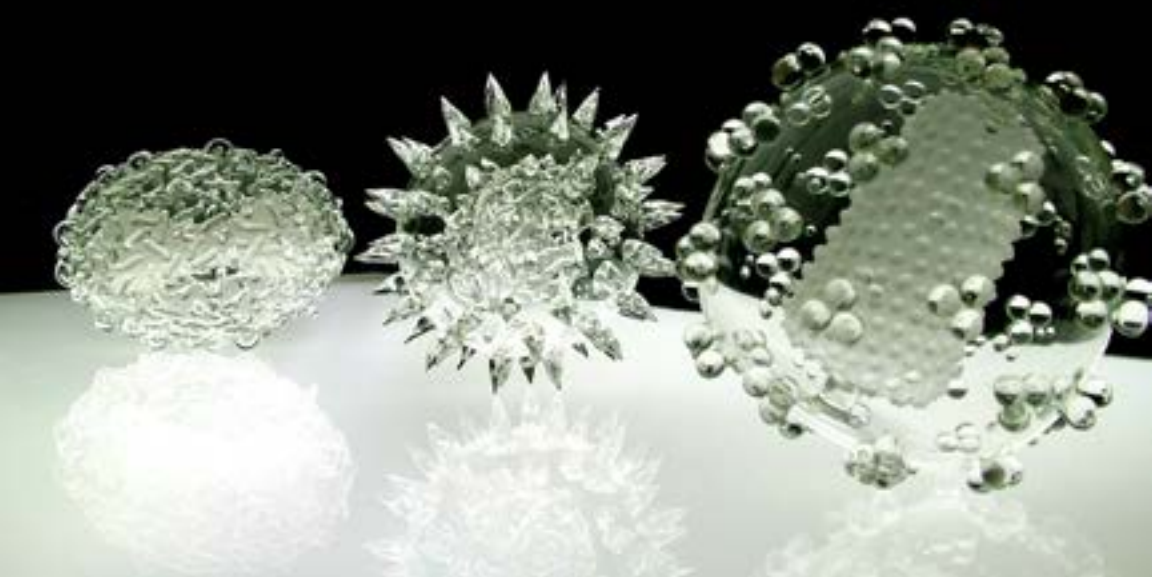
THE VIRUS TOUCH

THEORIZING EPIDEMIC MEDIA

BISHNUPRIYA GHOSH



THE
VIRUS
TOUCH

EXPERIMENTAL FUTURES: Technological Lives, Scientific Arts, Anthropological Voices

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Theorizing Epidemic Media

BISHNUPRIYA GHOSH

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Abbreviations

ACTG	AIDS Clinical Trials Group
ART	antiretroviral therapy
ARV	antiretroviral
BCI	Barro Colorado Island
CDC	Centers for Disease Control and Prevention
cDNA	complementary DNA
CFAR	Centers for AIDS Research
CHEETAH	Center for the Structural Biology of Cellular Host Elements in Egress, Trafficking, and Assembly of HIV
CNICS	the CFAR Network of Integrated Clinical Systems
DRC	Democratic Republic of the Congo
DSN	disease surveillance network
EID	emerging infectious disease
Env-DATA	Environmental-Data Automated Track Annotation
EVL	Electronic Visualization Laboratory
FDA	US Food and Drug Administration
GIS	geographic information system
GVFI	Global Viral Forecasting Initiative
HIVE	HIV Interactions in Viral Evolution
HMP	Human Microbiome Project

HST	Humsafar Trust
HVTN	HIV Vaccine Trials Network
IAC	International AIDS Conference
IUCN	International Union for the Conservation of Nature
JAMA	*Journal of the American Medical Association*
LDMS	Laboratory Data Management System
MSF	Médecins Sans Frontières
MSM	men who have sex with men
NACO	National AIDS Control Organization (India)
NCSA	National Center for Supercomputing Applications
NEA	National Endowment for the Arts
NIH	National Institutes of Health
NHP	nonhuman primate
PBMC	peripheral blood mononuclear cell
PCBs	polychlorinated biphenyls
PCR	polymerase chain reaction
PEP	postexposure prophylaxis
PEPFAR	US President's Emergency Plan for AIDS Relief
PLHIV	people living with HIV
PPE	personal protective equipment
PrEP	pre-exposure prophylaxis
RT-PCR	reverse transcription polymerase chain reaction
SAIC	School of the Art Institute of Chicago
SIGGRAPH	Special Interest Group on Computer Graphics and Interactive Techniques
SIV	simian immunodeficiency viruses
TG	transgender
TMV	tobacco mosaic virus
WHO	World Health Organization

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INTRODUCTION

Epidemic Media

We are not alone. Once, that iconic observation compelled fantasies of alien invasions and red planets. Now it discloses microbes that make up the human. The total weight of the microorganisms in the human body is as little as two hundred grams, we learn from the Human Microbiome Project (HMP), even as microbial cells outnumber human cells ten to one.[1] Placing these findings in histories of the biosphere, popular science writer Dorion Sagan radically decenters the Anthropos: we arrive at a distributed figure that Stefan Helmreich pithily anoints as *Homo microbis*.[2] With research on the microbiome comes a "new biology," argues Rodney Dietert, in which humans are multispecies "superorganisms" and not a single species at all.[3] Ed Yong offers a more poetic capture: minus human cells, a "ghostly microbial shimmer" remains around a "vanished animal core."[4] If the HMP illuminates an ever-swarming biobody

in the more-than-human Anthropocene, then it also establishes microbes as beneficial allies in ensuring human health.[5] Against the ecological tide, however, alarm at microbial abundance surfaces iteratively during acute infectious disease emergencies. In proliferating stories of infection and entropy, pathogenic microbes emerge as malevolent antagonists; among them, *pathogenic viruses* command the lion's share of attention. In every flu season and every viral outbreak, alarm turns to fear, fueling a warlike stance against these proverbial enemies.

This book is devoted to how the extreme situation of a global viral pandemic compels a recalibration of multispecies politics. Since the late twentieth century, acute infectious disease epidemics have been recast as unfolding ecological disturbances ("emerging infectious disease," or EID, events) in a reconfiguration I characterize as the *current epidemic episteme*. Such viral emergences grab our attention at the phase of extensive community transmission that health experts transcribe as a global public health emergency. Putting species extinction on the table, the recognition sends scientists hurtling back to where it all began, to origins, to changing multispecies distributions. As Sagan notes, if the planetary swarm of life, growing, eating, and merging into itself, always posed the problem of "crowd control," acute infectious disease epidemics force a new reckoning.[6] Then it becomes all too easy to revert to the anthropocentric fear and loathing of microbes as germs despite knowledge of "our" microbial shimmer. *The Virus Touch* analyzes how we make sense of the concert of microbial abundance and host loss in the epidemic episteme. Immanent to the logic of infection, multispecies relations habitually surface during infectious diseases emergences as organizing nodes for plotting targeted interventions into individual bodies, populations, and disease milieus. At the current juncture, this structuring node is the multispecies relation between SARS-CoV-2 and its human hosts. Such multispecies relations, sometimes characterized as "novel" (as in *the novel coronavirus*), *appear* to us medially as image and number, milieu and movement. Infection may be experienced in the fever and the fret, but it is not intelligible as such without technical mediation. We read PCR (polymerase chain reaction) results; we watch the curve. Spiky orbs become indelible cultural icons; creative images of lung damage proliferate. Enter epidemic media.

My study of epidemic media across epistemic settings—from laboratories to clinics to forests—affords an understanding of how epidemic media actualize multispecies relations so as to measure, assess, and locate harms. Mobilizing (what Hans-Jörg Rheinberger named) "epistemic objects" such as viruses and hosts, epidemic media set in motion research agendas, institutional action, and public policy.[7] Such media can compound or dislodge harmful habits of

targeted industrial interventions such as the shortsighted overuse of antibiotics or toxic pesticides in the post–World War II period; this is all the more reason to analyze their making/unfolding in concrete locations. But how exactly do epidemic media inscribe infection? What epistemic objects enable targeted interventions into fluctuating multispecies relations? One might begin with epidemic media as enactments of epistemic cuts in dynamic multispecies assemblies. There is mastery in the mediatic objectification of *one* multispecies relation plucked out from the living processes and relations of the biogeological churn. Yet, as we shall see, ongoing challenges to that media-technological mastery ultimately activate another kind of knowledge altogether: a sensuous apprehension of multispecies entanglements that implode all organismic boundaries. Epidemic media compel thinking-feeling one's molecules stretching intensively ("in" here) and extensively ("out" there), emplacing us in the experiential intensities of multispecies entanglement. They also alert us to varying harm and loss, since epidemic eventfulness is qualitatively different for communities made vulnerable by long-term socioeconomic inequities, willed biopolitical neglect, or exponentially high levels of chemical harms. Studying the media situation, I argue, attunes us to these multiplicities, recasting the (universalized) global health emergency in terms of living differentially "altered lives," as Michelle Murphy characterizes it, in the slow violence of planetary disrepair.[8]

This book began many moons ago with the last great pandemic in recent history: the long-wave HIV pandemic that closed out the twentieth century.[9] That global pandemic remains the historical archive for my reflections on epidemic media. Writing during the present COVID-19 crisis that stilled all life as we knew it in March 2020, I found my generational experience of HIV/AIDS suddenly historical in the flash of a spillover event. The cataclysmic COVID-19 transformed all frames of reference as stark differences emerged between the two global plagues. But the viral emergence of HIV remained a touchstone for theorizing epidemic media because of all those historical lessons learned (or ignored)—everything from deadly zoonotic spillovers, to population segregation, to pharma capitalism. Even as the scramble to manage the COVID-19 pandemic overshadows ongoing HIV/AIDS epidemic interventions, even as popular imaginaries of COVID-19 harken back to the 1918 influenza pandemic that claimed 56 million lives, and even as the biomedical solution for COVID-19 remains the obverse of HIV therapies (the HIV vaccine is as yet unapproved, and there are but few antivirals for COVID-19), the scientific-technological knowledge practices that made HIV/AIDS hyperendemic offer rich opportunities for "living otherwise" (as Murphy suggests) with global pandemics, for moving

beyond the short sight of health emergencies. Epidemic media are the engine for these knowledge practices as they inscribe, store, and transmit multispecies relations *and* tweak, alter, and modify them. I approach those knowledge practices in the long shadow of the collective traumas that are the HIV/AIDS and COVID-19 global pandemics. For many, these historical experiences are rent with enduring losses, flashing insights, and accumulating effects, generationally and personally. As a media scholar located in the Anglo-American academy, I live between the United States and India, nations with high death tolls in both global pandemics. This situation lends historical urgency to the questions I pose about epidemic media. Navigating the media storms around HIV/AIDS and COVID-19 has led me to ask: What can "epidemic media" as a research concept offer for living with pandemics? Conversely, what are the implications of a comprehensive epidemic media theory for media studies?

Now epidemics come in all shapes and sizes. Scholars across disciplines criticize the positioning of acute infectious disease emergences as *the* universal health emergencies at the cost of ongoing epidemics, some invisible (as in the case of chemical toxicities), some slow (as in the case of global metabolic disorders), and others chronic (as in malaria, tuberculosis, or dengue emergences in the Global South).[10] As Elizabeth Povinelli writes, the constitution of such universal events is an assertion of political power privileging the biosphere over the colonial sphere, in which ancestral catastrophes have been ongoing for centuries.[11] In keeping with this line of thought, I articulate the two spheres throughout the book: the deep timescales and nonhuman agencies of the biosphere appear and recede alongside the accelerating dispossession, (inter)generational trauma, and anthropogenic violence of the colonial sphere. This interrogation of acute infectious disease emergences as universal catastrophes informs and directs the multispecies politics of health in *The Virus Touch*. It compels a historical look at previous viral storms at a time when COVID-19 appears as a one-of-a-kind experience, a vertiginous rupture irrevocably changing all that came before. The centrality of the HIV/AIDS global pandemic in this book effects a conceptual displacement from the present, reminding us of all-but-forgotten historical lessons. The point is not to trace the uncanny familiarities between the two global pandemics—the widening health inequities, the uneven global distributions of biomedical panacea, the phobic myths of mysterious origins, the ever-mutating virus pointing the way to hyperendemicity, and all that feels like history's return as farce—but to probe a logic that structures both. That logic is *distribution*: the sharing of resources between parasite and host (biological), within populations (social), and across living systems (ecological).[12] What constitutes the health emergency is a multispecies relation—once the

HIV-human relation, now the SARS-CoV-2–human relation—whose distributive logic structures the complexities and multiplicities of global pandemics. Analyzing processes of mediation that materialized that multispecies relation for the HIV/AIDS pandemic not only provides a beginning for living with COVID-19 but also installs a new memory for pandemics to come.

