INTRODUCTION

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Emergent dynamics can destroy the existing order. Microbes that become emergent diseases—by finding novel exploits, pathways of transmission, or modes of existence—can quickly transform dominant political strategies, economic systems, or agricultural practices.[1] Emergences can also figure into collective hopes.[2] When a forest is clear-cut by loggers or destroyed by a volcanic eruption, emergent plants are the first to sprout. Nascent associations are able to exploit faults and fissures within established assemblages. They contain the promise of supplanting deeply rooted structures. Materializing in interstitial spaces, between divided forces, emergent forms of life can disrupt ostensibly unified systems. False starts in one direction can become significant beginnings along a new vector. Flying in the face of long-term agendas, unexpected detours and happy accidents can generate a novel sense of order.[3]

Emergent Ecologies is a study of multispecies communities that have been formed and transformed by chance encounters, historical accidents, and parasitic invasions. Insights from contemporary philosophy are used to reframe key problems in the field of conservation biology—relating to invasive species, extinctions, environmental management, and reforestation. Following the flight of capital and the trajectories of multiple species across national borders and through fragmented landscapes of the American tropics—from Panama to Costa Rica to the United States and back again—this book asks: How do certain plants, animals, and fungi move among worlds, navigate shifting circumstances, and find emergent opportunities? When do new species add value to ecological associations, and when do they become irredeemably destructive? When should we let unruly forms of life run wild, and when should we intervene? Instead of regarding the past as a legacy that should always be restored, this book focuses critical attention on present interests in ecological communities as well as their possible futures.

Do ecosystems exist in the world? Are they figments of the mind? If destroyed, will multispecies communities predictably reemerge? The roots of these questions go back to a contentious debate between two early twentieth-century biologists: Clements and Gleason. Frederic Clements, who led the botany department at the University of Minnesota, understood ecological associations as natural units of vegetation. A 1916 monograph by Clements described ecological units, like rain forests, marshes, or riparian woodlands, as "complex organisms." These superorganisms, according to Clements, involve stable associations of plants and animals. Following major ecological disturbances and destruction, he found some evidence that these complex associations would come back. Henry Gleason, of the New York Botanical Garden, published a paper in 1926 challenging the influential ideas championed by Clements. Gleason understood ecological associations as relationships in constant flux, arguing that they should not be understood as "an organism, scarcely even a vegetational unit, but merely a coincidence." According to Gleason, ecological communities are not part of the natural order of things, but instead are bounded by artificial lines that reflected the tendency of the human species "to crystallize and classify [our] knowledge."[4]

A. G. Tansley, who coined the term "ecosystem" in 1935, made arguments allied with Gleason: "The systems we isolate mentally are not only included as parts of larger ones," he wrote, "but they also overlap, interlock and interact with one another." While Tansley himself assumed that these systems were in constant flux, many contemporary ecologists have made his idea of the ecosystem unnecessarily concrete.[5] In 1981 Paul and Anne Ehrlich compared ecosystems to airplanes. They argued that it would be terrifying to ride on a partially disassembled flying machine: "As you walk from the terminal toward your airliner, you notice a man on a ladder busily prying rivets out of its wing. Somewhat concerned, you saunter over to the rivet popper and ask him just what the hell he's doing." Ehrlich and Ehrlich think that we should be terrified to live in ecosystems where essential parts, species,

are being driven extinct—being popped out of finely tuned systems like rivets.[6]

Popular metaphors are being questioned as a new generation of biologists are describing the emergence of what they term "novel ecosystems." Joseph Mascaro, a plant biologist, rejects the airplane comparison, writing, "Ecosystem function does not solely reflect species loss, as implied by the popping of rivets, it also reflects species additions."[7] Novel ecosystems "are diverse but invaded, neglected but resilient, anthropogenic but wild," in the words of Laurie Yung and colleagues.[8] Ecologists are starting to look for intellectual allies in studying the social and political forces at play within these "messy and neglected wrecks." They are developing approaches to conservation that encourage people to engage with forms of life that exist all around us, abandoning previous efforts to preserve visions of pristine nature. Other biologists have expressed reservations about this conceptual shift: "In today's predominant consumer culture there is a social value that ascribes worth to novelty," write Rachel Standish and colleagues. "The concern, then, is that people will value novel ecosystems simply because they are new."[9]

