1. Green Discs

"It doesn't sound very much like an insect, does it," asked the author of a 1928 article in *Nature*, "this great, soaring tone of [opera singer Enrico] Caruso's matchless tenor?" Aware that many readers were probably scratching their heads at this odd question, the author quickly revealed his motivation for asking it. Caruso's phonograph records were, in fact, the work of an "unassuming, short-lived, tiny, reddish-colored" insect and, not too long before, had been "gum-like lumps on the twigs of a far-off forest." The *Nature* author marveled at the strange agencies of modern invention and industry that had allowed this "humble child of Nature, hidden away on the other side of the world," to catch and hold the sounds that human listeners found delightful.[1] That humble child of Nature was the Indian lac insect, and the "gum-like lumps" were composed of a material secreted by the lac insect called shellac, a nontoxic bioplastic that was the key ingredient in most of the phonograph discs manufactured before the mid-1940s.

The phonograph industry's reliance on the lac insect may appear at first to be a trivial subject best passed over on the way to more serious topics such as the human scientists and inventors who developed sound-recording technologies, the record industry's corporate organization and marketing strategies, or the aesthetics of recorded sound. If our goal is an eco-centric criticism that engages with the materiality of the media, however, then the relationship between Caruso's matchless tenor and the labor of an unassuming reddish insect becomes a means to explore the strange agencies of the nonhuman world in modern media.[2] The lac insect played an essential role in the technological assemblage of recorded sound, and over the course of this chapter, the "up, down, and sideways" mode of eco-critical analysis will reveal the eco-sonic dimension of the early phonograph industry's infrastructure.

My study of the material infrastructure of phonography heeds Jonathan Sterne's recent call for media scholars to shift their attention to "the stuff beneath, beyond, and behind the boxes our media come in."[3] I am interested in the ways in which the early record industry circulated both material and sonic goods through infrastructural systems and the ways in which those human-made systems depended on natural systems to provide raw materials like shellac.[4] When an ecological dimension is added to the study of media infrastructure, the result is what Robert B. Gordon calls "industrial ecology," the study of the ways in which a modern industry consumes natural resources, releases wastes, and attends to the afterlife of its products. The guiding principle of industrial ecology is sustainability, which Gordon defines as "the concept that each generation should leave to the next undiminished opportunities for fulfillment of material needs."[5] I am guided by a similar goal and utilize green media archaeology to explore the history of media technology of the past as a resource for alternative designs of the future.[6]

With the goal of sustainability guiding my research, I want to tell a new story about the American record industry between the 1890s and the 1940s, a story in which lac insects and Indian workers are just as important as Western inventors, industrialists, and recording stars and in which ecological models are just as relevant as technological ones. Historians have tended to subdivide the first half century of the phonograph business in two ways. First, a historical demarcation is made based on the various disc formats that were on the market: consumers bought shellac discs that spun at 78 rotations per minute (rpm), and then they bought long-playing vinyl records that spun at either 33⅓ or 45 rpm. A second historical division is based on the type of studio technology used in the recording and playback of sound: there was an "acoustic" era of spring-wound motors and recording horns, and then there was an "electric" era of electric motors and electric amplification through the use of microphones and loudspeakers. Given these common historical divisions, we might visualize two fields, the first representing the period of the 78 rpm shellac disc and the second the period of acoustic recording and playback. Aligned as a Venn diagram, the overlapping area in the center is the domain that I call the era of "Green Discs." The discs of this era were green because they were produced through the labor of both human and nonhuman actors, required little electricity and so left a minimal carbon footprint, and were made from a reusable, nontoxic, biodegradable bioplastic taken from a potentially sustainable source.

My understanding of the phonograph industry as a technological network has been shaped by Bruno Latour's notion of an actor network. One of

Latour's key insights is that agency in a network extends beyond human actors to include nonhuman, nonindividual entities, which he calls "actants."[7] Latour is one of several influential scholars who have conceived of technology as an assemblage of articulations (or "dynamic interminglings") among such actants.[8] Jennifer Daryl Slack and J. Macgregor Wise write that a technological assemblage draws together a "territory" that includes "the bodies of machines and structures" as well as a range of "other kinds of bodies: human bodies, governmental bodies, economic bodies, geographical bodies, bodies of knowledge and so on."[9] To understand the territory drawn together by the Green Disc network, we must take vegetable and insect bodies into account as well. The fact that Latour's actor-network theory has sometimes been abbreviated as "ANT" serves as a subtle prompt to consider the bugs in the sound system.[10] Media theorist Jussi Parikka has embarked on a related project, fusing entomology and cultural theory in the pursuit of a "joint history of media and nature" that encompasses the ways in which nonhuman forces express themselves as part of the "media assemblage of modernity."[11] My examination of the natural history of lac insects and the plants cultivated by record enthusiasts for their needles aims for a similar joint history of media and nature.

Nonhuman actors play an important role in my analysis of the phonographic assemblage, but I do not want to undervalue the human actors in the Green Disc network. Latour writes that the various local sites of a network should not be understood as a hierarchy, but, instead, all the various links and connections in the system should be given equal weight: the landscape of the network should be kept "flat."[12] To flatten the topography of the phonographic network, I give equal time to performers in Western acoustic-era phonograph studios and the workers in India's shellac industry. Both made the network possible, and both embodied traditional knowledge that has new significance in the era of the eco-crisis.

In his discussion of eco-centric education, Patrick Curry describes the importance of learning from "surviving local indigenous traditions" because they embody models of "non-modern sustainability." Curry uses the phrase "traditional ecological knowledge," or TEK, to refer to a "fluid but tightly-knit mixture of local or bioregional scientifically ecological wisdom, spiritual values," and "socio-political ethics." TEK developed out of hundreds, and even thousands, of years of "direct contact with the natural world," he argues, and so where such knowledge survives, "it is extremely important to protect and encourage it."[13] There is clearly a danger in romanticizing cultural traditions deemed "non-modern." Anna Lowenhaupt Tsing warns that categories like "indigenous people and wild nature" exist only in opposition to modernist programs, and so "any generalizations we make about them are likely to be wrong." Nonetheless, she concludes that we cannot give up such "fantastical categories," in part because the "alternative fantasy" of a "falsely uniform modernism" is much worse. Moreover, the "regularizing modern imagination has had *such* a destructive effect on species diversity that almost any other human lifeway is likely to be better at maintaining it."[14]

When Curry writes about traditional knowledge, he is thinking primarily of land use, but the concept can be adapted to media culture. Early media practices were hybrids of modern and traditional knowledge, making them useful sources of alternative models as we contemplate a "postcarbon world" marked by diminishing fossil fuels, economic insecurity, and climate disruption. Indian lac workers, performers in early recording studios, and home consumers who operated spring-driven phonographs all embodied what we might call "traditional technological knowledge," or TTK, and eco-minded media scholars should strive to understand these practices as they existed in the past and encourage them where they still exist in the present.

Nadia Bozak is one such eco-minded media scholar, and I have drawn inspiration from her analysis of early cinema's "pre-industrial use of sunlight." Bozak refers to early film producers as exemplars of a "proto-solar cinema" because their glass-roofed studios did not rely on electrical lighting. Films made in this manner are, for Bozak, "textbooks for an 'unplugged' cinema, filmmaking off the grid."[15] Early phonography was similarly "off the grid," with recording studios powered by weight and pulley systems, home record players driven by hand-wound springs, and recorded vocal performances reliant on the "wind power" of the human breath. All that said, I do not want to exaggerate the early phonograph industry's eco-credentials. Jonathan Sterne reminds us that "if you can call something a medium, then it has a physical infrastructure," and any mass media infrastructure will leave behind an ecological footprint.[16] Readers will be quick to notice that I am not discussing *every* articulation in the Green Disc assemblage: not the coal-burning ships that carried shellac from India to the United States, for example, or the electricity used in pressing discs or the gas-burning vehicles used to transport shellac discs from manufacturers to retail outlets. Nonetheless, I believe that I cover enough of the Green Disc network's territory to demonstrate that it is worth remembering and might even serve as a blueprint for an alternative model for recorded sound in an era of MP3 files, iPods, and digital clouds.