Life, Returning

Since the late twentieth-century viral storms, each EID event has refocused attention on "life," again, despite all the debates over what life has come to mean. Life becomes immanently valuable as a particular configuration of matter during epidemics precisely because new processes and relations challenge that configuration. As a cultural shorthand, life appears as a time span one leaves behind as losses mount; life is palpable in shortness of breath, cascading fevers, and mounting fatigue; life is enmeshed in the tangle of tests, needles, tubes, and cylinders; life is a bat in the recesses of the blue planet, or a sick animal in a wet market. As life wanes (for the animal/plant host) and flourishes (for microbes), epidemic media render multispecies relationalities as distributions calculable in escalating viremia (in individuals) and in the R_0 or reproductive rate (in populations). *An epidemic emerges*. From the Latin root *emergere* ("to come forth"), and the later French *émergence* (an "unforeseen occurrence"), emergence signifies something that *appears* and something that is *new* or unprecedented.[13] "Emergent life," argue Nigel Clark and Myra Hird, confronts us continually, often in unpredictable microontologies, but only some ontological disturbances galvanize political action.[14] The acute infectious disease event is one such disturbance: its recognition motivates the remaking of multispecies relations constitutive of life. This remaking institutes what Isabelle Stengers characterizes as "reciprocal capture": microbe and human/animal/plant emerge with each other.[15] To differentiate species may well seem counterintuitive to the process-relational ontologies of planetary processes, as environmental theorists note.[16] Life, after all, continually unfolds; its relational unfurling and its endemic processualities are recalcitrant to stabilizing configurations such as distinct species. But in the epidemic episteme of acute infectious disease emergence, distinctions between the species, virus and host, are *immanent*: that is, the epistemological distinction is constructed as such to elaborate infection as fluctuating relations between two discrete entities. Following multispecies theorists, I understand these species distinctions as not "natural" but arising from motivated scientific-cultural performances. Viral epidemics are occasions for marshaling "the virus" as epistemic object: as a particle, as code, and as an

organism suddenly lifelike in its actions. At first glance, the pursuit of "the virus" in *The Virus Touch* seems to tarry in the deadening world of objects. But as in the case of Thom Van Dooren's snails, viruses in this book operate as portals into "giant networks" of biotic and geologic relations and processes.[17] Viruses' process-relational ontologies are biogeological because this is *nonlife* that undertakes *lifelike* activities—sensing (irritability) and replicating (reproduction). A bit of nucleic acid (with a protein coat and no cell walls), these obligate parasites "come alive" relationally; as border objects, they relocate their hosts in the planetary biogeological churn.

Despite these entangled materialities, the knowledge practices of the epidemic episteme render virus and host as the central biological participants in a struggle over resources, thereby motivating the search for viable "solutions" to balance (microbial) abundance and (human/animal/plant) loss. Industrial-technological fixes such as therapies and vaccines often constitute premier biomedical solutions. The biomedical triumph of the HIV antiretrovirals, for instance, turned exigent life into a manageable condition; so, too, with COVID-19 vaccines and experimental therapies. Those who survive HIV or COVID-19 have submitted to the technological governance of life. That governance plots a trajectory toward health as deliverable outcome; in turn, health as structuring horizon motivates the study of specific biological targets (antigens, cells, antibodies) to "correct" pathogenic multispecies distributions. In the persistent shadow of the current pandemic, we tend toward health in our bodies, our pods, our communities. For viruses, too, viable hosts are necessary, since these parasites rely on host resources to metabolize and to multiply. Hence, health in the epidemic episteme is an intricate multispecies game and not merely a human medical concern. If nothing else, the HIV/AIDS pandemic taught us these plain truths: we know health is a moving target that orients and reorients knowledge practices seeking to meddle in life. At this early juncture in the book, we can say that "life" under epidemic exigencies takes shape as distinct forms (host and microbe), as unfolding change (life spans), and as multispecies distributions (evolving relations) across domains of action.

If epidemics force a revaluation of "life," this particular configuration of matter or specific mode of organization is offset from "nonlife." There is a rich body of scholarship that questions the life/nonlife boundary and its devastating social and ecological consequences. The wariness is well founded, but there is no escaping the fact that global pandemics are historical thresholds when the specificity of life flashes up again and again. Anyone who has struggled not to die has inevitably instituted the life/nonlife binary as exigency—sometimes against the grain of their environmental politics. Many of us ward off radical

entropy with recourse to vaccines and therapies. This larger imperative toward anthropocentric survival mandates probing how life is epistemologically constituted *precisely* to take stock of valuing life over nonlife and human lives over nonhuman ones in emergency situations. In this regard, the virus is a particularly productive site *because* it crosses the border between life and nonlife. Once viruses assume parasitic relations, life becomes precarious for both virus and host. Confronted by potential loss, distinctive elements such as cells, genes, or proteins appear as iconic forms of life. They acquire significance as "lively materialities" that impinge on the media practices that seek to compose them in biotechnical forms. Later in the chapter, I pause on differential notations of life—the "lively," the "biological," and the "vital." But at the outset, let us stay with the incessant appearances of life in the epidemic episteme.

Notations of life surface amid epidemic agon because we confront massive species losses. (Some will remember musings on an "extinction-level event" in the early days of COVID-19.) When the species under potential erasure is *human*, the struggle for life can amount to narrow technological fixes engineered to provide "human health" as deliverable good. An anthropocentric myopia that privileges human health exclusively undercuts "structural one health" that constellates human, animal, and ecosystem health as historical necessity. Enshrined in the twenty-first-century principles of "planetary health," this ecological orientation has gained credence after the EID events of the late twentieth century.[18] To reckon with life at its most precarious is to address the "threatening ecologies," as the curators of the *Feral Atlas* put it, of the more-than-human Anthropocene.[19] Without this long view, global pandemics will be "our" perpetual planetary futures. Epidemics are one among many ongoing planetary crises: they disclose precarious life on a precarious planet. At the same time, epidemic histories illuminate all the ways in which the most anthropocentric of concerns, human health, has always been an unevenly distributed good. Think of the pharma wars of the HIV/AIDS pandemic or COVID-19 vaccine capitalism. Hence, a multispecies politics must necessarily address histories of race, colonialism, and capitalism that institute difference within new multispecies assemblies. No epidemic is intelligible without feedback effects between structural forces (racism, capitalism, and colonialism, for instance) and evolving molecular relationalities, as the burgeoning conversations on "molecular colonialisms" reveal.[20] Indebted to these conceptual turns, *The Virus Touch* crosshatches the study of interlocking *bio*technological, *bio*medical, and *bio*geographic interventions into new multispecies relations. The noticeable emphasis on the "bio" marks life as governed, becoming *bios*, and situates knowledge configurations in the multiform biosciences central to securing life. The

upshot is a transdisciplinary endeavor that articulates the biosciences with media studies to make the case for epidemic media as environmental media.

The epidemic episteme reconfigures life as form, process, and relation, and, perhaps most crucially, as mediation. Understanding the processes of mediation is critical to surviving perpetual pandemics, I argue, at least for those who are not in the space race to leave a damaged planet. To analyze epidemic media is to grapple with how we capture, manipulate, and sometimes fabricate life at its most exigent. The media question is fundamental to epidemics because of the microscopic character of microbial multispecies assemblies. How often do we hear of an "invisible enemy" since SARS-CoV-2 entered the scene? How often have we watched a curve to understand fluctuating infections within host populations? As submicroscopic particles, viruses are perceptible in their technical mediation. Even as virus-human relations manifesting as disease emergence harkens back to ancient plagues, and even as microbiology in the mid-nineteenth century instituted microbial life-forms as epistemic objects, the media-technological or machinic capture of the virus arrives at a later stage, in 1938, with its optical appearance. One hundred to five hundred times smaller than bacteria, these microbes had passed through Louis Pasteur's porcelain filters for bacteria and remained invisible under the ordinary light microscope. It took the electron microscope to render the virus technically legible as epistemic object. Media histories such as these dot *The Virus Touch*. They disclose a will to more precise, more efficient, more extensive machinic capture. But, as always, mediation is mutually transformative: as Rey Chow explains it, media-technological "capture" is ever a medial entanglement with machine, animal, human, and the environment.[21] Following this line of thought, I argue that multisensory attunements to multispecies relationalities always supplement technical-aesthetic object-making. Such mediatic matters are the focal point of this book. What media materialize biotechnical forms of life in the epidemic episteme? What processes of mediation detect and compose, alter and fabricate, life? How does understanding these processes illuminate their world-making force?

The Media Question

Contemporary expansions of the media concept provide a starting point for what epidemic media are and what they can do. "Epidemic media" in *The Virus Touch* is a capacious rubric for much more than the proverbial contagion fare of films and television shows, pulp fiction, and literary works.[22] My study of epidemic media attends to life unfolding as process-relational ontologies,

to life as always becoming. To bring into focus a singular "multispecies relation" is to enact an "epistemic cut" that privileges and selects, differentiates and stabilizes, particular objects, rendering them intelligible within (what Michael Foucault once named) the "order of things."[23] To emphasize such object-making as a "cut" is to call attention to the backcloth, to dynamic surrounds that remain in rack focus. As living processes and relations appear as *forms of life*, technical-aesthetic mediation is more than a representational moment, for the differential human, animal, and machinic agencies of making/doing/enacting complicate any objective mastery. These lively materialities activate a sensuous relation to the nonhuman world. Before I turn to media theories that inform the concept of epidemic media, let me elaborate the claim by way of an example from the COVID-19 experience.

We have become anxiously aware of the air/water within us, exiting the "molar" body (the self-contained, unified, organic body rendered distinct from the environment) as droplets (of respiratory mucous), then drying as aerosolized particulates, drifting in the air between us.[24] In these processes, a vital medium (respiratory mucus) transmutes into an elemental one (droplets and particles in air); both media are life-sustaining environments for microbes and humans. *Vital* designates medial substances like blood and saliva, urine, or feces that cannot survive for long *as such* outside their site of origin; their situatedness marks their finitude.[25] But as we shall see, vital media are danger zones for infection because they are immensely transitive; they *extend* well beyond their site of production. Extensive media environments as the surrounding milieu are familiar to environmental media studies, but as Joshua Neves writes, it is time indeed to think of media intensions.[26] This is especially crucial for configuring "infection environments," which are both intensive and extensive. Every COVID-19 test quantifies individuated multispecies distributions (the basis of positive or negative results), offering a snapshot of the intensive environment. Every public health advisory aims to measure and manage the air extending between us. We come understand these infection technicities over time, even as living with acute infection around us remains a visceral and affective experience. The notion of *epidemic intensity* encompasses all these infection modalities of pandemic time. Etymologically, *intensity* signifies an extreme stretching tight: these days, as we breathe, we feel the molecular stretch of particular surrounds (a body, a room, a county, the globe) with dangerous air rushing *into* our lungs as we seek *out* oxygen from our surrounds. Infection's risk environment spreads out but does not dissipate; epidemic intensity is a piling on, an accumulation. When scientific images, for example, render air/breath calculable, epidemic intensities appear in their technical valence:

as measures for gaseous and particulate concentrations, including magnitude, degree, direction, and level of dilution. Despite this seeming neutrality, epidemic intensities are deeply subjective. In the domain of feeling, intensity is the thickening, layering, and bundling of sensations/affects; it is a term that translates qualitative perceptions of energetic forces between things into subjective experience. In this regard, epidemic intensities are experiences of stretching tight, centripetally and centrifugally, in infection environments. Scientific, artistic, and popular media make epidemic intensities sensible, composing breath scattering into the air, infusing air into breath. Something latent, something imperceptible moves between us: we understand it informationally; we sense it affectively.

