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PERSPECTIVE

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The sluggard has no locusts: From persistent pest to irresistible icon

Nathaniel J. Dominy | Luke D. Fannin

Department of Anthropology and Graduate Program in Ecology, Evolution, Environment and Society, Dartmouth College, Hanover, NH, USA

Correspondence
Nathaniel J. Dominy
Email: nathaniel.j.dominy@dartmouth.edu

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Abstract

1. Desert locusts *Schistocerca gregaria* are threatening the food security of millions of people and devastating economies in eastern Africa and northern India. The ongoing outbreak is the largest in seven decades.
2. These events give us cause to reflect on the natural history of locusts, our fraught relationship with them, and how they are represented in American popular culture and others.
3. Symbolic representations span millennia and most have roots in the natural life cycle of locusts—they transform, they swarm, they devastate specific food crops. There is strong tendency to exaggerate the body size of locusts and the effectiveness of control efforts. Expressions of human futility are rare except in the form of ironic humour.
4. We conclude by suggesting that we humans indulge in hyperbole and humour to normalize and inure ourselves to the psychologically unbearable, and that this tendency is a precondition for the techno-optimism that drives anti-locust technologies.
5. There is no substitute for effective monitoring and management programs, but the importance of new and emerging anti-locust technologies is expected to increase with projections of increased cyclone activity in the northern Indian Ocean.

KEYWORDS
cultural studies, desert locust, film and media studies, *Schistocerca gregaria*

1 | INTRODUCTION

Locusts are grasshoppers (Orthoptera: Acrididae) capable of extreme phenotypic plasticity, known as density-dependent phase polyphenism (Simpson & Sword, 2008). In a family exceeding 12,000 species, fewer than 20 express this ability, which has evolved independently in different lineages globally (Song et al., 2017). The distinct phenotypes, or phases, develop in response to local population density. Low densities produce the shy, camouflaged solitarious phase, whereas crowded conditions produce the aggregating, migratory gregarious phase (Figure 1). Gregarious phase locusts assemble into enormous groups and embark on spectacular mass migrations, travelling as marching bands of flightless juveniles and vast flying swarms of winged adults. Psychological trauma from past irruptions is deeply embedded in many agrarian cultures; indeed, the term locust is derived from the Latin, *locus ustus*, meaning 'burnt place'—an allusion to the denuded landscape left in the wake of a ravenous swarm (Lockwood, 2004).

Even now the trauma is fresh. The current upsurge of desert locusts *Schistocerca gregaria* is the largest in seven decades,

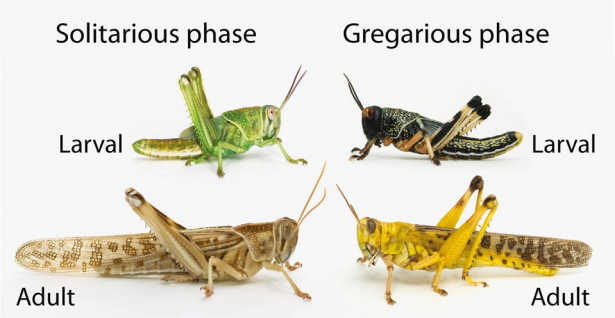

FIGURE 1 Solitarious and gregarious phase locusts of *Schistocerca gregaria* differ in brain size, body size and body shape, as well as many internal traits (Simões et al., 2016). One of the most striking outward differences of is that solitarious locusts are camouflaged, whereas gregarious locusts are aposematic (figure by Jeremy Niven, reproduced with permission)

threatening the food security of millions of people and devastating economies in eastern Africa and northern India. So immense is the scale that news reports struggle to put it into familiar terms. In July 2020, *The Economist* calculated that a swarm of 200 billion locusts in Kenya was eating as much in a day as the entire population of Germany (Anonymous, 2020). This allusion to food competition is fitting. Locusts eat essential cereal crops (wheat, maize, barley, sorghum, millet) and the grasses that sustain livestock, an appropriation of human resources that motivates different measures of impact. For example, the United Nations Food and Agriculture Organization (FAO) described the locust outbreak as a 'food chain crisis' with the potential to adversely affect as much as 10% of the global population (FAO, 2020a). The World Bank characterized it as a 'crisis within a crisis' in reference to the COVID-19 pandemic. It put the cost in economic terms, estimating $8.5 billion in agricultural damages by the end of 2020 (Kray & Shetty, 2020). Interventions in mid-2020 mitigated both of these worst-case estimates, but the FAO's forecasts for 2021 remain dire for the Greater Horn of Africa (FAO, 2020b).

Against this unfolding backdrop, the aims of our Perspective are threefold. First, we orient readers to the natural history and current upsurge of desert locusts, relating selected life stages to representations in popular culture. Second, we call attention to recurring motifs in human history, such as the tendency to exaggerate the size of individual locusts and the effectiveness of control efforts. Third, we wrestle with a basic question: *why do we indulge in such hyperbole?* We suggest that much of the imagery and discourse around locusts serves a psychological purpose, to normalize and inure ourselves to the unbearable. We conclude by arguing that such normalization may function as a necessary precondition for expressing the techno-optimism that impels advances.