Lately ecosystems have been shaped by competing ethical, political, and economic values. But the underlying dynamics at work in ecosystems are not necessarily "novel." Researchers in the field of geology and paleontology have recently given Henry Gleason (of the Clements-Gleason controversy) "a gift reserved for but a few theoreticians: irrefutable proof." Tree species have moved "as individuals and not as part of discrete communities or organisms" during times of environmental change in the relatively recent past (from 8,000 to 14,000 years ago).[10] In other words, the rivets that theoretically underpin ecosystems are often moving around on geological time scales, disappearing and reappearing, in a given locale.

Ecosystems have long been shaped by the loss of previous species, the acquisition of new organisms, and the emergence of novel multispecies assemblages.[11] Following Donna Haraway's "Cyborg Manifesto," this book takes "pleasure in the confusion of boundaries" at the margins of ecosystems and makes arguments "for responsibility in their construction."[12] Departing from anachronistic depictions of past environments, I consider the intersecting forces that shape present multispecies communities, as well as possible futures. *Emergent Ecologies* chronicles the actions of people whose instrumental use of certain critters, or love for some kinds of life, has led them to construct novel ecosystems—bringing machines, industrial supply chains, and biological elements together into unusual assemblages. Other forces and agents of assembly—diverse animals, plants, and fungi with their own interests and desires—are also at work in ecosystems emerging around us. People and other beings are becoming entangled in what Isabelle Stengers calls relations of reciprocal capture.[13]

Beings who fold one another into the enduring relationships of reciprocal capture, according to Stengers, often reach symbiotic agreements.[14] Transformative encounters, seductive moments that generate new entangled modes of coexistence, take place when two beings capture one another in a reciprocal embrace. Symbiosis, in the eloquent prose of Lynn Margulis and Dorion Sagan, involves "the co-opting of strangers, the involvement and infolding of others."[15] Symbiotic associations involve beings with a mutual interest in the continued existence of one another.[16] Symbiotic attachments, in Stengers's mind, are not categorically different from other forms of reciprocal capture—like parasite-host entanglements or predator-prey relations, where one party to the relationship is constantly trying to escape, evade, or destroy the other. The visual and cognitive abilities of the bird are brought into being by the camouflage of the caterpillar, which make it difficult to discern against a backdrop of foliage. The host's immune system, odor, and skin refer to the existence of the parasite and its clever modes of detecting the host and invading its body.[17] Beings are coinvented in relationships of reciprocal capture; they "integrate a reference to the other for their own benefit," forming a shared milieu, an environment.[18]

Parasites are key players in emergent ecologies. The word "parasite" is polysemic in French—meaning biological or social freeloader in addition to "noise" or "static."[19] Michel Serres celebrates the productive and creative nature of noise in his playful monograph, *The Parasite*. Parasites are jokers or wild cards, Serres claims, who take on different values depending on their positions. "The parasite doesn't stop," writes Serres. "It doesn't stop eating or drinking or yelling or burping or making thousands of noises or filling space with its swarming and din. . . . It runs and grows. It invades and occupies."[20] Within the realm of

tropical ecology, parasites and pathogens are regarded as forces that generate diversity. The Janzen-Connell hypothesis, a widely accepted explanation for tree species biodiversity in tropical forests, suggests that specialized insect herbivores, bacteria, viruses, and fungi reduce the numbers of common trees. Seedlings that germinate farthest from their parents should have an advantage since they are far from the species-specific parasites and diseases targeting other members of their kind.[21]