That the endemic transitivity of air/breath has transformed the medium into *the* risk environment for the COVID-19 epidemic experience is evident in diverse technical mediations. In the early days of COVID-19, there were several scientific visualizations of the distance that sneezes travel (six feet and over). Process-relational ontologies of the sneeze found transcription in animations, such as one published on the online platform of the *Journal of the American Medical Association* (*JAMA*) in March 2020 (figure I.1).[27] As this scientific visualization inscribed the scattering of the vital medium into air, respiratory mucus appeared in droplet form as lively media carrying "active" viruses enfolded in the elemental medium of air. The visualization articulates the transition of a vital medium into an elemental one, spelling danger in the composite. We find such visualizations of infection environments across COVID-19 epidemic media made in diverse epistemic settings, from basic science laboratories and art studios. For example, artist Pato Hebert's visual inscription of his own breath dissipating into air from the "Trying to Catch Your Breath" series (2008) took on a new life *after* he contracted COVID early in the pandemic. The photographs documenting his breathing complement the *JAMA* visualization, albeit sans measurement (figure I.2).[28] In Hebert's rendition, breath/air takes technical-aesthetic form as a dissipative unfurling visually stilled at the moment of exhalation. I return to Hebert later in the book and, more importantly, to media practices like these that attempt partial connections (as Isabelle Stengers describes them) between scientific and cultural "findings."[29] In such epidemic media practices, we find "modern practitioners" engaged in negotiating their often-differing visions of the world. They are the media makers featured in this book.

This brief illustration intimates how epidemic media direct our actions: the *JAMA* visualization, for instance, can serve to dictate the social conduct of life, informing public health advisories on physical distancing precautions. In this

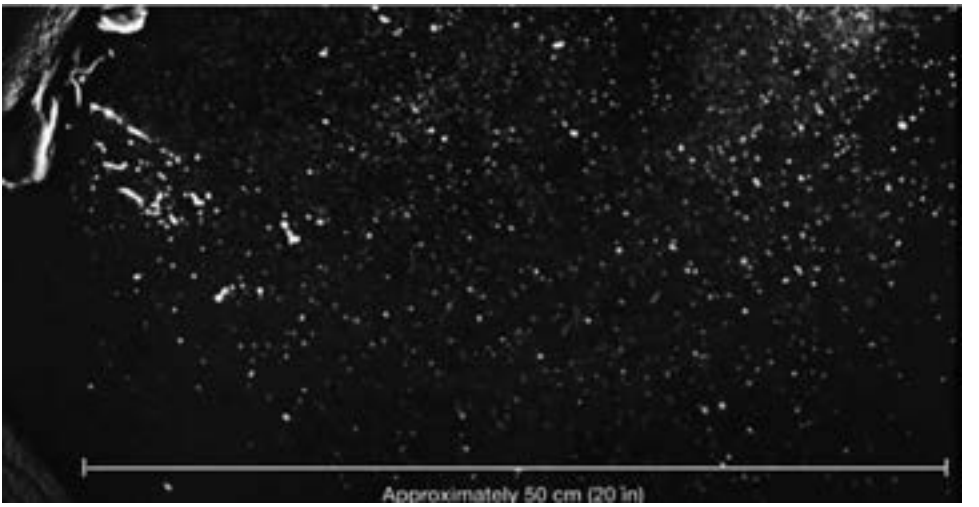

Figure I.1. Visualization of a sneeze, 2020. Source: Video illustration in Bourouiba, "Gas Clouds Demonstrate Their Ability to Travel Great Distances."

regard, epidemic media are world-making, as Adrian Ivakhiv suggests: as media "draw and hold things together," they enact the "worlding of things."[30] Beyond representational forms, looking closely at processes of mediation requires scrutiny of more than apparatuses and devices or technical media (print, photochemical, electronic). It requires understanding the physical processes, the interactions between "things"—light and fluids, in this instance—that have differential agencies and are mutually transformative. The relatively simple examples offered above emphasize what is commonplace to environmental media studies: media in/as environment compels thinking beyond the media-technological situation. Situated in environmental media studies, *The Virus Touch* engages the modern science of the virus alongside its media histories to study process-relational ontologies and their inscription, encoding, and composition as media environments.

Among the modern sciences, the geological has held pride of place in the crucible of climate catastrophes. But facing a pandemic activates a shift of gears, bringing *biogeological processes* into sharper focus. For the past fifty years at least, substantially dislodging biology's (so-called) anthropocentrism, the multiform biosciences have developed varying conceptual frameworks for rearticulating the biological with planetary processes; as we shall see, the turn to multispecies studies arises within this turn. More centrally, historians of the biosciences have underscored the need to study the impact of bioscience research on planetary damage. Hannah Landecker's writings on the articulation of the metabolic

Figure I.2. Pato Hebert, untitled, from the series *Trying to Catch Your Breath*, 2008. Archival pigment print, 10 × 13⅜ in. Credit: Pato Hebert.

sciences, industrialized agriculture, food systems, and planetary health, for example, exemplify such material histories.[31] Adopting the chemical gaze as a method, in historicizing metabolism, Landecker tracks "enzymatic and energetic conversions between different kinds of matter" to show how biological targets made and unmade in basic science laboratories and how industrial research units "carry forward" industrial products into living systems.[32] Drawing inspiration from her insistence on the planetary location of the biosciences, my study of epidemic media foregrounds the biological and technological hinge in the making/doing/enacting of epidemic media. How do media practices materialize biotechnical forms to ready them as targets of intervention? What are the planetary impacts of this constitution? To ask such a question is to think the biosciences and media studies together in their conjoined planetary world-making.

The qualifier *biotechnical* in *The Virus Touch* is an analytic for inextricable biological and technological processes that emphasizes their respective material

specificities. Epidemic media are biotechnical forms—an image, a number, a milieu, a movement—that materialize otherwise imperceptible processes and relations. In this respect, they are representations constrained by their settings, by the media practices that give them form. More often than not, epidemic media are *experimental* representations, reflexive and improvisatory, that gesture toward their own provisional nature. When the effort is to detect and compose a *novel* multispecies relation, the representation is necessarily, and often explicitly, conjectural or speculative. Machinic inscriptions often run up against accelerating viral changes (mutations becoming variants, for example) or the new complexities of multicellular organization (which of "our" proteins help the viral spike protein to fuse to "our" cells).[33] Such lively materialities find coding/transcription over time in bioscience research—but only *over time*. Media entanglements in furiously accelerated pandemic time motivate my exploration of epidemic media's forms and technologies. There is the urgent push for better probes, new software, and smaller cameras as media-technological processes unfold *with* lively materialities; not all of the latter, nonhuman agencies erupting in unpredictable events, are fully legible as *biological* processes. Sometimes liveliness registers as disruptive excesses, as strong affects. An animal spotting a camera trap alters its route and subsequently dislodges the camera; a vital medium poses haptic danger despite controlled safety precautions. Too much noise or disturbance, error or redundancy, scuttles efforts at efficient machinic capture. These differential agencies, animal and machinic, underwrite the speculative orientation of epidemic media's biotechnical forms.

My observations of epidemic media practices commence with *sense perceptions* of lively materialities as the not yet comprehensible, as the partially known.[34] The most abstract epidemic medium turns out to be irreducibly sensuousness. This sensuousness may arise from direct sense data, but not exclusively. Epidemic experiences reconstitute those perceptions as another kind of knowledge: an awareness of casual relatedness and processual flux between discrete entities that current environmental thought transcribes as *entanglement*. Too often a vague buzzword, *entanglement* has a range of critical modalities (as in Karen Barad, Donna Haraway, and Rey Chow) relevant to *The Virus Touch* that I turn to in the following pages. Here, Rey Chow's elaboration is most pertinent: media entanglement, suggests Chow, is the intuitive feeling for "mysterious connections" to media-technologically captured entities (animals, humans, minerals, or plants) even when *their* desires and motivations, actions and relations, remain obscure. These intuitions supplement the "active relation" that "contains, detains, and retains" its epistemic object in acts of mastery.[35] Media technologies like microscopes or camera traps might seek to

establish "enmeshments and linkages" between humans, animals, or machines, but in fact they afford an awareness of the "voidings and uncoverings that hold things together."[36] As media technological practices enfold sensory data, feelings, thoughts, and intuitions, they initiate a phenomenological awareness of entanglement. A coagulating *epidemic intensity* surfaces. In the midst of epidemics, no one is spared from this intensity, this "flux of participation," as ecologist philosopher David Abram describes it, and all the more in confronting radical uncertainty.[37] As modern practitioners struggle to objectively transcribe "life" as process and relation, they act with urgency, facing the pressing need to make intelligible radical uncertainties. The consequent speculative orientation of epidemic media gestures toward another space beyond the institutional settings of media practices—to inextricable multispecies entanglements. This sensuous knowledge accompanying objective mastery has implications for the "worlding of things" that I explore in the chapters.

It should be clear from these opening remarks that *The Virus Touch* traverses science and technology studies and environmental media studies to articulate the conceptual rubric of epidemic media. All too often, the articulation of the biosciences with media studies ends up as biomedia studies, with tangential implications for environmental media theory. My aim is to center the study of biological and technological processes in environmental media studies. What follows is the research framework that is the backbone of epidemic media theory.

ENVIRONMENTAL MEDIA

In the cross-disciplinary terrain of environmental media studies, media include "life-sustaining" elemental media rife with human and nonhuman signals as well as the media-technological practices that render them readable. A few years ago, John Durham Peters's monumental study of the four elements (in the Western sciences) reverberated as the field of elemental media studies.[38] Scholars turned to industrial histories of an elemental medium (e.g., Yuriko Furuhata on air); to mutual transformations of elemental media and media infrastructures (e.g., Nicole Starosielski on underwater cables); to mediatic transcriptions of risk signals (e.g., Rahul Mukherjee on electromagnetic transmissions); and to rethinking media theory in terms of specific elemental media (e.g., Stefan Helmreich and Melody Jue on ocean contexts).[39] There is excellent scholarship on the many conjunctures of media + environment: on the deleterious dimensions of media *in* the environment (from sonic booms to toxic e-waste); on how media scale between local events (a flood, a storm) and planetary processes (sea-level rise); on how media record and track ecological relations and processes, readying them as environments in need of intervention; and what

media can do to slow down, redirect, and even thwart ongoing planetary damage. In all these accounts, mediatic processes compose what we understand as the "environment." Throughout the book I analyze the making of *infection's media environments* in biotechnical forms. One classic example is the "interaction domain" whose processes shape viral particles entering host cells. Molecular visualizations zoom into viral protein assemblies—a wiggling viral spike protein reaching toward host cells—as they fuse with cellular membranes. The environment, in this case, is the extracellular fluid that transports viral particles at the interface with cell membranes. Conformational changes in that environment are crucial for viral proteins to begin their journey into cells; both host and virus are participants in the drama. The interaction domain vibrates with the form of life transcribed as the viral particle; the media-technological practices of scientific visualizations inscribe viral unfolding in molecular-scale "events" for scientific insights into unknown parameters. Here, as in other instances, biotechnical forms and media environments are not figure and ground but are configured as assemblages. Besides the interaction domain, there are the "interior milieu" and "biogeographic regions" in subsequent chapters: these are the media environments for quantified viral ratios in vital media (x number of particles in y milliliters of blood) or for animal movement patterns in biodiverse habitats. Taken together, these media-technologically rendered forms offer a comprehensive account of viral infection's nested risk environments.