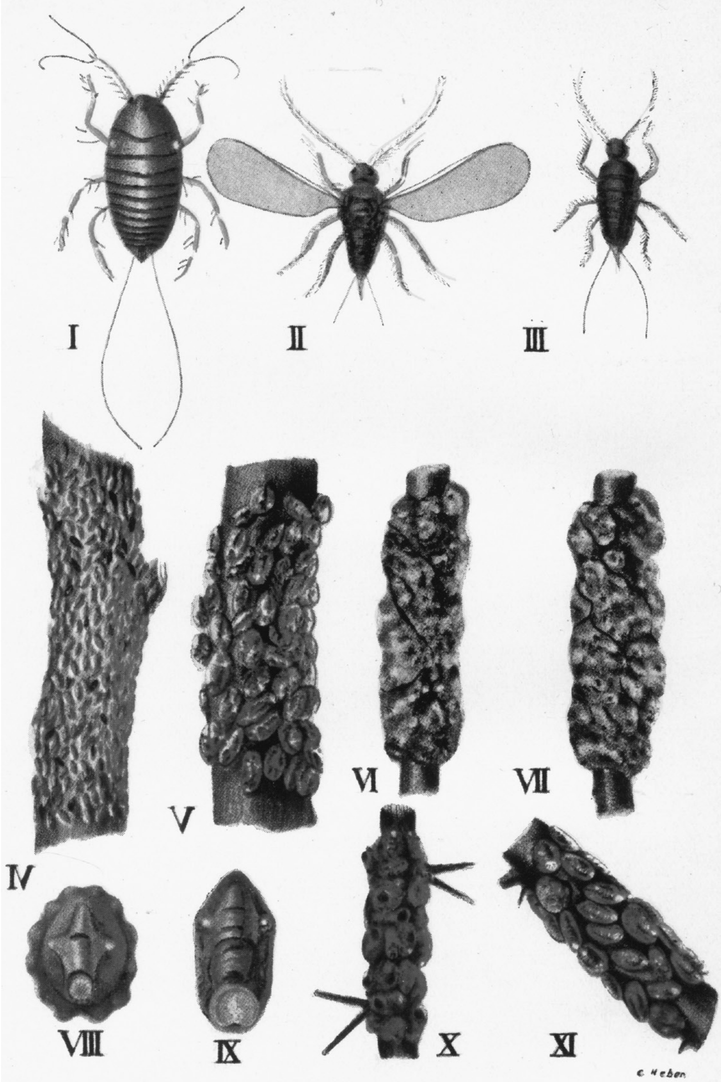
By exploring the materiality of early phonography, I hope to counter a rhetoric of virtuality and dematerialization that has long been encouraged by the technology industries and that often functions to conceal the ecological costs of the media.[17] My ultimate goal in mapping the Green Disc network, then, is not to chart a nostalgic return to the past but to sketch the possible future of a more convivial phonography—convivial in Ivan Illich's sense of recognizing "natural scales and limits." Gordon writes that industrial ecology must begin with a consideration of natural resources, and so our first stop in mapping the Green Disc network takes us, not to the grooves of the record, but to the groves of the Indian trees that served as hosts to that "humble child of Nature," the lac insect.[18]

A HUNDRED THOUSAND LAC INSECTS CAN'T BE WRONG

Laccifer lacca is a scale insect of the Coccidae family that lives in the forests of India, Thailand, and Burma. The life history of the lac insect begins when two hundred to five hundred larvae emerge from their mother and swarm over the branches of a host tree, usually a kusum, palas, ber, or peepal tree.[19] The larvae typically appear in the early morning hours of a sunny day, and, according to a 1921 report, the "great swarm of tiny slow-moving light crimson or mauve specks" on the trees make for a "remarkable sight."[20] The mass emergence of the larvae is the source of the insect's name: the term lac derives from the Sanskrit numeral *lakh,* which means one hundred thousand and refers to the large numbers of swarming larvae. The lac's name is thus a vivid example of a prevalent tendency to see insects as an undifferentiated swarm that is radically nonhuman.[21]

After several days of wandering about, the young insects select a suitable location on one of the tender shoots of the tree and settle close together. Each insect pierces the bark of the tree with a long proboscis and proceeds to suck the plant's sap. The sap provides nutrition to the growing insect, but some of it is exuded from glands on the lac's body as a golden secretion that forms a coating around the creature and protects it from predators and weather. The insects spend most of their lives under this "amber shield," and because they are crowded closely together, the hardened resin forms a continuous layer that covers the branch.[22] According to one observer, the host tree appears to be coated with "a multitude of little flat gummy domes," each one a "living tomb for a member of the lac tribe."[23]

The insects stay alive by maintaining three openings in their "gummy domes": two for breathing and one for the removal of excrement. These pores are kept open by waxy white filaments secreted by the insects, which give the encrustations on the branch a "snowy or frosted" appearance. After eight to fourteen weeks, the lac attain maturity, and the males, who constitute only



THE LAC INSECT

Reproduced (in slightly reduced facsimile), by the courtesy of the Indian Lac Cess Committee, from Glover's *A Practical Manual of Lac Cultivation*

I—Lac Larva (magnified 40 times). II—Winged Male Insect (magnified 16 times). III—Apterous Male Insect (magnified 16 times). IV—Newly Settled Lac Larvæ (magnified 3½ times). V—Immature Lac, Showing Developing Male and Female Cells (magnified 4 times). VI—Mature Lac 8–20 Days Prior to Swarming (magnified twice). VII—Mature Lac 3–4 Days Prior to Swarming (magnified twice). VIII—Female Lac Cell at about the Time of Male Emergence (magnified 20 times). IX—Male Cell Just Prior to Male Emergence (magnified 20 times). X—Immature Cells on Twig, Showing Cells Damaged by Chalcid Parasites (magnified 4 times). XI—Male and Female Cells on a Ber Twig (magnified 4 times).

(C.59) *Frontispiece*

FIGURE 2. *Laccifer lacca,* a scale insect that lives in the forests of India, Thailand, and Burma. Frontispiece from Ernest J. Parry, *Shellac: Its Production, Manufacture, Chemistry, Analysis, Commerce and Uses* (London: Pitman and Sons, 1935).