Emergent Ecologies describes parasitic invasions that destroyed established communities while simultaneously opening up new possibilities for flourishing.[22] A microscopic fungal disease that has pushed thousands of frog species to the brink of extinction is a central figure in my entangled tales.[23] Diverse technological apparatuses, scientific enterprises, market economies, and forms of life have been brought together to save frogs from this fungus. While describing the artificial ecosystems that have been constructed around literal amphibians, this book also explores the lifeways of "ontological amphibians"—insects, varieties of rice, and monkeys that are constantly moving among worlds, deciding which ontology they would like to inhabit.[24] Alongside endangered forms of life, I found a swarming multitude that was constantly creating new symbiotic associations, taking advantage of exploits in emergent ecosystems, and going wild along unexpected trajectories.[25]

Wild creatures are often understood as having an "existential independence" from human worlds.[26] Rather than treating wildness as a phenomenon that exists only beyond the reach of civilization or domestication, this book also focuses on the risky and out-of-control dynamics that emerge amid intimate entanglements with other species.[27] Contagious excitement and fear often accompany moments of capture, when humans involve and enfold other creatures into a new association. Mixed emotions are also at play when we release others from our care, allowing them to escape our tentative grasp. While some cultural critics have characterized conservationists as "misanthropes," as melancholics who see humans as inherently destructive while regarding other species as essentially good and innocent, my aim is to offer a more nuanced characterization of the desires, affective attachments, and dreams motivating people to care for wild things and living systems.[28]

Novel ecological assemblages are being created by expert practitioners, as well as by amateurs embracing a Do-It-Yourself (DIY) ethos, people who are experimenting with new ways of living responsibly with other critters in multispecies worlds.[29] Human interactions with animals have driven recent ethical debates in anthropology, history, and contemporary philosophy.[30] Departing from "the question of the animal," the polemic by Jacques Derrida arguing that "the human-animal distinction can no longer and ought no longer be maintained," *Emergent Ecologies* also engages with "the question of the fungus" and "the question of the plant."[31] Fungi illustrate "practices that thrive in the 'gap' between what is taken as wild and what is taken as domesticated," according to the Matsutake Worlds Research Group. "Thinking like a fungus" opens up questions like, Who is doing the domesticating? And to what end? *Plant Thinking*, by Michael Marder, regards plants as "collective beings," as "non-totalizing assemblages of multiplicities, inherently political spaces of conviviality."[32] Other beings who have "strivings, purposes, telos, intentions, functions, and significance" come together in Eduardo Kohn's book, *How Forests Think*.[33]

Following plants, animals, and microscopic fungi as they became caught in temporary entanglements, and then escaped, *Emergent Ecologies* uses the methods and tactics of multispecies ethnography to trace the contingencies of unexpected connections.[34] Conventional ethnographic interviews with biological scientists, environmental activists, and others living in the shadows of conservation initiatives were supplemented with original historical research in archival collections, my own biological experiments, and artistic interventions. Artists who cleverly use scientific equipment with a DIY ethos—to track the flight of pigeons in polluted urban air, or to listen to the laughter of laboratory rats—have inspired many ethnographers to adopt new tactics and techniques for studying biological subjects.[35] Venturing into the realm of microscopy as a participant observer, I noted the presence of beings and things at the periphery of the scientific imagination. Investigating the shared worlds of humans and animals led me to borrow methods from the field of ethology, a discipline based on the direct observation of animal behavior. Ethological methods have

long been wedded to explanatory frameworks focused on either proximate mechanisms or ultimate (evolutionary) functions.[36] Departing from conventional ethological techniques, which record and quantify predicted behaviors, I employed flexible and open-ended descriptive techniques for noting and filming behaviors in multispecies worlds.

Material gathered from diverse sources forms the basis of my interlocking tales from multiple sites in the Americas—from the Canal Zone of Panama to art galleries of New York City, riparian woodlands of Florida, and abandoned pasturelands of Costa Rica. These tales all speak to key questions: Which creatures are flourishing, and which are failing, at the intersection of divided forces, competing political projects, and diverse market economies? Amid widespread environmental destruction, with radical changes taking place in ecosystems throughout the Americas, where can we find hope? Holding onto hopes for the continued existence of vulnerable beings, like members of an endangered species, risks the possibility of cruel disappointment if they do indeed disappear. Even still, the maintenance work required to enhance the flourishing, endurance, and survival of critters in a precarious condition is more necessary than ever.[37]