What is the upshot of considering these different life-form–environment assemblages together in this book? Infection as a fluctuating multispecies relation occupies *extensive* planetary space. But to understand how infection travels from cross-species transmission into host individuals and populations requires a multiscalar analytics attentive to the specificity of media environments. The life-form–environment assemblages throughout the book afford a fractal view of the unfolding multispecies relation: that is, each assemblage is a fraction of the infection story, distinct from but resonant with what happens at another scale. This fractal multiscalar perspective positions infectious disease epidemics as biological-social-ecological catastrophes emerging both intensively and extensively. Epidemiological studies lead the way in such transcription of infection across institutional domains: infection is at once medical/clinical, social/industrial, and geological/atmospheric. Animal/human feces release bacterial swarms into the soil; mosquitoes breeding in standing water convey parasites between bodies. These disease vectors highlight the transitivity of infection. We know quantifying county or district fecal waste is one epidemiological method for assessing COVID-19 community infection rates: media-technological practices inscribe vital traces folded into elemental

media to materialize infection's environments as "risk environments" and to render harms calculable.[40] This complex picture can be grasped as fractal cameos that locate readers in the individual host (interaction domains), between hosts (the milieu), and, finally, between species (biogeographic regions). The point is most clearly developed in chapter 3's tracking of excorporated blood stored outside its site of origin. The biomedical goal of managing infection in individuals and populations necessarily "cuts" the vital medium into discrete "interior milieus," which are filed as blood samples, blood data, and blood pictures. The interior milieu points centripetally inward, but as the chapter demonstrates, each composition is constantly displaced centrifugally so that the vital medium comes to embody the greater disease milieu. In this way, *The Virus Touch* analyzes and elaborates infection's environments as epidemic media.

Finally, this book is in conversation with one disciplinary enclave in environmental media studies that stays with forms of life: the theory and practice of multispecies studies. As Helmreich writes, multispecies talk, especially regarding the *human* microbiome, is a "strange back-to-biology move" at a point when decentering anthropocentrism is urgent.[41] As we see in the next chapter, the new biosciences are hardly invested in either classical biological individuality or organic forms of life. Biology is indisputably "more than biological" today.[42] This decentering of anthropocentricism is formative to the heterogeneous field that is animal studies, one that includes multispecies theory and practice. While some strains in animal studies veer toward large, charismatic animals, multispecies inquiries analyze fungal, bacterial, and viral assemblies as teeming life grown into each other, their commingling imploding species boundaries. Two strains in these enclaves are intellectual settings for the study of epidemic media. The first is "microbial media" theory and practice. Artistic "multispecies spectacles" range from transgenic phantasmagoria (e.g., the Critical Art Ensemble's cultivation of *E. coli* bacteria) to self-ethnographies of infection (e.g., Caitlin Berrigan's experimental assemblage of HIV and the common weed), while theorists (e.g., Stefan Helmreich, Heather Paxson, Celia Lowe, Nigel Clark and Myra Hird, among others) rethink the multispecies politics of microbial media.[43] These critical-creative endeavors are salient to my study in their attention to the medial enactments of multispecies relationalities. Second, there is robust inquiry into disappearing animal species (extinction studies) and habitat fragmentation (biodiversity studies), and these inform my focus on zones of virulence. *The Virus Touch* engages animal hosts as lively media, as multispecies forms of transport carrying microbes over distances; their changing movements create new conditions for pathogenicity. Writings in animal studies such as Ursula Heise's *Imagining Extinction* and Frédéric

Keck's *Avian Reservoirs* shape these explorations of animal hosts. Their critical methods tracing the collaborations between biologists and veterinarians, naturalists and local buffs, big-data analysts and computer programmers that produce multisite field data and software programs inspire my research into media-technological inscriptions of zones of virulence. Chapter 4 directly addresses the multispecies question, pursuing animal-tracking media for sensing animal movements. Assembled into spatial forms, these tracking data are the basis for composing zones of virulence as threatening ecologies. As the curators of the *Feral Atlas* argue, pathogenic multispecies assemblies are organic and nonorganic relationalities—the nondesigned consequences of imperial and industrial infrastructure.[44] Such a focus on anthropogenic drivers obviates the depoliticized emphasis on evolutionary phylogenies that dominate natural histories of mutating viruses. Social and ecological histories of the colonial sphere become critical to understanding cross-species infection and the establishment of viral strains that go pandemic. In all these ways, environmental media theory and practice are the conceptual apparatus for my pursuit of epidemic media across the chapters. As they materialize biotechnical forms and media environments, epidemic media articulate pandemics as social-ecological catastrophes.

MEDIA AND THE BIOSCIENCES

My location of the biosciences in environmental media studies points toward science laboratories as some of the main settings for making epidemic media. Scholarship in science and technology studies has a formidable oeuvre on "what happens in the lab." Bruno Latour and Steve Woolgar's *Laboratory Life* (1979), documenting material techniques at the Salk Institute for Biological Studies, sets standards early in the game; Hans-Jörg Rheinberger's and Karin Knorr Cetina's elaborations of the material construction of "epistemic things" in science laboratories are other critical influences in this area of study.[45] One could multiply these histories, but here I select a few insights that shape my inquiries into experimental epidemic media in laboratories. Latour and Woolgar examine scientific facts as material performances and underscore their historical construction. "A substance could not be said to exist," they note, "without a particular configuration of apparatuses"; after all, one cannot run a viral bioassay without an "inscription device" such as a PCR machine.[46] Each inscription can be subject to a variety of interpretations before scientific facts come to stay. When an interpretation becomes "fact," it "loses all temporal qualification and becomes incorporated into a large body of knowledge drawn upon by others."[47] This insistence on making epistemic objects (and, consequently, facts) as situated

material performances is crucially important given the provisional character of epidemic media. To some degree, this provisionality arises from the sheer novelty of the problem at hand, its radical uncertainty. But beyond this general condition, there are scientists who eschew universalizing claims proven within the constraints of *one* scientific practice for negotiated understandings that make partial connections with other sciences. These "modern practitioners," according to Stengers, are willing to work across the discordant landscapes of modern science, willing to negotiate competing visions of the world.[48] We find them making epidemic media in three labs that craft the novel multispecies relation as image, number, milieu, and movement: a computational structural biology lab that images virus macromolecules, a clinical medicine lab that inscribes and stores blood samples, and two forests segmented for study as the "living laboratories" of the world. While the latter are not quite of the same order as the basic science laboratories, Latour reminds us that forests, too, materialize as such within scientific practices. Following two scientists, a botanist and a pedologist (specializing in soil science) into the Amazon, Latour describes how one sees the trees, and the other the soil; how the pedocomparator (a square box for soil-sample collection) as instrument, for example, transforms and orders what we come to know about the forest.[49]

Drawing on his two-year stint at the Salk Institute, Latour notes that naturalized techniques in laboratories appear *as* material construction at moments of failure or breakdown. As we shall see, the scientists, artists, computer programmers, and technicians who appear in this book all put pressure on the media-technological limits of what their apparatuses and devices can deliver; pushing boundaries, they call for new tool kits for imaging living systems, for more sophisticated PCR machines, for better motion-sensor technologies. In recognizing the limitations of machinic inscription/transcription, they reflexively convey a distributed sense of what exceeds machinic capture. The "traceability" of reference that hangs around material substances, in Latour's (1999) analysis of the Amazon forest, registers as noise, as partial or unclean data, indexing the difference between form and matter. The ontological question returns as lively materialities that proliferate at the edges of scientific practices. We find such instances of affective force in the many accounts of lively disturbances that surface in the book; the clearest examples are to be found in chapters 3 and 4 on vital media and animal movements. At the Clinical Retrovirus Laboratory, one of my research sites, I observed repeated evocations of "clean data" (meeting standards that other research facilities could trust) and intimations of "dirty" excesses scuttling precise inscription; and in interviews with Roland Kays about his remote-tracking experiments on Barro Colorado Island,

disruptive vegetal movements in tropical forests were a formidable challenge to differentiating animal movements. This sense of *supplementary* noise is endemic to epistemic cuts invested in bringing clarity to some phenomena at the cost of others. Attending to mediation—the makings/doings/enacting in laboratories—illuminates these medial actions as material performances. Mediation highlights the labor that enacts scientific findings and, ultimately, facts. Woolgar and Latour characterize these labors as "slow practical craftwork" thickly entangled in (what Karen Barad names) agential objects, apparatuses, and practices, a point to which I return shortly.[50]

Barad, Stengers, and Latour all hint at *discordances* between scientific practices, which, in turn, constrain media-technological practices in laboratory settings. Armed with a specific purpose, every scientific practice relies on particular apparatuses and devices to mediate its epistemic objects.[51] A structural biologist will have optical-computational technologies for the study of molecular structures; a geneticist pursuing genomic fingerprints will have a PCR machine. Epidemic media are intelligibility machines that make epistemic objects cohere within the constraints of scientific practices. And yet most experimental scientific endeavors are open to the *limits* of their own scientific practices and rely on evolving collaborations. The movement between scientific practices is most clearly plotted in chapter 2, where I track the making of the HIV-1 macromolecule through long-term and contingent collaborations among scientists, artists, and creative industries. The epidemic media that they make together accommodate competing visions of the world, pressing up against the limits of scientific practices. As modern practitioners, the scientists featured in this book collaborate with artists, software writers, health-care workers, and local animal experts, among others, and I track their making/doing/enacting of epidemic media in each chapter. Together, these modern practitioners make partial connections around specific epistemic objects—like the air between us—participating in making "a world of many worlds," as Marisol de la Cadena and Mario Blaser suggest, inclusive of humans and nonhumans.[52] Such "ontological politics," notes Stengers, are critical to environmental thought and action.[53]

BIOTECHNICAL FORMS

A domain of inquiry critically salient to making scientific images is biomedia studies, a field of theory and practice that informed the start of my inquiries into epidemic media. Taking the biosciences as the epistemic setting, in his landmark book *Biomedia*, media theorist Eugene Thacker set an agenda for studying interlocking biological and technological processes at the biodigital interface.[54] There is excellent scholarship on this interface inspired by the

conjunctions of cybernetics and biology in the mid-twentieth century, one in which the gene becomes the definitive substrate of life.[55] In subsequent alliances between new materialism and new media, processes of extraction implicated in the modification and alteration of life come under scrutiny. If new media design and build "life itself," molecule by molecule, and if biological substrates are subject to the same kind of flattening, reproduction, and patenting as are CDs, DVDs, and cassettes, it is time to evaluate how we study biological and technological processes as they transform each other.[56] Throwing down the gauntlet in *Life after New Media*, Sarah Kember and Joanna Zylinska, following Henri Bergson's account of life, define life as processual flux appearing as "life itself" in epistemic cuts that still the flow.[57] Studying viruses in an agar plate under the electron microscope, for example, involves multiple medial actions, ranging from preparing appropriate samples to setting the electron probe for precise detection. Quantifying viable viral particles in a demarcated time-space, as we shall see in chapter 3, enacts a cut that readies one unfolding multispecies relation for targeted therapy. Representations, in this regard, are one part of biotechnological interventions in life's processes and relations. Kember and Zylinska's epistemic cut is most relevant in my discussion of biotechnical forms confronting "lively" temporal excess in chapter 2. The radical incompletion of the -morphic image, I argue, opens to what is as yet to be medially graspable and exemplifies an encounter with speeding viral temporalities.