20 to 40 percent of the population, back out of a trapdoor in their cubicle and proceed to fertilize the females through the pores in their resinous chambers. The males die soon thereafter, but the females continue to grow, secreting large quantities of resin until their eggs hatch, at which time they cast off their eyes and legs and die. The process begins again as the larvae swarm out to find a new spot on the host tree. Lac insects typically go through two generations in this fashion every year.[24]

The resinous encrustations left behind by the lac life cycle become the raw material for the shellac industry, making lac insects "actants" in a biotechnological network. Bruno Latour uses the term "translation" to refer to the process by which an actant alters its environment to bring it into alignment with a network.[25] Lac insects translate tree sap to resin and do so in a manner that is still not completely understood. A 1937 article in the popular press declared that the sap was transformed "by some mysterious chemical action within the body of the strange lac insects."[26] The lac's act of chemical translation was sometimes explained through an analogy to modern industry. A 1921 report explained that the lac insect "manufactures" the resin in its body from the "raw materials" it gets from the tree.[27] The author of a *Popular Mechanics* article called the lac "an insect in industry, a bug whose product has become a big business." "Mr. and Mrs. Lacca," the author continued, "retain the world monopoly on the shellac business."[28] Comments such as these are symptomatic of a long-standing tendency to anthropomorphize insect activity: we tend to see "busy bees" and "industrious ants." That tendency was strong during the nineteenth century, when insects were often described as builders, architects, and industrialists: social roles idealized by the Victorians.[29]

Where the Western observers compared the lac's act of translation to industrial manufacturing, I want to describe it using the language of ecology, in which energy is defined as "the ability to do work" or "the capacity to move or change matter." The prime source of energy on the earth is the sun. Plants like the Indian kusum or palas tree are "producers" that draw energy directly from the sun and nutrients from the soil and then convert those resources into sap. Animals such as the lac insect are "consumers" that digest compounds produced through plant-based photosynthesis and generate waste (like the lac's resin).[30] The lac insect's "manufacture" of resin is thus a stage in an energy cycle that is only two steps removed from the solar source. Latour writes that a network is "not a thing, but the recorded movement of a thing" and suggests that scholars attend to "*what moves through* a network and how this movement is recorded."[31] The network drawn into being by the labor of the lac insect records the movement of solar energy through various states of matter and, given a stable forest ecology, remains sustainable. The maintenance of that ecology was one of the principal duties of the human actants drawn into the shellac network.[32]

TRADITIONAL TECHNOLOGICAL KNOWLEDGE

The Indian shellac industry was concentrated in the northern states of Bihar and Jharkhand. During the early nineteenth century, the lac insect's resin was most valuable to humans as a source of red dye. European demand for dyes like cochineal had driven the early exploitation of lac, which was controlled by the British East India Company. The colonial dynamics of the early industry are difficult to miss. The first Western lac factory in Calcutta was established in 1855 by Martin Kenneth Angelo and Elliott Angelo, two grandsons of a soldier who served as bodyguard for the first governor-general of India. The Angelo brothers supplied red dye for the scarlet dress uniform of the British troops.[33] The market in lac dye went into rapid decline in the 1880s as the result of competition from synthetic alternatives, and it had practically disappeared by 1900.[34] At around the same time, the demand for the lac insect's resin began to rise.

The Angelo brothers held a monopoly on machine-made shellac, but the majority of manufacturing took the form of traditional, small-scale operations that had existed for centuries. In the early twentieth century, traditional shellac manufacturing provided income for somewhere between one and four million poor *adivasi,* or indigenous people, in northern India.[35] The industry was based on the ownership of lac-bearing trees, which were rented to cultivators, called *raiyats*.[36] An important function of the shellac laborers was to maintain the health of the trees: the successful cultivator of lac, a 1935 text explained, pruned and fertilized the trees to ensure the healthy flow of rising sap and the growth of tender young twigs. In addition to forest husbandry, shellac workers were breeders of "tiny livestock" and carefully observed the female lac insects for indications that they were due to give birth. Lac-encrusted branches (or "brood lac") were then transported to the branches of other trees. In this manner, the *raiyats* could monitor the extent of lac infestation on a given tree: an important task given that host trees had poor growth, few leaves, and often lacked flowers and fruit.[37]

Raiyats were thus required to be stewards of the forest eco-system to ensure a sustainable production of resin: a 1921 report states that one of the main aims of lac cultivation was to "maintain an equilibrium between the lac and the tree and not to over-infect or too frequently infect the same host-tree."[38] We might say that shellac production was an "ecological economy" that yielded both ecosystem goods (in the form of raw materials used in human industry) and ecosystem services (in the form of forests that regulated the climate, controlled atmospheric gases, provided habitat for a variety of species including the lac insect, and served as a space for human recreation and spiritual enrichment).[39]

Shellac workers collected the branches that had become coated with resin, known as "stick lac," and sold them to traveling peddlers, or *baiparis,* who then sold the stick lac to a broker *(arhatiya),* who in turn sold the merchandise to a manufacturer.[40] The majority of manufacturing before the 1930s was done in small village operations that utilized traditional tools to transform stick lac into a marketable commodity.[41] The first step was to scrape the resin from the sticks to produce what was called "seed lac." Seed lac was then taken to washers *(ghasandars)* who stood in a stone vessel and washed it with their feet. Washed seed lac was given to workers *(karigars),* who placed it in a long tubular bag and twisted it over a charcoal oven called a *bhatta.* A melted mass oozed out of the bag and onto a stone slab, and workers *(bhilwayas)* stretched the hot mass into thin four-foot-square sheets by holding it with their toes, hands, and sometimes teeth. An 1876 report claims that it was not uncommon to see workers "lift the hot sheet to their mouths and bite out any foreign substance, such as dirt or sand, that may appear in the semi-transparent yellow surface."[42] These large sheets were dried and cooled and then cut into shell-like shapes, hence the designation of the finished product as "shellac."

Western accounts of Indian shellac manufacturing from the first half of the twentieth century often described the various stages by which workers transformed raw materials into a finished product. As such, they resembled films of this era that depicted processes of industrial manufacturing. A staple of filmgoing by the late 1920s, "industrial films" used editing techniques to provide a comprehensive view of the stages by which modern companies turned raw materials into marketable goods.[43] Often featuring an image of the *bhilwaya* stretching a sheet of hot shellac, Western depictions of shellac production combined the desire to see the details of industrial transformation with an Orientalist fascination with the bodies engaged in modes of labor that seemed to be compellingly "pre-modern."[44] Indian shellac manufacturing was not simply premodern, however, but simultaneously traditional and modern.

The shellac industry was traditional to the extent that it was small-scale, lacked precise standardization, and resisted modes of scientific efficiency. In

1920 a writer for the phonograph-industry trade journal *Talking Machine World* complained that Indian shellac production was not reaching its full potential because "the native of India has no ambition to make money": "He goes out and makes a few baskets of shellac and sells these for enough money to satisfy his simple wants. To go out and gather twice the number of baskets and earn twice as much money never even occurs to him. There are here and there a few enterprising natives with some business sense, but the great majority are supremely indifferent."[45] Ten years later Max Weber described this phenomenon in his influential book, *The Protestant Ethic and the Spirit of Capitalism.* Weber argued that, for "pre-capitalistic" laborers, the opportunity to earn more money was less attractive than the opportunity to work less: the worker did not ask "how much can I earn in a day if I do as much work as possible?" but instead, "how much must I work in order to earn the wage . . . which I earned before and which takes care of my traditional needs?" Weber claimed that this attitude offered stubborn resistance whenever modern capitalism began its work of "increasing the productivity of human labor by increasing its intensity."[46]

Indian shellac manufacture was precapitalistic in this regard, and, moreover, it relied on traditional knowledge related to the life cycles of trees and insects. Nonetheless, it resulted in a quintessentially modern material: one of the first mass-marketed plastics. The push and pull between modern and nonmodern modes of production is captured in Ben Singer's notion of the "ambimodern." Singer writes that modernity is best understood as "a heterogeneous area of modern and counter-modern impulses" that yields cultural expressions on both ends of the spectrum as well as "ambivalent or ambiguous positions in between." Shellac production certainly falls in the "ambiguous" category, but it is less "counter-modern" than "extramodern," Singer's term for those cultural traditions and practices that continued into the modern era and coexisted alongside "modern currents and countercurrents."[47] The situation becomes even more complex when we consider that shellac is a *bioplastic* that is biodegradable, nontoxic, reusable, and sustainable. The development of bioplastics is now a burgeoning area of cutting-edge research, making the Indian industry appear not so much premodern as a century ahead of its time. Timothy Morton makes a similar claim when he counters Western notions of a timeless, premodern Tibetan culture with the argument that, due to the fact that Tibetans live at remarkably high altitudes and have long included notions of outer space in their culture, they "would make the best space pilots." Morton concludes that traditional Tibetan culture does not belong in the past or in a museum but rather in the future.[48] Similarly, the *baiparis, karigars,* and *bhilwayas* of the

Indian shellac industry do not belong in a museum but rather at a green manufacturing expo.