Contemporary writing on the environment is largely focused on doomsday scenarios. *Emergent Ecologies* departs from this dominant plotline, insisting that we reject apocalyptic thinking.[38] Against the backdrop of pervasive fears, this book explores the possibility of grounding hopes in shared futures. Living with contingencies in shared worlds, navigating circumstances and forces beyond our control, requires imaginative as well as practical labor. Rather than remaining anxiously focused on possible losses, this book explores the imaginative horizons of organic intellectuals who are sifting through the wreckage of catastrophic disasters, searching for hope within landscapes that have been blasted by capitalism and militarism. Reaching into the future, these thinkers and tinkerers are grabbing on to hopeful figures and bringing them into existence in the present.[39] Tactfully guiding interspecies collaborations, new generations are learning how to care for emergent assemblages by seeding them, nurturing them, protecting them, and ultimately letting go.[40]

CHAPTER ONE

PARALLAX

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Barro Colorado Island is an "open-air biological laboratory" in the Panama Canal. It is run by the Smithsonian Tropical Research Institute, and its activities are outwardly united by a single goal: "to increase understanding of the past, present, and future of tropical biodiversity and its relevance to human welfare."[1] At this facility, long-term projects have been established around specific research questions and focal organisms: the dispersal of seeds by mammals, the population dynamics of canopy trees, the pollination ecology of euglossine bees, symbiosis and parasitism in fig trees, and the neuroethology of bats. Many biologists on Barro Colorado Island are knowledgeable about the historical forces that have shaped their island laboratory. Egbert Leigh's influential textbook, *Tropical Forest Ecology: A View from Barro Colorado Island*, clearly states, "Barro Colorado's biota is in no sense 'pristine.'"[2] Despite this historical consciousness, I found depictions of reified Nature in the Smithsonian's archives that only gave room for some forms of culture.

Rewinding past more than one hundred years of history, to early U.S. military adventures in Central America, and then fast-forwarding back again, produces a parallax effect—a mode of three-dimensional depth perception that emerges when nearby objects move against a distant backdrop. Early visitors who toured the Panama Canal experienced "stereoscopic visions," in the words of Ellen Strain, where tourism doubled as a mode of time travel. Learning to view the landscape through hand-operated stereoscopes, containing a pair of photographs that used the parallax effect to produce three-dimensional illusions, visitors came to view Panama "as the ideal tourist object with its natural wonders—tropical fruits, luxuriant vegetation, the Rio Grande River, fresh water springs, and scenic bays—and its combination of an intriguing past, an exotic present, and a bustling future which lies ahead."[3] Contemporary scientific objects—like euglossine bees, symbionts, and parasites—gain depth when viewed against the backdrop of these earlier objects of wonder and when situated within the political and economic forces that shaped the ecology of Central America. President Teddy Roosevelt helped create the nation of Panama in 1903, supporting separatist insurgents and initiating a naval blockade against Colombia. On the heels of this military action, the United States took over the construction of the Panama Canal—a spectacular marvel of engineering that facilitated the flow of global commerce, fortified an emergent empire, and created a "living laboratory."[4]