Each chapter stages a dramatic encounter between lively materialities and biotechnical forms, even as different theorists diverge on what "life" is and can become. Analyzing simulations of living systems from a mechanist perspective, for example, Manuel DeLanda places models of living systems on a "synthetic-biologic" continuum but argues that ultimately what is not known can be mathematically theorized; conversely, in her account of scientific enchantments with "excitable" molecules, Natasha Myers argues for the irreducible liveliness of matter.[58] Still others, like Jennifer Gabrys, suggest that the biological organization of matter is "anterior" to its media-technological capture; therefore, emergent life-forms on a computationally programmed earth are "organism-machine-milieu" assemblages.[59] Whether it is the preparation of biological samples for optical inscription, or protein modelers twisting and turning with their 3D models, or vegetal interferences disrupting animal motion detection, notations such as these designate lively actions that exceed machinic inscription/transcription despite faster microprocessual capabilities, despite the theoretical power of infinite simulations. My attention to tangible media (live cell cultures, for instance) and material performances (of laboratory procedures and techniques, for example) underscores the "lively materiality" of epidemic

media. When they disrupt or confound planned outcomes, such materialities are often perceived as excesses to be weeded out; nevertheless, they also invoke curiosity, even wonder. This affective charge is indicated in the qualifier *lively*.[60]

An insistence on lively materiality bucks a history that reduces the virus to its molecular constitution as code. We know this cultural history well in the celebration of virus*like* behaviors or uncontainable virality that thwarts all attempts at social or political control. The virus is feted for its uncontrollable informatic cutting, pasting, and multiplying (the meme); for its simple microprocessuality (the homegrown machine); for its bottom-up, hydra-headed, acentered organization (the swarm or brood); and for its ability to set in motion a series of sudden and unpredictable effects (contagion). In these capacities it is something of a cultural analogue for informational and social systems. Jussi Parikka's early *Digital Contagions* references HIV as a cultural figure for understanding the behaviors of computer bugs, worms, and viruses; in the 1980s, informatic contagion would be known as "computer AIDS." Of course, Parikka's later conception of medianatures, an attunement to machinic-geological continuities, probes media materialities beyond tropological capture; but the notion of informatic virality remains resonant in the study of new media.[61] In a different intonation, Tony Sampson's *Virality* extends the model of network contagion to rethink microsocialities and the capacity for social transformation. Both Parikka and Sampson see contagion not as a fearsome force but as an open-ended system that enables a jump cut to something qualitatively new.

In a fascinating reflection on curves and simulations, Sampson and Parikka argue that such data visualizations are *the* "epidemic image" for the COVID-19 experience because of their microprocessuality: they are capable of changing with new inputs coming in every day from a massive operational matrix.[62] Everything from human behavior to health-care provision to viral mutations impacts the curve, contouring it in feedback loops. By contrast, the image of SARS-CoV-2 as spiky orb may well be ubiquitous, but it has limited capacity, argue Sampson and Parikka; the viral image is a stable configuration that captures the epidemic only at molecular scale. In this regard, the image seems less capable of keeping up with the fast-moving landscape than the moving curve. There is no doubt that watching the curve—a mathematical form that has come to stay since the early twentieth century—has become a fundamental media experience in unfolding pandemics. Moving curves keep abreast of pandemics as a dynamic multitemporal emergences. And yet, the viral image is a significant competitor as *the* iconic epidemic image: a constant reminder of the immanent multispecies relation that galvanized a qualitative multitemporal shift. As Kirsten Ostherr noted in an interview on COVID-19, the heightened

anxieties in the early days of the pandemic were fueled in part by not being able to locate the microbial agent responsible for the shift.[63] Externalizing a microbial agent as epistemic object, the viral image was the pandemic punctum; in this regard, visualizing data in the viral image is a fierce competitor to the curve. As classic disease emergences, pandemics make us feel our internal environments intensely—our cells and microbes, mucous and lungs. The viral image gestures inward, as we feel molecular in constant tests, and outward to what lies in planetary matrices; perceptually, it overwhelms other technical mediations, settling as the cultural icon of a pandemic. More importantly, scientific viral images are anything but stable: their very functionality lies in their malleable, constantly editable, dynamic and speculative capacities. Biotechnical images keep abreast of fast-paced research, as we shall see in chapter 2, and they intuitively entertain scientific hunches in confrontations with the radically unknown. That unknown inheres in the biotic qualities of the multispecies relations that keep changing, as we know from the current confrontations with wily variants. At the biodigital interface of the postgenomic era, then, the viral image returns us to the multidimensional problem of life that biology poses; it exemplifies an integrative approach to the biological complexity of living systems. Chapter 2's discussion of structural biology as it interfaces with genomic research resituates informatic understandings of viruses (the virus as code) in the expanding frame of the multiform biosciences.

Beyond both curve and image, as I have suggested, infection environments are ubiquitously palpable during epidemics. Bristling and active, vital and elemental media require constant negotiation at every scale, as we see with managing breath/air during COVID-19. Machinic inscriptions render these media intelligible in biotechnical forms as the surrounds are cut out from dynamic biogeological processes. The exhausting uncertainties of pandemic situations, however, make us deeply aware of living processes and relations that are not as yet fully comprehensible. At the biological and technological fold, these "lively materialities" are all too apprehensible, affecting us daily, as we know from sense perceptions of uncontrollable viral variants—uncontrollable in part because they are only partially known. As media-technologies inscribe infection environments, medial entanglements sharpen awareness of lively materialities. This general awareness is keener still when the biotechnical processing involves tangible media: technologically fabricated cell cultures, blood samples, agar preparations, animal models, all that sustains biotic relations so that they can be stabilized for study. Following Myers, "tangible media" in *The Virus Touch* refers to this "wetware," visceral in modality; volumetric and tactile, such tangible media are critical to the constitution of biological targets.[64]

This discussion of biotechnical forms gestures toward what lies beyond machinic capture as the biosciences, armed with new technologies, explore the "limits of life."[65] On the way, life expands as theoretical object. But what does this imply for making/doing/enacting epidemic media? Accompanying biotechnical intelligibility, lively materialities are referential traces of what lies beyond. Registering on the perceptual sensorium, these materialities activate another kind of knowledge—a multisensory "knowing" that troubles abstraction. In every instance of biotechnical forms, "life," manifest in multisensory media-technological processes, exceeds machinic inscription and aesthetic composition.

MULTISENSORY MEDIATIONS

Epidemic media enact multispecies distributions: they are rife with human, animal, and machinic signals, some bristling below conscious awareness, some escaping human perceptual registers altogether. Take, for example, our immune system, the focal point of HIV epidemic media. Research on HIV has extensively traced how the virus attacks the CD4 or T-cells, which are the "intelligence units" in the immune system, in that they recognize pathogenic attacks and send instructions to other cells (often called the foot soldiers) to attack pathogens. All the vaccine talk of the COVID-19 era is about installing a memory of SARS-CoV-2 in our immune systems. Perception, then, is a cognitive process that regulates the emerging-with nonorganic and organic matter. Immune systems have memories, as do muscular and nervous systems; volumes have been written about the sentience of living systems. It is amid mounting ecological damage that we tune in to these intelligences, consciously installing, as Stengers maintains, a "new memory."[66] The smoke in our nostrils, she argues, has become ontological evidence of snowballing damage, bringing home the causal interrelatedness of planetary existence.

The example of immune system memories locates the human senses in a perceptual complex. As one register, the human sensorium is our conduit to direct sensuous experiences. And it is this sensorium that epidemic media organize in their machinic compositions. Inscribing a new vital relation, each composition invokes some senses and "partitions away" others as supplementary; intelligibility comes at a price.[67] Intelligibility connotes the normative governance of multiple intelligences, if we follow Michel Foucault's evocative phrase "grid of intelligibility," the system of elements by which we order and classify process-relational ontologies.[68] An extracting, distilling, classifying, and composing is underway in the making of epistemic objects, abstracting different kinds of matter as image, number, milieu, and movement. But confronted with

lively materialities that do not fit, making/doing/enacting epidemic media is equally a dispersion into the sensorium. Supplementary sense data may compel intuitions or hunches, or they might just irritate. More importantly, they open to an awareness of animal-machinic perception unfolding together and therein of nonhuman agencies, of our entangled materiality.

In posthumanist studies, the perceptive capacities of all living forms are testament to nonhuman agencies. We hear of "smart" bugs, of "extrasensory" plant sentience, of animal "intelligence." This robust scholarship provides the broader intellectual context for new materialist and environmental media theorists, who, in turn, examine mediatic traces of nonhuman intelligence in communicative signals—from whale songs and bird flight patterns to plant movements and microbial chatter. The scholarship on vast, untapped perceptual worlds teeming with indiscernible signals compels new analytics, histories, and theories. Throughout the book, theorists of life-forms and living systems underscore the sensing of forces and relations as the open spatiality of life. Some see perception as the unfurling of the body into its milieu. Knowledge is sensory immersion in a phenomenological milieu: one organism senses possibilities in the milieu, as we know from Jakob Uexküll's example of a tick intuiting the warm blood of a mammal.[69] Active relationalities in the environment bristle, becoming sensory knowledge; lively materialities affect medial acts of mastery. In this phenomenological domain, one influential thinker is David Abram, whose study of magicians/healers in *The Spell of the Sensuous* theorizes the craftwork of "throwing" the senses beyond what is immediately given.[70] As intermediaries between human communities and the larger ecological field of animals, plants, and landforms, Abram's version of "modern practitioners" render the hidden dimensions of the sensible world directly sensuous; they focus on the malleability of perception to yield a constantly emergent world. Although Abram opposes direct experience to machinic mediation, and although subjective illusion (of magic) is not the craft of epidemic media, ongoing technological and aesthetic experiments among scientists, artists, and activists, among others, reveal a commensurate immersion in techniques of perception. The modern practitioners of epidemic media, intent on perceiving a new multispecies relation, are caught in the "flux of participation," in the vortex of human and nonhuman intelligences.[71] The "touch" in this book's title, then, signifies much more than the haptic sense or indeed pure sense data alone. It encapsulates another kind of knowing based on experience, one that medially entangles as/in the environment.

The craftwork of epidemic media renders the processualities of life *sensible*. Natasha Myers (*Rendering Life Molecular*) invokes "tangible media," and

Inga Pollmann (*Cinematic Vitalism*) "vital media," in their respective takes on machinic engagements with lively matter; theorists of immersive media like Oliver Grau (*Virtual Art*) highlight the medial experiences of "being with" living systems. These renditions of sensuousness proliferate in the book. Then there are those media scholars who approach lively materiality in terms of media-technological limitations. An abundance of signals is the "noise" of lively milieus that challenges the effective computation of animal motion–sensing data. Such "parasitic" noise, as Greg Siegel notes, is endemic to the signal, in that it is a part of the "contrapuntal matrix" from which information must be extracted.[72] As I illustrate in chapter 4, movement ecology scholars address such interference with a range of techniques such as object segmentation and deep-learning classifications. Still others explore critical media practices that push against technological limits. In every case, the making of biotechnical forms is confronted with technical difficulties, which stimulate further media-technological innovation and aesthetic experiments—new apparatuses, devices, and tool kits, new practices and designs. Epidemic media practices reflexively become media theory attentive to lively materialities. In all these respects, a theoretical curiosity opens epidemic media to untapped fluctuations and complexities, unruly spatialities and unexpected agencies, and perceptual complexes. Epidemic media render life intelligible as it ingests, digests, excretes, expands, grows, or shrinks. In them, we come to know only a sliver of human and nonhuman signals, for "Nature," as Victor Frankenstein once learned, does not yield "her secrets" easily.