Regardless of how we classify the shellac industry in relation to the currents of Western modernity, it produced a special kind of commodity: plastic. In a well-known essay Roland Barthes writes that plastic is less a substance than "the very idea of its infinite transformation," less a "thing" than "the trace of a movement."[49] In one regard, Barthes is certainly wrong. Landfills overflowing with product packaging, urban landscapes littered with discarded carrier bags, and the troubling phenomenon known as the Great Pacific Garbage Patch: all of these make clear that plastic is very definitely a "thing."[50] We will return to the environmental costs of plastic at the end of the chapter, but Barthes's discussion of plastic prompts us to return to Latour's suggestion that a network is less a thing than the recorded movement of a thing.

Lac insects were part of an energy cycle in which sunlight was translated into tree sap, and tree sap into resin. Human actants continued that process of translation, transforming brood lac to stick lac, then to seed lac, then to shellac. In these regions of the Green Disc topography, what circulates is a form of matter that "remembers" its previous existence as energy by maintaining the plasticity of that earlier state. In that regard, we might note that one of shellac's first industrial uses was in the European hat industry, where it stiffened the felt in formal hats like the bowler but, at the same time, gave them a certain malleability, so a hat could adapt its shape to the contours of the wearer's head.[51] In India, shellac had been used primarily for wood finishing, coloring, and the production of jewelry. Recall that the demand for shellac resin had grown during the decades around the turn of the century, just as the demand for lac dye was shrinking. The increase in demand for shellac at that time was largely the result of the nascent industry of recorded sound.[52]

Thomas Edison's earliest cylinder phonograph inscribed sound waves onto fragile tin foil sheets, but cylinders were made of wax by the 1880s.[53] Emile Berliner's first gramophone discs were composed of hard rubber, but his employee Fred Gaisberg made sample records from shellac after he learned that the Newark Durminoid Company was making buttons with the material. After these discs were judged to be superior to rubber, Berliner switched to a shellac mixture in 1896.[54] Shellac had a number of properties that made it congenial to record production: it required only moderate temperatures and pressures to shape it; it held a stable and accurate molding; it combined well with various fillers and pigments; and manufacturers could rework the scrap into the production process.[55] Due to these qualities, shellac became the key resinous ingredient in most phonograph records made between the 1890s and 1940s, although the particular recipe used by each company was a closely guarded trade secret.[56] In 1906 the newly launched trade journal *Talking Machine World* claimed that more than six thousand of the thirteen thousand tons of shellac that had been exported from India the previous year had come to the United States—a significant increase from previous years and one due directly to the manufacture of records. Four years later shellac exports from India had quadrupled. By the end of the 1940s the United States was the world's largest importer of shellac, acquiring between half to two-thirds of the total quantity sent abroad, most of which was used to make phonograph records.[57]

The next phase of my analysis of the Green Disc network follows the trail of shellac exports, moving from work done in the forests of India to that done in American recording studios. These two nodes in the network mirror each other as sites of material transformation and traditional technological knowledge. Thus far, I have been exploring the area on the Venn diagram that includes Green Discs and the shellac era. In the next section my focus shifts to the area formed by Green Discs and the acoustic era of phonography. Acoustic practices of record production and consumption demonstrate another way in which phonography of this era can be understood as eco-sonic.

UNPLUGGED PHONOGRAPHY

Acoustic-era studio production, like Indian shellac manufacturing, was both modern and traditional at the same time. Recording did not require electricity during this period and so was a form of low- or no-wattage media production. An 1890 instruction manual for recording operators assumed that "all recording apparatuses are constructed with manual operation" and advised workers to practice rotating the machine's hand crank while watching a clock to assure the proper rate.[58] Manually powered devices were succeeded by gravity or weight-driven motors. Several industrial handbooks of the early 1900s discuss the merits of mechanical weight motors. One author noted that the "obvious superiority" of the weight motor was due to the fact that the source of its power was "even and constant" and that its simple construction meant that it was not likely to get out of order.[59] The Gennett Records studio in Richmond, Indiana, was still using a cable-and-pulley system "much like a grandfather clock" in the early 1920s. According to historian Rick Kennedy, Gennett's recording machine was attached to a cable with a large weight on the other end, and the turntable spun when the weight was lowered into a shaft.[60] Acoustic studios were reliant on gravity, human muscle power, and mechanical knowledge, and so fall into the category of ambimodern TTK, as much as do Indian *karigars* and *bhilwayas.*

Muscle power was required not only of the operators who turned the crank on the apparatus but also of the performers who stood before the recording horn. Sound was funneled through a horn to a flexible diaphragm that transferred vibrations to a stylus that engraved grooves onto a wax disc. No electronic amplification was involved in this process, and so performances had to be quite loud to produce a viable recording.[61] Vocalists needed stamina as well as sheer volume, since they were frequently required to perform their material multiple times. In her study of American recording studios, Susan Schmidt Horning writes that before methods of mass duplication were perfected, "the work of recording studios was truly labor-intensive. Recordists and performers simply made multiple copies, one after the other, to fill demand."[62] Dynamics of the acoustic-era studio thus favored those performers who had developed techniques to address audiences in large spaces, such as opera singers, political orators, variety show performers, auctioneers, and street performers.[63] Jonathan Sterne has argued that early phonograph exhibitors "helped the machine" by using well-known rhymes, quotations, and other forms of conventionalized language to make sound recordings more immediately understandable. Vocalists of the acoustic era "helped the machine" in another way by lending it the power of their breath in a wind-powered phonography that distributed the energy costs of recording between human exertion and the apparatus.[64]

We have thus far encountered two kinds of transformation achieved by the Green Disc network: the lac insect's translation of energy and the shellac worker's transformation of raw materials. Recording studios were the site of another kind of transformation that Sterne has defined as "transduction"—the process by which audible vibrations are changed into another form, in this case, the grooves on a phonograph disc.[65] These various registers of material transformation were interlinked when sound waves were pressed into a shellac disc. The undulating waves of air that entered the acoustic horn draw our attention to yet another dimension of transformation in this network: the plasmatic quality of sound itself.

The Soviet film director Sergei Eisenstein famously describes the "plasmatic" quality of the characters seen in animated cartoons, by which he means their "ability to dynamically assume any form." Eisenstein also finds the quality of protean changeability in folktales, "spineless circus performers," the movements of fire, and music, which he considers remarkable because "the images created by it flow continuously, like flame itself, eternally changeable, like the play of its tongues, mobile and endlessly diverse."[66] Not just music, but all sound is characterized by that plasmatic quality. Michel Chion makes a similar point when he writes that the voice is "the mother of all special effects": "imagine someone who in a matter of seconds could double in height, expand like a balloon and retract into a string bean, or change their face from sweet and harmonious to horribly disfigured—that's what the voice can do with no external props or tricks, just through the natural means of phonation."[67]