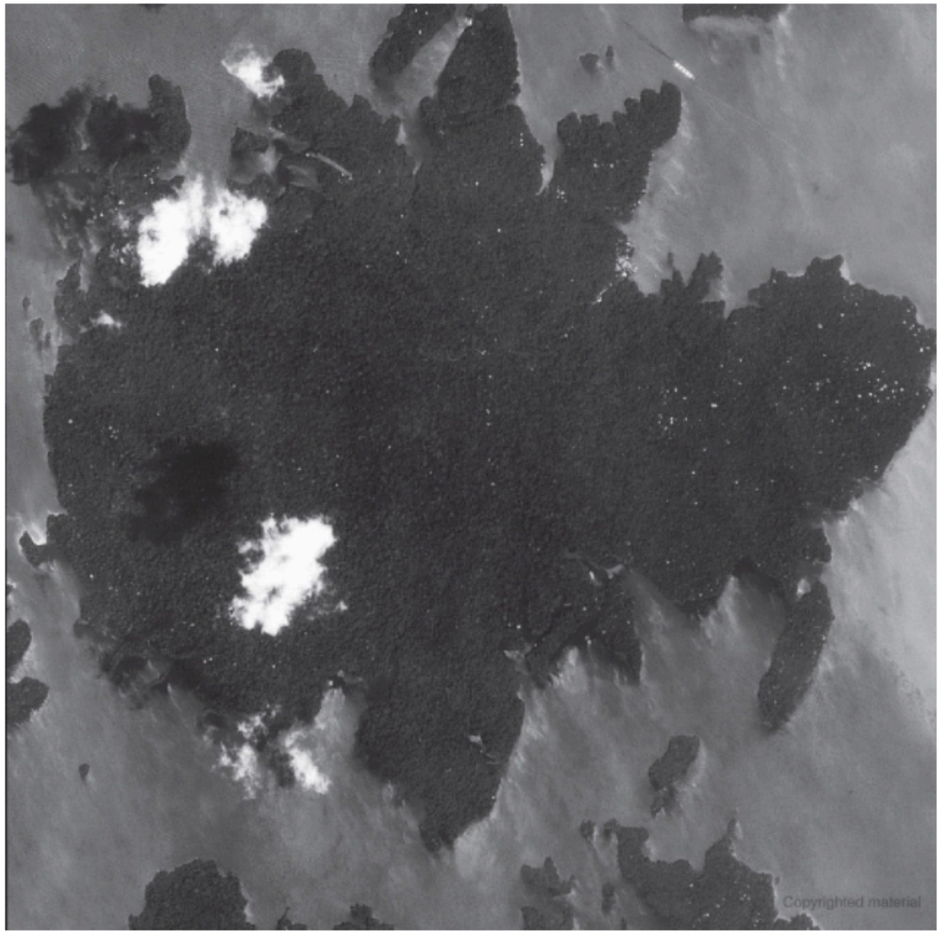

FIGURE 1.1. Barro Colorado Island as seen from outer space by QuickBird, a high-resolution satellite. A massive cargo ship, transiting the canal, can be seen in the top right-hand quadrant of this picture. Image from NASA's Earth Observatory.

Barro Colorado Island was gradually created by the rising waters of the Chagres River after U.S. engineers installed a dam in 1914 during the construction of the Panama Canal. Widespread cutting and clearing of the forest from the nineteenth century, from the French attempt to build a canal, left a lasting impact on the northeastern half of the island.[5] After Barro Colorado Island was declared a reserve in 1923, an ecosystem emerged that served U.S. strategic interests and the desires of biological scientists. Seven Panamanian farmers who remained on the island were eventually forced to leave. "Remnants of the plantings of bananas, oranges, limes, guava, etc., are still encountered in the bush," according to a 1924 clipping in the Smithsonian archives, "although all cultivation by natives is now a thing of the past."[6] "The island is set aside solely for the purposes of scientific study," according to another early archival document, "and hence no hunting permits, or tree-cutting permits will be issued for this natural preserve except for scientific purposes."[7]

Administrators were preoccupied by Panamanian incursions onto this nature reserve even though activities by the U.S. government were arguably much more ecologically destructive. The Smithsonian archives are relatively silent on the impacts of the Panama Canal on local flora and fauna, as some twenty-two square miles of rain forest and farmlands were expropriated by the United States and drowned under floodwaters.[8] Hunters with historical ties to the lands of the Canal Zone became "poachers" who were routinely fined, detained, and sometimes assailed with gunfire. While researchers from the United States were given permits to capture, kill, and collect animals and plants on Barro Colorado Island, other uses of forest resources by Panamanians were strictly prohibited. "Whatever destruction takes place is that which is ordered by Nature and which is the law of the wild," according to a 1931 article by James Zetek, the first director of Barro Colorado Island. "Plants grow, reach maturity and die. They have their enemies. So also animals grow and die, must fight for their existence. They also have natural foes. But Man is out of this picture. When he comes to the island he is a peaceful intruder. He comes to study, not to destroy."[9]