Life, Emerging

Back in 2008, one of the starting points for *The Virus Touch* was the rise of new materialism as a media theory insistent about process-relational ontologies.[73] Early in the twenty-first century, a number of critical approaches coalesced as new materialism, crafting distinctions between "life" as an ontological force and "life itself" as its extraction. Jane Bennett's *Vibrant Matter* and William Connolly's *The Fragility of Things* are often regarded as posthumanist works that question the distinction of the human within its material environment. They challenge any separation of human matter as more vibrant than other configurations; the emphasis falls on how matter *moves* and *morphs* in new assemblies. New materialism includes many strains of thought that I will not rehearse here. What is compelling about the turn is its questioning of the anthropocentric focus on *human* life plucked from its environment. Against human mastery over ecological domains come theories of nonhuman agencies and entangled

materialities. Of these, entanglement remains a key concept in my study of epidemic media, but the term's vertiginous intellectual migrations makes it imperative to specify how it operates in the following pages.

A range of critics locate "entanglement" as a theory that understands matter as a group of particles that come into view in their relation *with each other*. In the physical sciences, the point is to consider the quantum state of the whole. As Karen Barad argues in *Meeting the Universe Halfway*, theories of entanglement position groups of matter as *intra-active agents* that transform each other. Their complementarity articulates coming into being (the *ontos*) with knowledge production (the *episteme*). After Niels Bohr, Barad calls for an "onto-epistemology" that grasps the "agential realism" of matter. Realism is no longer preoccupied with correspondences between representation and reality but with the practices/doings/actions, as Myers describes them, that *perform* epistemic objects.[74] To track entanglement is to expose the mastery of the knowing subject over an epistemic object as an illusion. The environment, in this account, is hardly inert or passive: nonliving matter has intentions and motives, claims and actions. Entanglement foregrounds material agencies in making worlds; in their coming into being, the world is always emergent. Barad's emphasis on scientific-technological material performances returns us to Adrian Ivakhiv's medial "worlding of things."

Writing for *The Multispecies Salon*, Barad expands these observations to one life-form's entanglement in its material environment. The brittle star, she explains, is a creature without a brain whose entire morphology (skeletal and nervous structures) *is* an optical system. To perceive/know is its very "mode of being," for there is no separation between the subject and an external world.[75] In this regard, the brittle star exemplifies knowing as onto-epistemological process. Barad's elaboration of this life-form is illuminating for thinking about multispecies entanglements emergent in epidemic media. Epidemic media, as I have suggested, institute epistemic cuts in biotechnical forms: these transcribe signals in visual or numerical terms, most of the time, cutting into living processes and composing them as forms of life. But as intra-active performances, these media enfold distributed sense data that are supplementary in that they are irrelevant to the task at hand. A haptic sense of blood's transitivity, for example, is simply irrelevant to quantifying the viral load. But Barad's theories suggest these "supplementary" sensations, affects, and intuitions may indeed open to entangled modes of being—to emerging-with matter as *another kind of knowing*. In the epidemic episteme, we come to "know" multispecies relations in technically and aesthetically composed biotechnical forms; we objectify virus and host as distinct entities in the grid of (biological) intelligibility.[76]

While attempting to weed out media-technological distractions—the "blurry traces, sibilant transmissions, unruly corporealities," writes Siegel—epidemic media open to what Brian Larkin has named "the material conditions of existence for media."[77] But they also intuit something else. Crafting epidemic media *accentuates* sensuous medial entanglement because of the experiential intensity of the epidemic situation, the furious accelerated time of crisis. Epidemic intensities are deeply visceral: there is trouble "in here" and "out there," breaching all constructed boundaries. In this scene, viscerally materializing biological-geological processes as epistemic objects and navigating tangible media (blood samples to feces) only deepens the awareness of multispecies entanglements. Modern practitioners caught in the flux of participation find themselves in a vortex of lively affects.

In sum, epidemic media are material performances that institute a new multispecies relation by imposing temporal cuts, spatial boundaries, and fractal configurations. Struggling with what remains unintelligible—pushing for more data, more precision, more accuracy—epidemic media are reflexive about their conjectural, provisional nature. Openly speculative, they court the apprehensible. Yet curiosity and wonder are tempered by urgencies: the need to produce biotechnological or biomedical solutions to stem host losses. This is epidemic media's instrumental yoke, one that is often expressed as a warlike stance toward perilous microbes. As we shall see in the next chapter, such a stance has yielded deadly consequences. The point is that epidemic media have always directed how we live with pandemics by attempting to fix multispecies distributions. In this regard, their material construction of epistemic objects extracts and isolates biological targets from processes and relations, then compounds the problem by iteratively folding those targets into problem-solving exercises aimed at producing viable industrial solutions.[78] Pesticides and antibiotics—the DDT strategy, as Stengers names it—that have generated microbial drug resistances and cancerous conditions are historical evidence of why the material construction of biological targets matters.[79] In epidemic media, isolated microbes appear as exterminable targets. But if epidemic media also open to sensuous entanglements, they can possibly recast the myopic view that ends in a biotechnological fix (in vaccines and drugs). We could begin to know "our" multispecies entanglements and to emplace "our" precarious life in a precarious planet. The heuristic separation of "life" and "techne" in *The Virus Touch* illuminates the limitations of media-technological inscription: biological processes outpace machinic capture even as "we" race to modify a new multispecies relation. Put simply, even though we'd rather turn our backs on pathogenic germs, exterminating them when we can, *we have no option but to emerge with*

them. The radical uncertainty of new pathogenic emergences just reinforces the issue. Under epidemic conditions, "life" is, once again, "untamed ontology," as Michel Foucault named it, and we become deeply aware of its *qualitative difference* from technological processes.[80] Epidemic histories tell us it is not always possible to calculate all outcomes to life's unfoldings. If all outcomes were indeed calculable, after the first SARS outbreak, why was COVID-19 a black swan event?

These contours of epidemic media set in motion the "biological" (the *episteme*) and the "lively" (the *ontos*) in *The Virus Touch*. Biology codes process-relational ontologies, but unprecedented qualitative shifts call for another notation. When epidemics emerge, a qualitative shift in multispecies relationalities is already underway, for the most part without our knowledge. The virus has jumped, infection has spread, and then the shift becomes sensible as a crisis at the phase of extensive community transmission. Catching this qualitative shift in evolving multispecies relations at a particular moment of history, epidemic media enact reciprocal capture: they render spiraling viral replication (viremia) and deteriorating host conditions (disease) intelligible. Ongoing multispecies relationalities materialize as "life" in biotechnical forms. In the intra-action of objects, practices, and apparatuses, "life" becomes *bios*, to be governed—but not entirely. The remainder is the lively materialities pulling the knowing subject into an affective vortex. Liveliness indexes material conditions of the media-technological situation, including affective and sensory perceptions that index that other space of multispecies entanglements; liveliness as noise obviates objective mastery, spurring curiosity. As new multispecies relations materialize in biotechnical forms, their untamed ontologies challenge and excite the experimental ethos. Throwing the senses toward the nonhuman world, epidemic media entangle us in multispecies relations when they feel most difficult.

Theorizing Epidemic Media

The Virus Touch theorizes epidemic media as processes of mediation that render multispecies relationalities sensible so as to manage them during, or, even better, before the next epidemic. These media materialize in scientific practices, artistic compositions, and activist inscriptions. In epistemic cuts, epidemic media render one novel relation—the one responsible for the qualitative shift—intelligible, readying it for targeted interventions. They materialize biotechnical forms as image, number, milieu, and movement. Yet, as medial actions tangle with lively materialities, the processes of mediation—that is, epidemic media

as making/acting/doing—activate a distributed sense of interlocking living systems. This is especially salient for perceiving multispecies entanglements. There is no getting past dwelling with viruses, with sharing accommodations on the blue planet. This open promise of epidemic media is inherent in the research concepts that animate the chapters on specific biotechnical forms: the "-morphic image," the "sensible medium," and the "multispecies kinesthetic." Predictably, the keen sense of lively materialities motivates engagements with media-technologies. Epidemic media are critical practice: they recognize the inherent difficulties of rendering human, animal, and machinic signals intelligible. They are constantly evolving, pushing media-technological boundaries, recomposing the times, spaces, and agencies of the more-than-human Anthropocene. Materializing not just new multispecies relations but also media environments, epidemic media operate as theoretical tools for contemplating what media can do in an epidemic. As they disperse the mastery of the knowing subject, partially dislodging warlike stances toward difficult kin, epidemic media train the analytic gaze on mediation as prehension, as a grasping, meddling, interfering in life's process-relational ontologies. This orientation alerts us to media's world-making capacities: Will epidemic media deliver specific technological fixes? Will they attune us to multispecies relationalities? Smart media, they neither foreclose possibilities nor pretend we can wish away the virus touch. They enable us to recognize epidemics already here, and epidemics to come—or, should we say, epidemics that *will* come—as productive sites for a renewed multispecies politics as survival strategy. The long game marks the intentional politics of this book: I elaborate a "multispecies politics of health" in the following pages, knowing that both "multispecies" and "health" continue to be thorny problems in environmental studies.

Unfolding this argument, the book commences with a historical chapter on the epidemic episteme, followed by three chapters on research concepts familiar to media studies: image, medium, and movement. Even as these concepts arise in specific media histories, it is in their articulation together that one can understand how life comes to be reconstituted in the epidemic episteme. A comprehensive epidemic media theory is in order, I argue, one that constellates a range of media practices that inscribe, store, and transmit a new multispecies relation. The brief conclusion draws out the theoretical and disciplinary implications of analyzing epidemic media.

Chapter 1 lays historical ground for the current epidemic episteme. That episteme harkens back to the late twentieth-century viral emergences that recast global public health crises as ecological catastrophes. With this turn, four decades of research on HIV-human multispecies relations came to shape

epidemic media as we know them. This is why the living archives of the previous global pandemic are critical for understanding our new encounter with SARS-CoV-2. The EID outbreaks since the early 1980s set the new agenda in two ways. First, a reckoning with precarious life means a recalibrated multispecies politics; and, second, this politics implies that a rethinking of health across differential epidemic experiences is in the cards, once again. Arguably, all modern pandemics have been crucibles for reengaging health for individuals, populations, and species; yet, the massive overhaul of health during the HIV/AIDS pandemic was a watershed, as health expanded to the care of life, to health as global commons, and to structural one health. This chapter articulates a multispecies politics of health as the condition of possibility for unfolding medial actions that attempt to inscribe, store, and transmit life.

Chapter 2 presents classic instances of epidemic media instrumentally oriented toward machinic capture that nevertheless emplace scientists and artists in living systems. Following media practices of molecular visualization that make "scientific images," the chapter focuses on collaborations between artists and scientists, biotech and creative industries, in three locations: at the Center for Computational Structural Biology at the Scripps Research, San Diego; in the Chicago-based (art)n collective; and in the media practices of cell biologist and scientific animator Janet Iwasa (based at the University of Utah's Animation Lab). The *-morphic image* as critical practice animates the chapter's study of epidemic media. -Morphic images in the epidemic episteme have specific goals: to ensure health is conceived as altered molecular relationalities and delivered as biotechnological solutions. As such, these are malleable, speculative images that integrate multiple data streams to keep abreast of lively fluctuations (expressed as viral mutations). In this functionality, the -morphic image is one stop in turning data into flesh. The emphasis on visible form embeds these scientific images in cultural histories that transcode them, despite the imperative toward greater mathematical realism—toward more precision, more accuracy, more faithfulness to data. That imperative inevitably leads to preoccupations with tools and techniques, image production and image experience; circling mediation as prehension, the -morph returns as technique. As with other epidemic media, as the machinic drive encounters lively materialities, the -morphic image appears incomplete, imperfect (as suggested by the suffix form). Exploratory media-technological experiments engaging more than the visual sense afford multisensory experiences and attune viewers/users to lively temporalities.

