《我國苔藓研究的拓荒者》). *Journal of Nanjing Normal University* (Natural Science Edition), 1, 94-96.