The record industry used plastic to make sound into a marketable commodity, and at the same time it made a commodity out of the plasmatic quality of sound. The avatar of Green Disc plasticity was Gilbert Girard, the early phonograph industry's premiere animal mimic. A French Canadian born in San Francisco, Girard was said to be fond of imitating animals as a boy. He became a stage performer as a young man, working as a circus clown and a musical comedian before finding success as part of the first theatrical troupe to visit Alaska.[68] Girard began recording in the mid-1890s and often worked in collaboration with pioneer recording artist Len Spencer, who took the lead speaking parts while Girard populated the aural scene with a host of stunning animal characterizations.[69] Several records cast Spencer in the role of an auctioneer, with Girard voicing the various creatures on sale. In *Auction Sale of a Bird and Animal Store* (1902), Girard is a cat, a monkey, and a parrot; in *Auction Sale of Household Goods* (1902), he is a crying baby and a cuckoo clock; and in *Auction Sale of a Stranded Circus* (1908), he is a dog, a hyena, a goat, and an elephant. In the 1902 barnyard farce, *Daybreak at Calamity Farm,* Girard voices a rooster, a chicken, a cow, a dog, a horse, and a crow. That same year he collaborated with Spencer on *Passing of a Circus Parade,* where he is an elephant, a donkey, a lion, a dog, and a pony. Girard made a number of children's records on his own, such as *Mother Goose and Other Rhymes* (1901), in which he animates Mother Hubbard's dog, the little pigs going to market, and Bo Peep's sheep.[70]

Girard created a plasmatic phonography in which a single performer uses the natural means of phonation to transform from species to species. We might pause for a moment to recognize that Girard was producing some of the same effects as the much-heralded digital morphing or computer-generated imagery of our own era, but at a tiny fraction of the energy and labor costs. Girard's records are eco-sonic because they were made during the low-wattage Green Disc era, but also because they make audible the plasmatic quality of sound and so subtly acknowledge the phonograph network's reliance on plastic materials and the natural and social support systems required to produce them.

I have been focusing on weight motors, recording horns, and the performance techniques found in early studios, but the first decades of the twentieth century are also known as the "acoustic era" because of the hand-cranked playback machines in American homes. Edison's earliest cylinder machines were given their motive power through a variety of means: hand cranks, water power, treadles similar to those on sewing machines, springs, and, in some cases, primitive electric batteries.[71] Berliner's first disc gramophone machines of the mid-1890s relied on hand cranks to propel the turntable.[72] This was a time when the majority of American homes were not wired for electricity, and battery-operated machines were messy and impractical for home use.[73] Berliner's spring-wound motor was developed by a young mechanic from Camden, New Jersey, named Eldridge R. Johnson, who also adjusted the machine's sound box and vertical crank, resulting in the "improved gramophone" of 1897.[74] The fact that Johnson rose to the top of the industry as the cofounder of the Victor Talking Machine Company is emblematic of the industry's ambimodernity: he was both the head of a modern media corporation known for its cutting-edge marketing strategies and a machinist skilled in forms of TTK.

When home listeners played their phonograph records, they took part in an act of transduction, whereby the grooves on the disc were transformed into sound waves in the air. Sterne's focus on transduction as the central operation in sound reproduction has been a productive way to historicize modern audio devices and to explore discourses adjacent to sound recording such as the scientific study of hearing, regimes of education for the deaf, and the history of medical dissection. Those adjacent discourses tend toward the concerns of doctors, educators, scientists, and inventors, but consumers and manufacturers of records often located the materiality of sound reproduction not in the transduction achieved by the phonograph's diaphragm but in the phonograph needle. One advertisement declared that the needle was the "tongue" of the phonograph, suggesting that it was the site of the device's enunciation.[75] The needle was a significant component of the infrastructure of phonography during the Green Disc era and needs to be included in a material history of recorded sound.

CACTUS PETE

Walter H. Bagshaw established the Bagshaw Needle Company in Lowell, Massachusetts, in 1868. Bagshaw had learned how to manufacture comb pins in the English industrial town of Leeds, and his Massachusetts factory produced needles for the textile industry. In 1897 Bagshaw received an order for one hundred thousand needles that came not from a textile firm but from a Philadelphia company called Zonophone, one of Berliner's early rivals in the disc business. As the recorded-sound industry grew, the Bagshaw company grew with it, to become one of the largest manufacturers of phonograph needles in the world.[76] The scale of the needle market was apparent by the 1910s: the author of a 1916 article in the trade press breathlessly declared that, given the common assumption that the needle should be changed after every playback of a record, an ordinary American family used between twenty and twenty-five needles a day.[77] One Bagshaw advertisement showed a stream of needles pouring over the globe and boasted of shipping an order for 1.75 billion needles: "the largest single order on the face of the earth for talking machine needles."[78]

We can read this advertising image, against the grain of its original intention, as a representation of the environmental damage wrought by countless disposable steel needles. Bagshaw was, in fact, one of the pioneers of disposable consumer culture: the 1897 order from Zonophone came just five years after William Painter invented the disposable tin bottle cap and only two years after King Gillette's cheap, disposable razors revolutionized American marketing.[79] The phonograph industry was thus complicit in the birth of a throwaway culture of obsolescence that is the antithesis of contemporary green marketing practices. Steel needles were made to be used once and then thrown away, but the phonograph trade press reported on the surprising ways in which their consumers were reusing discarded needles: they were used to hang pictures on the wall, grate horseradish, clean dirty milk bottles, repair shoes, make tattoos, support window frames, plug mouse holes, and serve as grit on slippery streets.[80] The German military found an innovative use for old phonograph needles during World War I. At a French army hospital on the western front, a soldier's injured arm was found to contain steel phonograph needles that had exploded out of a trench bomb.[81]

Steel needles could tear through human flesh, and they could also damage shellac phonograph discs. It is not a surprise then, that one of the distinctive characteristics of the Green Disc era was a widespread consumer awareness of the costs of sound reproduction. Phonograph listening at this time was always active listening to the extent that playback required human exertion to wind the spring, place the record on the turntable, and select and mount the proper needle. Industry handbooks and trade-press articles advised consumers on how to choose the appropriate needle: thicker needles produced greater volume, for example; the music of brass bands was pleasing with a longer pointed "soft tone" needle; and "loud tone" needles should be used in small rooms with low ceilings.[82] We have grown accustomed to the idea that playback of a CD or MP3 file is the same every time we hear it, but the act of selecting and replacing the needle marked each playback as a unique sonic performance and one that always inflicted damage to the disc. The damage wrought by hard steel needles was easy to perceive: if the needle was too sharp, it would dig down into the bottom of the groove; if it was too blunt and wide, it would deform the sides of the groove. As a result, the average life of a shellac disc was estimated to be around 75 to 125 spins.[83] Sound reproduction during the Green Disc era was, to paraphrase Paolo Cherchi Usai's comments on the cinema, the art of sound destruction, with listeners doing the most damage to the recordings that they loved and played the most frequently.[84]

Listeners who wanted to maximize the frequency of playback and minimize the damage to their records had two alternatives to the destructive steel needles. One option was to invest in "semi-permanent" or jeweled needles that had a sapphire or diamond tip.[85] The Pathe Sapphire Ball, for example, was tipped with a polished sapphire purported to lengthen the life of the record because it did not dig into the disc's surface: an ad declared that "after a thousand performances, Pathe discs show no perceptible wear."[86] Edison introduced Diamond Disc records in 1912, meant to be played with a diamond-tipped stylus. Jewel-tipped needles did not have to be replaced as often as steel needles, but some consumers were concerned that they were not flexible enough to conform to the shape of the record's groove.[87] Needles made of natural fibers were a second, more flexible, alternative.