Chapter 3 turns to mediatic processes that clinically translate a vital medium into frozen blood samples (for refrigeration), blood data (for the databases), and blood pictures (for clinical points of care) and thereby organize time-spaces

of infection as serial snapshots. These are the blood files that denature and fabricate, quantify and transcribe blood. Analyzing transmuted vital media as infection's milieu, I track the circulation of blood files in the global biomedical infrastructures of "managed HIV." I start with blood-specimen processing at the University of Washington's Clinical Retrovirus Laboratory, then examine blood samples stored in the Centers for AIDS Research (CFAR) biorepositories and blood data stored in the CFAR Network of Integrated Clinical Systems (CNICS) databases, and end up at three points of care: Seattle's Madison HIV Clinic, Mumbai's Sanjeevani clinic, and the "original" HIV adherence club in Khayelitsha, Cape Town. The chapter explores epistemic cuts that compose blood as specific "interior milieus" to enable the clinical control of the transitive medium. And yet the lively materiality of blood disperses this milieu beyond individuals and demographic aggregates. As interior milieus unfurl into disease milieus and further into global hot spots, blood emerges as an extensive infection environment. At every site, blood in biotechnical forms tangles with the knowing subject, heightening the sense of multispecies entanglements.

Chapter 4 examines processes of mediation that differentiate particular animal hosts from their milieu (swaying grasses, leafy vibrations, diverse animal forms), aesthetically recompose them as organism-environment assemblages, and then locate them in spatial forms of planetary habitation (maps and atlases). These mediatic processes ultimately produce the "multispecies kinesthetic" as the basis for controlling zoonotic spillovers. As a figure immanent to the epidemic episteme, the animal host is center stage, assuming biotechnical form as a lively medium for the transport of microbes. Entering the "living laboratories" of tropical forests, I follow wildlife biologist and epidemiologist Anne Laudisoit's "walk with the chimpanzees" in the Ituri highlands of the Democratic Republic of the Congo (DRC) and Uganda, and zoologist Roland Kays's experiments at the Smithsonian Tropical Research Institute's Biological Station on Barro Colorado Island. Their multispecies kinesthetic employs geospatial technologies (radio collars, camera traps, and thermal sensors) and techniques (walking the transect to object segmentation) to detect wild primates (the reservoirs for HIV) in threatened habitats. I close with signal and noise from tracking media that materialize in two different geospatial forms: EcoHealth Alliance's zoonotic surveillance maps and the open-ended *Feral Atlas* project. Knowing multispecies distributions in animal-host media appears provisional, conjectural, as lively traces surface and disappear, as noisy forests create disturbances. In such dissolving differentiations, the sensuousness of organism-environment assemblages haunts epidemic media, once more; in the distribution of the senses, multispecies entanglements become apprehensible.

In the brief conclusion, I turn to the implications of studying epidemic media for media studies more generally, remaining aware of the difficulty of "theory in an epidemic." Turning to specific interventions and critical method, I argue that epidemic media are crucial for installing a new memory of epidemics as biological, social, and ecological catastrophes. Such a new memory, and the critical discordance that accompanies it, is crucial for living otherwise with perpetual pandemics.

The orientation toward mediation eschews understanding biotechnical forms as exclusively shaped by the biological sciences. There is no doubt that mediatic processes that elucidate blood data or viral entry are crucial interventions that alter and modify "biological substances" as they materialize in scientific settings. And yet the media histories of epidemic media provide a more complex view. They show how image making, record keeping, and motion sensing are fundamentally collaborative endeavors that constellate media makers and scientists, formal and informal expertise: biologists hook up with moviemakers to simulate possible outcomes; clinical medicine labs rely on grassroots communities to ensure drug adherence; eco-epidemiologists solicit information and data inputs from local experts and citizen-scientists. We come to experience how modern practitioners accommodate worlds within their worlds, a transformative thinking-feeling that moves beyond the imposition of universal reason. Epidemic media, in these stories, are intensely collaborative, articulating skills and talents, institutions and industries, agents and actors. The focus on collaborations defines the mixed research methods of this book: historical-archival digging, semistructured interviews at multiple sites, short-term participant observation, and critical-interpretive media analysis. I hope to bring into the same critical space epidemic media made in institutional settings (accruing value as expertise) and those made in informal ones. The scientific practices of molecular visualization, clinical translation, and animal movement tracking all evidence robust negotiations of knowledge practice across epistemic settings. Their pursuit opens readers of this book to the living archives of epidemic media that span everything from marvelous virus crystals in sweltering caves to homespun art-science long forgotten in a garage.

To think of multispecies relations during a global pandemic is to approach the problem from an extreme situation, in the thick temporality of epidemics. The environmental thrust of *The Virus Touch* challenges the myopic call for expensive technological solutions. If ecology has installed a new kind of memory for revaluating "unintentional processes" of the past that led to harm ("the DDT strategy") we should know by now that anthropocentric survival strategies are misguided. Recognizing the biological, social, and ecological dimensions of

novel multispecies distributions is but a first step toward this new memory. Under these circumstances, how do we approach aggressive parasites? The ones that threaten social paradigms of kinship? How shall we live with them? Will we persist in the failing war on germs? As carriers of biological-social-ecological memory, epidemic media emplace us in interlocking milieus. Sometimes that milieu is but six feet in distance; at others, it stretches to dark caves in Yunnan province. Along these stretches, intensely, we feel the virus touch.

Notes

INTRODUCTION

1 I am echoing Michael Balter's iteration in his coverage of the HMP, launched in 2008. Balter, "International Human Microbe Program." The HMP was *the* new "big science" initiative, generating the same degree of excitement within scientific communities as the international Human Genome Project did a decade ago. A collaboration between the National Institutes of Health in the United States and the European Commission, the HMP plans to sequence approximately nine hundred microbial genomes of bacteria, viruses, and fungi from samples collected from specific sites of the human body (the digestive tract, the mouth, the skin, the nose, and the vagina), first from healthy volunteers and, later, from humans with specific illnesses. The European Commission's Metagenomics of the Human Intestinal Tract Project (MetaHIT) specializes exclusively in the microbiome for the human gut; other partners include major science and health agencies in France, Japan, Canada, and several other countries. See Yong, "Microbiome Sequencing."

2 Sagan's "The Human Is More Than Human" (in *The Cosmic Apprentice*) calls for a defamiliarization of the human based on a symbiotic perspective on planetary evolution. I return to the basis of his claims—to symbiogenesis—in chapter 1. Here I invoke Sagan as a key figure who constellates scientific and cultural histories of multispecies emergence. Helmreich discusses Sagan's essay in writing about the implications of the HMP in "*Homo microbis*."

3 Dietert, *Human Superorganism*, 2.

4 Yong, *I Contain Multitudes*, 1857.

5 Carl Zimmer, "How Microbes Defend and Define Us," *New York Times*, July 13, 2010, https://www.nytimes.com/2010/07/13/science/13micro.html; and Helmreich and Paxson, "Perils and Promises of Microbial Abundance."

6 Sagan, *Cosmic Apprentice*.

7 Rheinberger, *Epistemology of the Concrete*.

8 Murphy, "Afterlife and Decolonial Chemical Relations."

9 A long-wave epidemic is one that emerges over the years with different modalities of impact. The first stage is usually when infected people are not visible to medical science; stage 4 commences when the number of cases threatens to overwhelm health resources. See Whiteside, *HIV/AIDS*.

10 Writing on the chemosphere, medical anthropologists such as Nicholas Shapiro and Alex Nading, among others, have tracked the epidemics—such as chemical poisoning and kidney diseases—that do not register as political emergencies primarily because they unfold as long-term harm among vulnerable (often racialized) communities with little recourse to mechanisms of political redress. See Shapiro and Kirksey, "Chemo-Ethnography"; and Nading, *Mosquito Trails*. On metabolic disorders, see, for instance, Nobert, Birkenfeld, and Schulze, "Global Pandemics Interconnected."

11 Povinelli, *Between Gaia and the Ground*.

12 Cheng, Juhasz, and Shahani, *AIDS and the Distribution of Crisis*.

13 See Online Etymology Dictionary, s.v. "emergence," accessed July 26, 2022, https://www.etymonline.com/word/emergence.

14 Clark and Hird track the politics of microbes encountering each other and humans encountering microbes. Clark's oeuvre represents a swathe of critical geography that grapples with the spatialization of entanglements, interconnectivities, and enfoldings in human and non-human agencies. See Clark and Hird, "Microontologies."

15 In her oft-cited notion of "reciprocal capture," Stengers elaborates the point as the "dual process of identity construction" that unfolds in species relations: "one values the other," giving rise to "immanent modes of existence." Stengers, *Cosmopolitics I,* 35.

16 In recent years, there has been a return to Alfred North Whitehead's critique of Newtonian physics as an account of the universe in discrete fragments. Whitehead, following the radical empiricism of Henri Bergson and William James, argues for the "togetherness of things," which nature exemplifies. This relatedness of nature is available to us in two modes of perception: pure perception (colors, sounds, smells) and a perception of causal relatedness (an intuitive knowledge) based on experience. In the midst of ecological catastrophe, Whitehead's insistence on our deepening awareness of processes and relations between the living and the nonliving makes sound sense for scholars of environmental media and of philosophies of science. See Stengers, *Thinking with Whitehead;* and the essays in Gaskill and Nocek, *Lure of Whitehead*.

17 Van Dooren, *World in a Shell*.

18 The Rockefeller Foundation–*Lancet* Commission on Planetary Health situates human health within human systems: "The threats that our species faces are not abstract physical risks," they argue, "such as disease, climate change, ocean acidification, or chemical pollution. The risks we face lie within ourselves and the societies we have created. When we consider climate change, the main metric of danger is greenhouse gas emissions. But that measure should also include the capacity of human systems to monitor the threat, understand its importance, and act on that

knowledge. Second, planetary health concerns the natural systems within which our species exists—for example, the health and diversity of the biosphere. Human beings live within a safe operating space of planetary existence. If the boundaries of that space are breached, the conditions for our survival will be diminished. Currently, natural systems are being degraded to an extent unprecedented in history, with known and as yet unknown and unquantified effects on human health." Horton and Lo, "Planetary Health," 1921.

19 Anna L. Tsing, Jennifer Deger, Alder Keleman Saxena, and Feifei Zhou curate the online *Feral Atlas* (https://feralatlas.org/), which includes contributions from over a hundred participants. I discuss the atlas at greater length in chapter 4.

20 See, for instance, Redvers et al., "Molecular Decolonization."

21 Chow, *Entanglements*, 12.

22 There is excellent scholarship on contagion fiction and nonfiction, movies and television shows, video games, and comic books; see Wald, *Contagious*. I discuss science journalism on EID outbreaks at greater length in chapter 1.

23 In *The Order of Things* (first published in 1966), Michel Foucault explains how all empirical observation materializes objects by placing them in a system of elements or a "grid" that differentiates them. Social power underwrites "grids of intelligibility" that encode what I describe as epistemic objects.

24 Wang et al., "Airborne Transmission of Respiratory Viruses."

25 A loaded term, *vital* carries with it universes of debate that echoed throughout the nineteenth and early twentieth centuries. Vitalism is a strain of thought that argues that the processes of life (organic life) are not explicable by physics or chemistry alone. Living organisms have a distinctive organization that cannot be compared to that of machines (as opposed to the mechanist argument of the human as differing only in degree of complexity from mechanical devices). Going back as far as the Stoics, vitalism (the old vitalism of the nineteenth century) saw itself in opposition to the "mechanist" theories of life; theorists struggled to explain how life emerged, its internal trigger, the essence revitalized by electricity. Unlike traditional vitalism, which located the inner principle of life in the soul, the modern vitalists were materialists concerned with the organization of matter and preoccupied with distinguishing biological transformations from physico-chemical ones. Writing the Gifford Lectures delivered at the University of Aberdeen, 1906–8 (published as *The Science and Philosophy of the Organism*), the German biologist and philosopher Hans Driesch (1867–1941) argued for that which escaped prediction and control. Driesch christened this "something" *entelechy*, while Henri Bergson named it *élan vital* in his early twentieth-century classic, *Creative Evolution* (1907). Both drew on Immanuel Kant's notion of *Bildungstrieb*, which is the self-organizing power of organisms that gives matter its coherence. For Kant, this agentic power, as Jane Bennett explains in *Vibrant Matter*, is an invisible presence that is not explicable through physico-chemical reactions. How the egg grows and changes, its *morphogenesis* or becoming manifold in space, is proof of this presence. But while Kant finally situates this agentic force in a divine power, Driesch and Bergson variously theorize it as a driving biological force active in nature. They largely eschew the mechanist

model of life, which tuned in to patterns of change and to variations in organismic complexity but saw the "aim" of the organism as predictable: it sought to replicate and readjust to a pattern it recognized as its own (autopoiesis). The neovitalists argued that the "pattern" made by small incessant changes (variations) could not be foreseen or predicted; living organisms "see" the pattern in retrospect. Human "intelligence" grasps and organizes this changefulness as duration in the organism's life: a now and then, a past, present, and future; but much of the flux remains unavailable to consciousness.