James Zetek's own research on Barro Colorado Island was focused on the destruction of certain kinds of life. Financial backing from the American Wood Preserver's Association, the Grasselli Chemical Company, and the Southern Pine Association, among other sources, enabled him to test the efficacy of a variety of poisons on termites.[10] Alongside research

initiatives that directly aided U.S. commerce, a multitude of other projects emerged within the architecture of empire. Despite being dramatically shaped by industry and agriculture, this man-made island quickly became the premiere site in the Americas for studying tropical ecology. The island was viewed by early researchers as an exotic field site for adventures in the present, which contained the mysterious secrets of nature's past, where new discoveries might unlock future possibilities. It became a site of pilgrimage for aspiring scientists. Visiting became "a rite of passage," in the words of Pamela Henson, a historian at the Smithsonian Institution Archives. "A field trip to the tropics [was] a route to fame for young North American naturalists."[11]

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The historical archives of the Smithsonian are full of accounts by young men whose lives and careers were transformed by encounters with other forms of life in the Panama Canal Zone. Surprising behaviors by monkeys and ants, as well as uncanny features of plants and fungi, captured the imagination of visiting researchers and prompted new studies of ecological interdependency.[12] As Barro Colorado Island became a key institution supporting the fledgling discipline of ecology, certain categories of people were excluded from the social world of this new science. Social separation was naturalized among humans even as ecological entanglements were discovered. An architecture of apartheid initially separated men from women and whites from "coloreds" at this Smithsonian research station.[13] "The first women to conduct field work in the tropics encountered many of the well-known barriers to professional women," writes Pamela Henson, "as well as the challenges of dealing with unfamiliar environments and cultures."[14] Disputes about whether or not groundskeepers of "white descent" should have the privilege of using the white toilet, the same toilet used by researchers, were among the contentious subjects animating the correspondence among founders of the biological station.[15]

Barro Colorado Island, with its sharply divided social worlds, was a microcosm of the Canal Zone—a place of U.S. military operations that was off-limits to Panamanian citizens who did not carry a special pass.[16] Gamboa, the nearest town, was designed by the U.S. government "to reflect and facilitate a system of industrial relations based on a rigid class and racial hierarchy . . . with a sharply segregated workforce divided by a dual wage system into 'gold' (white/U.S.) and 'silver' (non-white/non-U.S.)." The Smithsonian Tropical Research Institute began administering Barro Colorado Island in 1946. Even after the dual wage system was abolished in 1948, segregation continued to be "a powerful institutional and cultural force" in the Canal Zone. The architecture of many buildings, such as the clinic, contained separate entrances, waiting rooms, examination rooms, physicians' offices, and overnight quarters for "silver" and "gold" social categories.[17]

Those who were privileged enough to belong to the gold social category participated in a government-sponsored utopia. The gold workers enjoyed a stable and comfortable lifestyle in the policed atmosphere of the Canal Zone—with sports facilities, movie theaters, and churches all built in a series of planned towns. Social harmony and stability, very much in line with Sir Thomas More's original novel *Utopia* (1516), prevailed there in contrast to the chaotic state of affairs in Panama and Central America more broadly. Like other utopian projects, there was what Foucault regards as "a panopticon effect" in these planned towns, with spatial systems of surveillance built into the landscape. In Gamboa, workers' houses were carefully arranged, with the lowest-paid living close to the canal in a low valley, and the higher-paid supervisors living on a ridge overlooking the scene. Imagination and authoritarianism came to life there, as part of the broader midcentury new urban movement described by David Harvey in *Spaces of Hope*.[18]

Expatriate U.S. citizens who took up long-term residence within this Canal Zone utopia began calling themselves "Zonians." A third-generation Zonian, who masquerades online under the anonymous username of killbyte, has posted photographs on Flickr and snippets of text that offer candid views of a social world united by doing fun things together amid a military occupation: "I am indeed part of a small, privileged group that belong to a dwindling, elite club that will never exist again. Yes, perhaps it was an experiment in US colonialism—they made sure we retained our US heritage by importing everything cultural that made us feel like US citizens, but we were distinct enough in the sense that we could go into the rain forest & use it as our own private playground. The jungle swimming holes were amazing!"[19]