Frederick Durize Hall, the founder of the B&H Fibre Company, had initially been unimpressed by the sound of the phonograph, which he found to be tinny and harsh. Hall set himself the task of correcting these deficiencies by improving the connection between the sound box and the disc, a response that indicates how attention to the process of sound reproduction could center on the needle rather than the diaphragm. Hall searched for a natural material that could be shaped into a needle and would play records without any "scratching, hissing, [or] rasping sound." He tried many varieties of wood before settling on a particular type of Japanese bamboo that was suited to the task.[88] Hall was satisfied that the tone produced by his bamboo needles was "simply remarkable" and wrote that "the manner in which delicate shadings, too often obscured, are brought out is delightful indeed to the critical listener." Moreover, Hall claimed that his needles preserved the life of the record and could play a disc up to three thousand times without damage.[89]

Hall's bamboo needles met with great success and became the most prominent alternative to steel for many years, although they were not without competition.[90] Other companies at this time sold fiber needles made of various natural materials: needles were made from the thorns found on apple trees and South American shrubs; another company marketed needles made from the sharp horns of the dogfish; and in England the spines of the hedgehog were given favorable reviews.[91] Cactus needles were particularly popular with record enthusiasts during the first half of the twentieth century. The Tusko Company of Chicago manufactured phonograph needles made from Arizona barrel-cactus needles. The Permo Company of Oakland, California, marketed the Permatone cactus needle and in 1921 could proclaim that "the use of cactus in the manufacture of needles has long been regarded favorably by music lovers."[92] Given the assumption that fiber needles were gentle on records, it is not surprising that record collectors sought out cactus needles in the hopes that they would extend the life of their beloved 78s. Cactus needles were the subject of several cartoons that appeared in the *Record Changer,* a magazine for record collectors published during the 1940s. Gene Deitch published a series of comics in the magazine that documented the trials and tribulations of the record-collector community. In one, we see an assortment of "technical experts," including a figure labeled "Cactus Pete," who is shown cultivating a cactus plant to harvest its needles. In another, Deitch's comical jazz-collector character waters his cactus plant while incredulously asking a friend, "You use *needles* on your records?!"

Cactus Pete and his ilk were certainly a specialized cohort of enthusiasts, but their cultivation of cactus plants deserves to be remembered for several reasons. First, it is another example of vegetable actants in the Green Disc network, with cactus-growing jazz buffs mirroring the Indian *raiyats* who tended their kusum trees. Second, cactus needles—like all replaceable needles of the era—acknowledged the material costs of phonographic playback and did so in a form that was a biodegradable and sustainable alternative to the throwaway culture of steel needles.[93] Cactus needles might thus find a place in a convivial phonographic network that includes shellac discs and acoustic technologies of recording and playback.

Spring-wound, acoustic playback was one of the first aspects of the Green Disc network to disappear, since electric motors were sold as attachments to phonograph players in the early 1920s. An ad for the Johnson Electric Motor Company of Chicago announced the arrival of the electrical talking machine and claimed that two phrases that retailers would be hearing in the coming year were "Do It Electrically" and "Why Crank Your

Phonograph?"[94] In 1925 the first "fully-electric" record player—the Brunswick Panatrope—went on the market with an electric motor, a magnetic pickup, and a vacuum-tube amplifier and speaker.[95] Electric motors were marketed to consumers as a modern convenience that reduced physical exertion. In an ad for Shelton Electric Motors, we see the image of a well-dressed woman listening to an electric phonograph, reclining dreamily on a chair laden with luxurious pillows, her eyes half shut.[96] A few years later an ad for the Roberts Electric Phonograph Motor Company shows a woman and three children all comfortably seated on a sofa and chairs, listening to the phonograph. Ad copy reads, "The Electric Age Comes to the Phonograph Industry."[97]

Though undoubtedly convenient, electrical playback meant that record listeners no longer participated in the energy costs of phonographic playback through their muscle power. Instead, the burden of playback was borne by electric power created by the burning of fossil fuels. The phonograph was one of a host of electric appliances that became commonplace in middle-class homes at this time. Benjamin Kline writes that American consumption of electricity rose from 57 million to 188 million kilowatt-hours during the 1920s, and, consequently, American power plants "consumed 42 million tons of coal, 10 million barrels of oil, and 112 million cubic feet of natural gas."[98] Given the decline in muscle-powered phonography, it may not be a coincidence that some of the best-selling records of the early 1920s were Walter Camp's Daily Dozens and the Wallace Reducing Records series, which led a sofa-bound populace through a regimen of home calisthenics.

Electrification meant that playback did not require the listener's muscle power and that recording did not require the studio performer's wind power. Western Electric demonstrated electric recording techniques to the industry in 1924, and a year later microphones replaced the recording horn in Victor's recording studios.[99] As has often been noted, the sensitivity of the microphone created opportunities for new modes of studio performance such as the popular "crooning" style of singing. Mark Katz argues that crooning was "only possible with the microphone, for without amplification such singing would be expressively flat and nearly inaudible."[100] Electric recording allowed for new protocols of popular singing and provided more frequencies of sound, more nuances of expression, and a fuller sense of the spaces in which a recording session took place. These are all admirable developments if the goal is sonic fidelity. If, however, the goal is a convivial phonography, then gains in fidelity are less significant than a loss of equilibrium in the network. That is, during the acoustic era, there had been a balance between power derived from fossil fuels and human exertion. Both sounds of relaxed crooners and images of reclining listeners illustrate the decline of human energy inputs in the phonograph network.[101] Critics of the 1920s and 1930s who complained that crooning was an "unmanly" or debased style of singing seem comically wrongheaded today, but perhaps the style merits a different kind of critique, as a symptom of increasingly fossil fuel–dependent and unsustainable practices of media production and consumption.

The transition from the acoustic to the electric era of phonography during the 1920s marks a departure from the optimal field of overlap on the Venn diagram described earlier. Nonetheless, the shellac disc continued to be the primary format for recorded sound for two decades after the introduction of electric recording. In fact, one eco-friendly attribute of shellac became most perceptible during the twilight years of the Green Disc era.

SAVE THE PIECES

Shellac shortages became a cause of concern for the phonograph industry during World War I, when the government required shellac for the production of munitions.[102] An even more dramatic crisis occurred with the onset of World War II, when the U.S. War Production Board rationed rubber, gasoline, sugar, and other scarce materials. Used in aircraft instrument panels and ammunition casings, shellac was among the materials deemed vital to military production. In April 1942 the board issued conservation order M-106, which forced record companies to consume only 30 percent of the shellac they had used the previous year. To make matters worse, the Japanese army took control of several shellac-producing areas in Asia, slowing exports to the West.[103]

Wartime shortages inspired new ways of enacting patriotic citizenship on the American home front, such as recycling, responsible consumption, and the cultivation of Victory Gardens. In addition to reducing their consumption, Americans were encouraged to take part in scrap drives for metal, rubber, paper, and fats.[104] The major record companies of the time—RCA-Victor, Decca, and Columbia—launched a campaign in 1942 to collect old shellac discs, though much of the work of collecting the discs fell to local distributors and retailers. Scrap barrels for discs were placed outside record stores, and scrap reminders were enclosed with bills and mailings. Consumers were encouraged to return old discs every time they purchased new ones. Jackson's Furniture Store in Oakland, California, announced that customers would be given a new record for every twelve old ones they brought in. "You can help the record manufacturers and keep them making records as before," the ad declared. "Your old discarded records will do just that, no matter how old and worn out they may be." Albright's record store in Annapolis, Maryland, announced that it would pay six cents a pound for shellac records, "broken or whole."[105]

The big record producers worked with a number of different organizations in the pursuit of scrap. They made agreements with theater operators so that patrons could pay admission in old records. They worked with urban ballrooms to host "disc nights," where customers were given credit for old records. A patriotic group of musicians called Records for Our Fighting Men dedicated itself to shellac salvage, and popular singers encouraged New York schoolchildren to take part in the scrap drive, presenting them with special diplomas when they had a reached their quota on old records.[106] Civic groups such as the Boy Scouts, the Red Cross, and the American Legion joined the drive as well. *Time* magazine reported that 1.5 million members of the American Legion and the Women's American Legion Auxiliary were canvasing the nation as part of "the greatest record hunt in history": "Corn cribs, set up on street corners in small Kansas towns, bulged with old phonograph records . . . [and] open-mouthed caricatures of Hitler, Mussolini and Hirohito on Manhattan's Times Square made inviting receptacles to throw discs into."[107] Some firms were even said to be enlisting the help of janitors to comb houses for old records.

