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 eco-

systems "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 mon-

keys 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 ethno-

graphic 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 intel-

lectuals 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]