Forested ecosystems on the banks of the Panama Canal, and the surrounding watershed,

became linked to the life of global commerce in the 1970s. Ashley Carse, a cultural anthropologist, suggests that nature became part of the U.S. government "infrastructure" in Panama for storing water and regulating its flows. Agricultural methods of Panamanian farmers, which involved periodically clearing the forest in swidden systems, came to be seen as "the specter of commercial death" for the canal. The forest for these campesinos was not a fixed object, a green space on the map, but a dynamic system, an emergent ecology, tied to their own economic livelihoods. A 1978 essay by Frank Wadsworth, "Deforestation: Death to the Panama Canal," mentions a number of factors contributing to water scarcity in the canal system—drought, ship traffic, and municipal water use. But, ultimately, only Panamanian agricultural practices were targeted by policy makers. Parklands and nature monuments were created as farmers were pushed from their lands with a combination of financial incentives and military operations.[20] Policing operations in the forest where expatriate Smithsonian scientists worked also intensified. "Poachers still roamed the more distant portions of Barro Colorado almost at will in the early 1970s," writes Egbert Leigh in *Tropical Forest Ecology*, "but poaching on the island was almost entirely suppressed by 1985."[21]

By 1997, when I made my own initial pilgrimage to Barro Colorado Island as an undergraduate research assistant, armed forest rangers (*guardabosques*) were still a visible presence at Smithsonian facilities. The entitlements of white Zonians were rapidly dwindling, even though some measures of distinction and segregation were in place. My U.S. passport continued to grant me privileges—like entry to the old Officer's Club on Clayton Army Base. My citizenship also facilitated my initial access to Smithsonian facilities. A forty-minute boat ride separated the Smithsonian's living laboratory from Gamboa, and it remained inaccessible to ordinary Panamanians who could not afford to pay for a day-long guided nature tour. In the 1990s, local historical memories were haunted by the 1989 U.S. invasion of Panama that killed some three thousand civilians and deposed President Manuel Noriega (who had formerly been regarded as a CIA "asset").[22] Future uncertainties also loomed large on the horizon. The United States was slated, in accordance with international treaties, to give the Canal Zone to the nation of Panama on December 31, 1999. But messages from powerful political factions in Washington signaled that the planned transfer of sovereignty might not take place.

The project that initially brought me to Panama as an undergraduate assistant was indirectly in the service of U.S. geostrategic interests—it was research that would potentially benefit the citrus industry. The electric ant (*Wasmannia auropunctata*), an insect native to Panama, had become a common agricultural pest in the southern United States. Fruit pickers were demanding premium wages to work in infested orange groves in Florida, because the ants can deliver a painful sting, like an electric shock. They were notorious for swarming inside the workers' clothes. The electric ant had become a cosmopolitan insect, ranging over many different countries, free from national limitations or attachments.[23] Spreading in areas disturbed by humans, it had invaded ecosystems emerging around human agricultural schemes. Hitching a ride in shipments of produce, nesting in rolled leaves or dead sticks or almost anywhere, this nomadic species had taken up residence in West Africa, Melanesia, Polynesia, and islands throughout the tropical Americas.[24]

Electric ants in Panama live within a diverse community of other ants in leaf litter on the forest floor. The project that brought me to Barro Colorado Island in 1997 sought to understand if competition with these other species helped regulate electric ant populations. During the fieldwork stage of the project, my role involved placing tuna fish baits at marked spots on the ground, collecting ants at the baits, and identifying them under the microscope back in the lab. While gathering data in tangles of underbrush, dripping with sweat from the sweltering heat, I became familiar with the habits of *Ectatomma ruidum*—one of the largest ants at the baits, which frequently wrestled large chunks of tuna fish away from smaller competitors. I came to easily recognize *Ectatomma* with my naked eye and began to follow these charismatic insects away from the tuna baits, on alternate lines of flight.