The industry's active participation in the 1942 shellac drive can be seen as a precursor to green marketing initiatives of the current era. For one thing, it was an early example of the environmental design strategy in which customers are paid for returns. It also resembles the industrial practice of extended product responsibility (EPR), in which corporations are asked to factor ecologically responsible disposal into their business strategy.[108] EPR has been one of the solutions offered to address the problem of health hazards caused by discarded electronic consumer goods when they enter the waste system. The wartime shellac drive was a rare instance of media-industry EPR, and we should note that it was made possible by the particular characteristics of shellac as a reusable bioplastic. In other words, the fact that shellac records were easy to break made them amenable to recycling. "The cry of 'save the pieces' is going up in shops and among the customers," wrote a reporter in the *Baltimore Sun* in 1942. "No more will the graven discs go to waste. Record dealers all over town are beginning to ask for the pieces in exchange for a few pennies when a new record is purchased. . . . The pieces are turned back to the wholesaler by the retailer and then go back to the factory to be melted down in the manufacture of new records."[109]

Despite these resemblances to green marketing strategies, World War II scrap drives did not significantly slow American consumerism; neither did they spur the record industry to take EPR to heart in any sustained manner. Instead, the industry's primary response to wartime shellac shortages was to redouble its commitment to finding synthetic alternatives. The record industry had long experimented with using synthetic plastics instead of shellac. Cylinders made in the 1900s by the Lambert Company had contained celluloid, the first synthetically produced plastic, as did Edison's 1912 Blue Amerbol cylinders. The chemist Leo Baekeland was searching for a "more serviceable substitute for shellac" when he produced a synthetic resin that was marketed as Bakelite. Edison used Bakelite in his 1912 Diamond Discs.[110] In the wake of World War I shellac shortages, industry laboratories were said to be "hard at work day and night" in the effort to find an affordable shellac substitute.[111] The rationing of the 1940s gave new urgency to that effort. In 1942 the new record company Capitol shocked competitors by turning out a surprising number of discs, given the wartime reductions in supply. Capitol's secret was revealed to be a new disc manufacturing process that did not rely on shellac. As *Newsweek* put it, the company was actively searching for "chemical substitutes for the juice of the Indian lac bug."[112] Strong incentives for developing alternatives continued after the war, when price controls were lifted and the cost of shellac rose to a prohibitive level. It is not a surprise, then, that RCA-Victor introduced its first transparent, ruby-red plastic discs in 1945.[113]

RCA-Victor's discs were made of a synthetic compound of petroleum and chlorine called polyvinyl chloride (PVC), or "vinyl" for short, which was marketed commercially by the Union Carbide Company in the 1930s.[114] Peter Goldmark, the CBS researcher who played a central role in the development of Columbia's long-playing records, wrote that he had been looking for "a smooth, hard material to replace shellac," and he found it in vinylite, "a World War II era development" that had been used primarily in the manufacture of garden hoses.[115] It is easy to see why the industry saw vinyl as an improvement over shellac. Lighter and tougher than shellac, vinyl was considered to be "unbreakable." The sturdiness of vinyl had come in handy during World War II, when the material was used to produce "V disc" records for the armed forces, some of which had to be dropped to soldiers by parachute.[116] Vinyl was harder and finer than shellac and so allowed for more grooves to be pressed onto a disc, hence the material's importance for the development of long-playing records.117 All of these facts made it self-evident that the introduction of vinyl records signaled a change for the better, one of many signs that postwar consumers were entering an era of "Better Living through Chemistry."[118]

The defining moment in the birth of the modern environmental movement—Rachel Carson's 1962 exposé of the chemical pesticide industry—was a provocative challenge to that optimistic narrative, and an eco-critical perspective emboldens us to question record-industry marketing rhetoric that would have us believe that the undeniable benefits of vinyl LPs came without any significant costs. Vinyl is generally made from petroleum, which is a nonrenewable resource. Nonrenewable resources like minerals and mineral fuels can only be used once, and the geological processes that form them are too slow to be sustainable. By contrast, shellac is a potentially renewable resource, given that the forest ecology that supports it is allowed to regenerate faster than the rate at which it is consumed.[119] The shift from shellac to vinyl records thus speeds the depletion of nonrenewable fossil fuels.

Whereas shellac is nontoxic and even edible, PVC has been called "the most environmentally pernicious plastic in use" due to concerns that it causes cancer among factory workers and releases deadly chemicals like dioxin into the food chain.[120] Greenpeace writes that of all the plastics, vinyl is "the most environmentally damaging. Throughout its lifecycle it requires hazardous chemicals for production, releases harmful additives and creates toxic wastes."[121] From the perspective of recycling and reuse, the fact that vinyl is "unbreakable" is a weakness, not a strength. Recall how scraps of shellac were reused in the production process and how old and broken shellac records were returned to dealers to be melted and remolded.[122] Less than 1 percent of PVC is recycled, and because products made of vinyl are difficult to repair, they are typically discarded instead of being reused. Historian Susan Strasser argues that the rise of plastic consumer products during the postwar era fostered "a relationship to the material world that required consumers to buy things rather than make them and to throw things out rather than fix them. Nobody made plastic at home, hardly anybody understood how it was made, and it usually could not be repaired."[123] This has implications for landfills, and nonbiodegradable plastics like PVC account for approximately 18 percent of the volume of municipal waste.[124] In other words, once records were made of vinyl, they became nonbiodegradable hyperobjects. In 1945 a writer for *Billboard* magazine wrote that the new plastic LPs were "ageless copies of the music that the family wants to keep forever."[125] The statement was correct but incomplete, since the ecological implications of producing millions of indestructible Mitch Miller LPs were not part of the discussion.

Columbia Records unveiled their 33⅓ rpm vinyl LPs at a 1948 press conference. The company presented its new format as a lightweight means of storing more sound than was previously possible. In its coverage of the event, *Life* magazine ran a photograph of Columbia's Peter Goldmark standing beside an eight-foot-high tower of "old-style" 78 rpm records that weighed more than three hundred pounds. To demonstrate the benefits of the new format, Goldmark held in his arms the equivalent amount of recorded sound in vinyl: a one-foot-high, thirty-pound stack of LPs.[126] This industry-choreographed photo opportunity made use of rhetoric similar to that used to portray recent digital music devices as thin and lightweight and cloud-based services as offering limitless storage space for dematerialized music files. Then, as now, the issue is not as simple as triumphalist industry marketing would suggest.[127] For green marketers concerned with the life-cycle analysis (LCA) of consumer products, the greenest devices are sometimes those that *reject* the miniaturization that leads to "thoughtless disposal."[128] If we look more closely at the case of the vinyl LP, we can see how the rhetoric of lightweight media formats and bountiful storage space encourages the escalation of consumption and obscures a number of significant ecological problems.