26 Joshua Neves, "Technology + Pharmacology: Notes on Current Research," *Heliotrope,* September 15, 2021, https://www.heliotropejournal.net/helio/technology-pharmacology.

27 See "Gas Clouds Demonstrate Their Ability to Travel Great Distances," a video embedded in Lydia Bourouiba's "Turbulent Gas Clouds and Respiratory Pathogen Emissions." This close-up view of a sneeze filmed at two thousand frames per second (duration 0.25 second) shows it's a hot, moist, turbulent gas cloud containing air and mucosalivary droplets that travel as far as twenty-six feet (seven to eight meters). See also, Anfinrud et al., "Visualizing Speech-Generated Oral Fluid."

28 Pato Hebert, "Trying to Catch Your Breath," 2008.

29 Stengers, "Challenge of Ontological Politics," 91.

30 Elaborating Félix Guattari's *The Three Ecologies*, Ivakhiv provides an architecture for thinking the threefold nature of ecology. First, there is ecology as the material relation between things (appearing as objects); second, there is ecology as the experience of processes (the subjective or social relation); and third, there is ecology as mediation (the basic relational act). Making possible the first two relations, the third, mediation, is the focus of environmental media studies. See Adrian Ivakhiv, "Why *Three* Ecologies?," *Immanence: Ecoculture, Geophilosophy, Mediapolitics* (blog), January 15, 2021, https://blog.uvm.edu/aivakhiv/2021/01/15/why-three-ecologies/; see elaborations in Ivakhiv, *Shadowing the Anthropocene.*

31 See Landecker, "Metabolic History of Manufacturing Waste"; and Neubauer and Landecker, "Planetary Health Perspective."

32 Landecker, "Metabolic History of Manufacturing Waste," 531–32.

33 The "furin cleavage," for instance, is under investigation for evaluating the infectiousness of the delta variant; furin is a protease made by the human body. See Xia et al., "Role of Furin Cleavage Site."

34 See the elaboration of speculation as a critical-creative practice that confronts uncertainty in Uncertain Commons, *Speculate This!*

35 Chow, *Entanglements*, 12.

36 Chow, *Entanglements*, 12.

37 Abram, *Spell of the Sensuous*, 57–58.

38 Peters, *Marvelous Clouds*.

39 Furuhata *Climatic Media*; Starosielski, *Undersea Network*; Mukherjee, *Radiant Infrastructures*; Helmreich, *Alien Ocean*; and Jue, *Wild Blue Media.*

40 By now there are several methods for quantifying the viral shedding in the stool of COVID-19 patients as fecal data that can yield localized epidemiological estimates.

See, for example, Natarajan, "Standardized Preservation, Extraction, and Quantification Techniques."

41 Helmreich, "*Homo microbis*," 54.

42 Helmreich, "*Homo microbis*," 55.

43 Some of the most famous cases of art practitioners performatively probing the limits of "making life" are Eduardo Kac's GFP Bunny, which generated controversy, and the Critical Art Ensemble's *E. coli* culture, which resulted in a raid on cofounder Steve Kurtz's home. See Eduardo Kac, "Rabbit Remix," accessed July 26, 2022, https://www.ekac.org/gfpbunny.html; and Critical Art Ensemble, *Digital Resistance*. Berrigan's experiments, featured in "Life Cycle of a Common Weed," are of significance to my work because of their emphasis on living with HIV. On theorizing multispecies distributions, see Helmreich and Paxson, "Perils and Promises"; Celia Lowe, "Infection"; and Nigel Clark and Myra Hird, "Microontologies."

44 See "Introduction to Feral Atlas," accessed July 26, 2022, https://feralatlas.supdigital.org/?cd=true&rr=true&cdex=true&text=introduction-to-feral-atlas&ttype=essay.

45 Latour and Woolgar, *Laboratory Life;* Rheinberger, *Epistemology of the Concrete*; and Knorr Cetina, *Epistemic Cultures.*

46 Latour and Woolgar, *Laboratory Life*, 64.

47 Latour and Woolgar, *Laboratory Life*, 106.

48 Stengers's contribution to the collaborative project of making worlds references her long engagement with the discordant landscapes of science. In "The Challenge of Ontological Politics," she addresses making partial connections (as proposed by Marilyn Stathern) with reference to a few successful environmental coalitions: the worldwide "GMO event," as she calls it, and a negotiation between multiple stakeholders on dunes in the Cape Flats, South Africa.

49 Latour, "Circulating Reference."

50 Latour and Woolgar, *Laboratory Life*, 62; see also, Karen Barad, *Meeting the Universe Halfway*. Despite the common usage of *craftwork* as a moniker for do-it-yourself practices, I deploy the phrase to describe medial actions in laboratories so as to highlight the provisional "making do" of epidemic media under pandemic/epidemic situations.

51 Following the morphing thyrotropin releasing factor hormone or TRF(H), Latour and Woolgar in *Laboratory Life* note the set of positions within which an object takes shape; it acquires meaning and significance depending on a particular network of individuals. See also Latour, "On Technical Mediation."

52 As de la Cadena and Blaser describe it in their scholarly elaboration of the Zapatista invitation to reworlding. See de la Cadena and Blaser, "Introduction."

53 Stengers, "Challenge of Ontological Politics."

54 Central to the biotech industry is the growth of the information industry. Tracing the historical conjunctions of molecular biology and the information sciences from the 1970s, Thacker argues for the turning of flesh (biological DNA) into information (digital file) and then again into flesh (e.g., new proteins in proteomics) as constitutive of processes of optimization. His books—*Biomedia* and *The Global*

Genome—take as their inspiration the genomic revolution that led to the mapping of the human genome in 1990.

55 Sarah Franklin's *Dolly Mixtures*, a cultural history of the first cloned animal in the United Kingdom, remains another staple in assessing the social impacts of the biotechnological enterprise. The Roslin Institute in Scotland successfully cloned "Dolly" in 1996, attempting to create "better" genetically modified livestock; the search was on to isolate and develop genetic substrates through digital modulations.

56 "Making life" involved writing code, as in the stellar example of the J. Craig Venter Institute's development of the first entirely synthetic cell in 2010. A digital code of an organism's entire genetic code was rendered into chemical DNA (made by Blue Heron Bio), stitched into longer fragments grown in yeast culture, and then transplanted into bacteria (*Mycoplasma capricolum*). The new synthetically programmed (and watermarked) DNA replaced the former code (*Mycoplasma mycoides*), giving birth to a new synthetic cell. Such innovations in potential autografts and allografts gave new impetus to organ-transplant and stem cell research. Aside from the gene, cells have further emerged as ground zero in the technological control of life. As they slice and dice, design and build life itself, biotechnologies are at the front and center of both social debates and legal controversies. See, for example, Burgess, Thurtle, and Mitchell, *Biofutures*.

57 Kember and Zylinska draw on the Bergsonian concept of vital fluctuations as tiny variations in life as unfolding activity. The notion is typically attributed to French philosopher Henri Bergson, especially in *Creative Evolution* (1907), a work considered a seismic shift in the world of letters. Where mechanistic notions intimated that the organism will always try to retain its original structure/pattern, and therefore there is no change per se, Bergson emphasizes living/surviving as creative progression: each state is different from the previous one, but the difference means the previous state also exists or continues into it.

58 DeLanda, *Philosophy and Simulation*; and Myers, *Rendering Life Molecular.*

59 Gabrys, *Program Earth.*

60 Myers's ethnography of protein modelers moving with the molecules that they excite for study describes the force of that affect. Myers, *Rendering Life Molecular*. Excited by material presences that are sensible, protein modelers perform embodied encounters even as institutional constraints determine what is ultimately composed.

61 Parikka, *Geology of Media*.

62 Sampson and Parikka, "Operational Loops of a Pandemic."

63 Kirsten Ostherr, interview with Pujita Guha, Surojit Kayal, and Maile Aihua Young, *The Digital Pandemic Interviews* (podcast), parts I and II, November 14, 2020, https://podcasts.apple.com/us/podcast/the-digital-pandemic-interviews/id1531208911.

64 See Myers, *Rendering Life Molecular*, 75.

65 The study of living matter is far older in the ancient, medieval, and early modern sciences: one could venture as much into Aristotelian theories of spontaneous generation as one could into Islamic golden age physiology. But biology would emerge

as a modern discipline post-Enlightenment: for example, the botanist, physician, and zoologist Carolus Linnaeus refers to the Latin *biologi* in his *Bibliotheca Botanica* ([1736] 1968), a book that proposed a massive classification of plant genera and species in the known world. A century later, by 1838, biologists had established the cell as the basic unit of life and theorized principles governing life from this perspective. Over the course of the nineteenth century, biology evolved into different branches, from physiology to microbiology; by the early twentieth century, not only was biology gradually differentiated from physics, but the life sciences also underwent internal differentiations (physiology, genetics, zoology, botany, and so forth).

66 Stengers, "Challenge of Ontological Politics."

67 The partition of the senses as central to aesthetics refers us to Jacques Rancière's much-discussed *The Politics of Aesthetics* (2004), in which Rancière elaborates the governance of the human sensorium in artworks that meet the mandates of propriety.

68 The grid is elaborated in Foucault's *The Order of Things*; see note 23.

69 Uexküll, "Stroll through the Worlds of Animals and Men."

70 Abram, *Spell of the Sensuous,* 44.

71 Abram, *Spell of the Sensuous*, 59.

72 Siegel, *Forensic Media*. In the chapter "Black Boxes," Siegel develops a theory of noise with reference to the "black box" on flights, whose recorded signals are forensically deciphered as an account of "what really happened." Following Michel Serres's notions of the parasite, Siegel makes a case for what the noise accomplishes, including situating listeners in the affective chaos of death.

73 In one of the best articulations of the turn, the editors of *New Materialisms* argue for "thinking anew the structure of matter has far-reaching normative and existential implications." Coole and Frost, "Introducing the New Materialisms," 15. For my purposes, their emphasis on the new promises and threats of the new models of living matter arriving from molecular biology and its cognates in biomedicine and biotechnology is particularly relevant.

74 Myers, *Rendering Life Molecular*.

75 Barad, "Invertebrate Visions," 227.

76 See Thurtle, *Biology in the Grid,* on making epistemic objects in the grid.

77 Siegel, *Forensic Media*, 136; and Larkin, *Signal and Noise*, 239.

78 I owe the point to Hannah Landecker's discussion of her paper, "Coming Home to Roost," presented at a workshop ("Altered Lives") organized by Vincanne Adams, Lochlann Jain, and Kelly Knight, February 2022.

79 Stengers, "Ontological Politics."

80 Foucault, *Order of Things*, 303.

CHAPTER ONE. THE EPIDEMIC EPISTEME

1 Exactly what proportion of the population died of smallpox is the locus of debate among historians: some argue for one-third to one-fifth, while others believe the it was as high as half in some provinces and only a little less in others. Whichever