FIGURE 1.2. *Ectatomma* is a genus of ant found throughout Central and South America comprising many different species. My own encounters have mostly been with *E. ruidum*, one of the most common ants in the forests of Panama and Costa Rica. This species lives in groups of around 150–300 individuals in underground nest chambers with pupae and larvae. The unadorned holes of *E. ruidum* colonies are easy to distinguish from those of *E. tuberculatum*, a slightly bigger ant that builds tubular nest entrances at the base of small trees and vines. This picture of *E. tuberculatum* was taken in Gamboa, Panama. Photograph courtesy of Alex Wild. (Alex Wild has an outstanding photographic portfolio, featuring ants and other insects, available online: http://www.alexanderwild.com.)

Most ant species vigorously defend the boundaries of their colony—killing intruders from different colonies of the same species on contact. For most ant species, the stranger is the enemy "with whom there is the real possibility of a violent struggle to the death."[25] Casual observations of *Ectatomma ruidum* suggested that this species is different from most ants—in a certain sense it is exceptional, in fact. While studying "competition" among leaf litter ants, I found surprising forms of collaboration among *Ectatomma* ants. Spending hours casually watching different colonies, I watched ants carry food, larvae, other workers, and even winged queens between distinct nests. Making my own informal experiment, I put up a barrier around one focal *Ectatomma* colony and let the ants continuously collect tuna fish bait for an hour. After removing the barrier, and the bait, I watched as tuna fish was redistributed. Ants exited the focal colony and carried it into the nests of neighbors. Minutes after watching tuna entering one neighboring nest, I watched as it was carried out again to an even more distant nest. As I spent more time watching *Ectatomma*, I found that guards will sometimes stand in the nest entrance and occasionally bite or drag away *Ectatomma* ants from other colonies that are trying to get inside. But often the nest entrances stand empty. Ants actively guarding the nest entrance also sometimes stand aside, letting members of neighboring nests pass unmolested. Once inside, these ants have access to caches of food.[26]

Marking individual adult ants with paint, and gripping a hind leg with a pair of steel forceps, I positioned them at the entrance of colonies that were not their own. Almost unfailingly, when released, the ants went inside. Conducting my own experimental trials in 1997, I spent close to 150 hours in the field—staring at small holes in the ground, squatting on my knees, waiting for these painted ants to reemerge. In short, during all this waiting and watching I found that *Ectatomma* ants regularly enter the nests of their neighbors. I also discovered that ants from distant nests—more than three hundred meters away—can readily enter the colonies of strangers. Rather than a categorical rejection of all nonkin, I found a nuanced pattern of graded recognition. Hostile acts (low-level biting, dragging, but never fatal stinging) were only occasionally directed toward stranger ants.[27]

In the late 1990s, the era when I made these observations, the genetic determinism of E. O. Wilson's sociobiology held sway among myrmecologists, experts who study ants.[28] In the ideal ant colony (at least according to Wilson and his followers) there is a single queen and all of the workers are sisters: nonreproductively viable females.[29] Sociobiologists were asserting that the ant colony "is a superorganism." Nests of ants were "analyzed as a coherent unit and compared with the organism in the design of experiments, with

individuals treated as the rough analogues of cells." In an encyclopedic tome published in 1990, simply titled *The Ants*, Bert Hölldobler and E. O. Wilson speculated that "natural selection can produce selfish genes that prescribe unselfishness."[30] As an undergraduate, majoring in cultural anthropology and biology, I became fascinated by behaviors of *Ectatomma ruidum* that did not fit with the prevailing consensus of the 1990s. Conventional models regarded the ant colony as "a hub, or star, or network in which all lines . . . radiate from a central point along fixed lines." I found that *Ectatomma* ants were entangled in something more like a "distributed, or full-matrix, network in which there is no center and all nodes can communicate directly with all others."[31] If ant colonies were to be understood as superorganisms, my findings about workers moving among colonies suggested that the cells were running wild.

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