The much-heralded extended playing time of the LP can be viewed in the same manner that Nadia Bozak critiques the cinematic long take. For Bozak, the long take is a "signal of material excess and an ideology of material decadence," whereby the camera is left to idle, perpetuating habits of waste and overconsumption. "There is an ideology of limitlessness, expansionism, and unfettered expenditure built into this specific formal decision," she writes, "wherein the camera aperture is opened indefinitely and seemingly indefatigably." A similar ideology of unfettered expenditure is signaled by recording devices allowed to record the long unbroken sides of the new LPs. I am one of countless record fans who would cringe at the thought of a world without LPs containing the extended improvisations of postwar jazz musicians like John Coltrane and Bill Evans; the long-form comic routines of Mort Sahl, Lenny Bruce, and Bill Cosby; or the album-length musical cycles of postwar recording artists such as the Beatles, Van Morrison, or Marvin Gaye. Nonetheless, it is time to reinvest in the merits of "short media" in a manner roughly analogous to the way in which the "slow food" movement has reshaped popular attitudes about eating. The four-minute, single-track 78 rpm disc should be appreciated as the phonographic equivalent of what Bozak calls "cinematic thrift," whereby filmmakers repurpose extant films, repeat a single shot, or by some other means acknowledge the photographic image as "a valuable, potentially finite resource."[129]

There is a flipside to high-fidelity records as well as long-playing ones. Vinyl records were part of a postwar "revolution" in sound technology,

FIGURE 3. Peter Goldmark stands beside a three-hundred-pound tower of 78 rpm records while holding a thirty-pound stack of vinyl LPs. Eric Schaal, Life Picture Collection, Getty Images, Seattle, WA.

hailed for its stunning increase in sonic fidelity. Shellac was difficult to standardize, since batches of the material tended to contain various amounts of impurities that caused some of the pops and hisses that we associate with early phonograph records. Vinyl, on the other hand, had a high degree of uniformity from batch to batch and contained fewer additives than shellac, resulting in discs that had considerably less surface noise. A century of industry advertising has made it seem natural to base qualitative judgments about recorded sound on the faithful reproduction of a source event and the absence of "noise."

Scholars in the field of sound studies have demonstrated the extent to which discourses of sound fidelity were shaped by the specific historical context of the early twentieth century, making clear that it is only one possible criterion for assessing sound recordings.[130] The "impurities" in shellac were caused in part by material traces of the trees and insects that produced the bioplastic material needed for sound reproduction. In our culture, where "a speaking subject is jealously guarded as an exclusively human prerogative," the noise of the shellac can be appreciated for the way in which it resists the tendency for nature to become silent. "We require a viable environmental ethics to confront the silence of nature in our contemporary regime of thought," Christopher Manes argues, "for it is within this vast, eerie silence that surrounds our garrulous human subjectivity that an ethics of exploitation regarding nature has taken shape and flourished."[131] The pops of Green Discs can be heard not simply as noise to be eliminated but as an eco-positive attribute of shellac, giving voice to the kusum trees and reddish insects that provide a material base for the voices of Gilbert Girard or Enrico Caruso.[132]

What I hope has become clear is that there were a host of hidden ecological costs associated with the introduction of unbreakable, lightweight, long-playing, high- fidelity vinyl records. Moreover, an eco-critical perspective reveals the particular material benefits of shellac. The fragility of shellac encouraged extra care to be taken in sound reproduction, leading to a consumer ecology that included the cultivation of fiber needles and the acknowledgement of the material costs of playback. Shellac discs had the potential to remind listeners of the role played by nonhuman producers, and by extension the larger ecology of energy cycles, in the phonographic system. For these and other reasons, the Green Disc era should be revisited as the point of departure in the construction of a more convivial phonography.

Ivan Illich describes a historical pattern whereby technologies cross two thresholds. The first is a watershed that occurs when the desirable effects of a new discovery become "easily measured and verified," and new knowledge is applied to a "clearly stated problem." At a second watershed, technology becomes the means to its own ends and is used for the exploitation of society in the service of "self-certifying elites." Illich gives the example of transportation technology, writing that "it has taken almost a century to pass from an era served by motorized vehicles to the era in which society has been reduced to virtual enslavement to the car."[133] Illich is certainly painting with broad strokes (few technologies, for example, have the neat trajectory he postulates), but it is useful to think of the Green Disc era as a convivial sweet spot between two watersheds. The first marks the invention of sound recording, which allowed for the preservation of sounds in all their diversity and specificity and the development of a popular market for recorded sound. The second watershed marks the passing of the Green Disc era and the decline of a relatively low-impact and sustainable infrastructure.[134]

Over the course of this chapter I have mapped the Green Disc network in terms of the circulation of energy, the industrial transformation of raw materials, the transduction of sound waves into record grooves and back again, and the recycling of old records as reusable scrap. When we zoom back to consider the Green Disc network as a whole, the content of the network appears to be the process of transformation itself, be that the plasmatic play of sound, the material malleability of plastic, or the circulation of energy. If we were to reorient the network around the attribute of plasticity as opposed to fidelity, then we might pursue a convivial infrastructure that provides the maximum play of plastic transformation through the least amount of damage to the planet.[135]

As an emblem for that pursuit, I offer the humble lac insect, whose labor was essential to one of the first modern media industries and whose process of manufacturing is convivial in ways that human industry is not. Designers William McDonough and Michael Braungart write that "all the ants on the planet, taken together, have a biomass greater than that of humans. Ants have been incredibly industrious for millions of years. Yet their productiveness nourishes plants, animals, and soil. Human industry has been in full swing for little over a century, yet it has brought about a decline in almost every ecosystem on the planet."[136] Likewise, the industry of the lac insect was part of a sustainable natural energy cycle, as opposed to a human plastics industry that relies on "non-renewable geological capital."[137] Human observers thought that they were elevating insects by comparing them to Victorian industrialists, but the irony is that Mr. and Mrs. Lacca were way ahead of us in the implementation of convivial manufacturing. In fact, our nonconvivial industrial practices are a threat to the very existence of the lac insect. Anthropogenic climate change has caused temperatures to rise in lac-producing areas, leading to a drastic decline in the number of the insects. Lac insects and their host trees are vulnerable to changes in climatic conditions, and extremely hot weather is particularly hazardous to the former because at a certain temperature their "gummy domes" melt, suffocating the insects inside. Changing climate patterns have also caused shifts in seasonal patterns, allowing parasites on the lac to proliferate.[138]

I would like to end this chapter not with the Indian lac insect, however, but with the human laborers in the Indian shellac industry. The record industry's shift to vinyl placed the Indian shellac industry in a "severe crisis" that threatened the employment of millions of workers and small-scale cultivators.[139] The Indian government formed a committee in 1931 to counter the growing market pressure caused by the development of synthetic resins, but it could not stop the decline of the industry.[140] The rise of synthetic plastics resulted in the loss of valuable income for millions of Indian lac cultivators as well as an economic motivation for maintaining the health of the forest. Given the role of synthetic chemicals in the collapse of the shellac market, there is a terrible irony to the fact that one of the worst industrial accidents in world history took place in India and involved the company that first marketed PVC. On December 3, 1984, Union Carbide's chemical pesticide plant in Bhopal released more than forty tons of toxic gas, killing thousands of people and providing a horrifying demonstration of the costs of "Better Living through Chemistry."[141]

There is another form of contemporary Indian labor that may provide clues to a twenty-first-century practice of convivial phonography. India is one of the few countries that continues to produce hand-wound, acoustic phonograph players. These machines circulate globally, but the Western collector community denigrates them as "Crap-o-phones" or "Franken-phones," due to the fact that they are often composed of parts taken from various machines of different vintage. As this chapter has shown, we can appreciate these machines, not as second-rate knockoffs or quaint nostalgic bric-a-brac, but as TTK in action—signs of surviving ambimodern skills that should be understood and encouraged as we face what John Michael Greer calls the "deindustrial age."

As the supply of petroleum inevitably declines, Greer claims that Western populations will have to scale back their expectations and make do with technologies that work with available renewable resources. Greer suggests that his readers adopt an obsolete technology and learn how to use it before those skills are forgotten and have to be "laboriously reinvented decades in the future."[142] We do not need to subscribe to the most apocalyptic aspects of Greer's scenario to appreciate acoustic phonography as a lesson in green media practice. Recall Maxwell and Miller's provocative question to media scholars: "how much communication and entertainment media is enough to attain a system that serves everyone on the planet fairly without contributing to 'ecological suicide?'" If I had to answer that question with regard to sound media technology, I would begin with the Crap-o-phone and not the iPhone.