2 | OUTBREAK

The father of acridology, Sir Boris Uvarov, described phase polyphenism in *Locusts and Grasshoppers* (1929). It was a landmark achievement for determining that solitarious and gregarious phases were variants of the same species—it explained the biology behind the sudden appearance and metastasis of devastating swarms (Waloff & Popov, 1990). In the case of *S. gregaria*, the solitarious phase is found in low numbers throughout the deserts of North Africa, the Middle East and southwest Asia. It survives in isolation by sheltering on sparse annual vegetation and laying eggs in moist sandy soil after intermittent rains. This arid/hyperarid region is some 16 million km^2 in size and extends across 30 countries. It is called the recession area and calm periods without widespread infestation are called recessions (Cressman, 2016).

Uvarov believed that outbreak centres existed within recession areas. He thought that if centres could be located it would be possible to prevent swarms. He hypothesized that one centre lay in the Rub' al Khali desert or Empty Quarter of southern Arabia, where dry watercourses drain the Dhofar mountains. He reasoned that heavy rains from occasional cyclones would drain inland and support dense patches of ephemeral vegetation at the edge of the sands. To investigate this premise, Uvarov sent the legendary explorer and travel writer Sir Wilfred Thesiger. His account of the journey in *Arabian Sands* (1959) is a classic in the travelogue genre.

2.1 | Outbreak and upsurge 2018–2020

A cyclone (Mekunu) hit the Empty Quarter in May 2018 (Figure 2), causing vegetation to flourish and locusts to increase 400-fold over the next 6 months (Salih et al., 2020). As the habitat dried, food became depleted and large numbers of locusts concentrated on the remaining patches of vegetation. At this point two sensory pathways can trigger phase change: sight and smell or direct contact with other locusts (Anstey et al., 2009). Both pathways have similar time courses and end points, a process termed gregarization, which begins with groups of hoppers (wingless nymphs) and adults that fuse to form dense bands. Transformation between the solitarious and

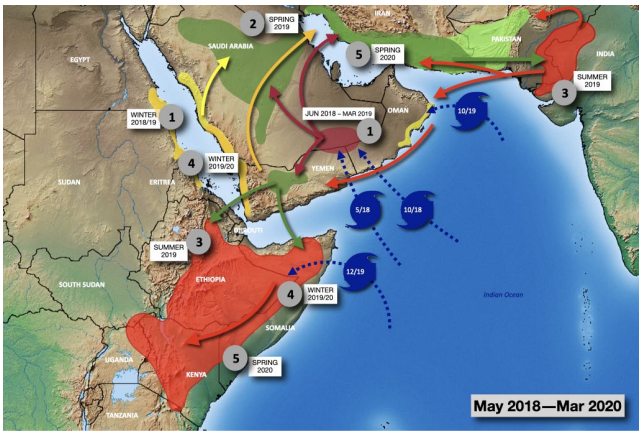

FIGURE 2 Chronology and map of outbreaks, migrations, and invasion areas (May 2018–March 2020) beginning with a series of cyclones in the northern Indian Ocean. Map produced by the Locusts and Other Migratory Pests Group, United Nations Food and Agriculture Organization, reproduced with permission

gregarious phase is called the transient phase, and these locusts are referred to as transiens (Cressman, 2016). It is an astounding process, with changes in outward appearance, nutritional and reproductive physiology, metabolism, endocrinology, molecular biology, immune responses, and pheromone production (Simpson & Sword, 2008). Even the brain transforms, growing 30% larger in the gregarious phase, with greater proportions allocated to sensory processing (Ott & Rogers, 2010). No wonder this transformation captured the attention of surrealist painters (Figure 3).

Another cyclone (Luban) hit the Empty Quarter in October 2018 (Figure 2), and three generations of breeding went undetected and uncontrolled (Stokstad, 2020). When two or more generations of transient-to-gregarious breeding occur in succession, it is called an upsurge (Cressman, 2016). By March 2019, the upsurge had increased 8000-fold and headed to southern Iran, crossing territory that had not seen the insects in 50 years, and moved east into India and Pakistan (Stokstad, 2020). Many locusts flew south with prevailing winds into Yemen, where civil war prevented any spraying of pesticides. The swarms then moved to Ethiopia and Somalia in October 2019, a predictable pattern of migration (Everard, 2019).

Yet another cyclone (Pawan) hit the Horn of Africa in December 2019 and more breeding ensued (Figure 2). By the end of that month, growing swarms had entered Kenya. In January 2020, the swarms had spread across the Horn of Africa laying eggs, which hatched in March and swelled numbers further. At the time of writing (July 2020), prolific swarms were devastating vast areas of eastern Africa and northern India. A period of one or more years of widespread and heavy infestation is called a plague, and a major plague exists when two or more regions are affected simultaneously.

FIGURE 3 The surrealist painter Salvador Dalí was a lifelong sufferer of acridophobia, and grasshoppers or locusts feature in many of his works (Kritsky et al., 2013). Pictured here is Dalí's *Locusta et Brucus* (1967), a lithograph on rag paper (48.3 × 34.9 cm; © Salvador Dalí, Fundació Gala-Salvador Dalí, photograph by Ariel Amio, the owner of the work, reproduced with permission). The title differentiates two phases, winged adults (*locusta*(*e*)) and wingless hopping nymphs (*brucus/i*). The central subject, however, is a single individual that appears to embody both phases at once. We view it as a symbol of transmogrification that portends future crop damage. The other subject matter—a human skull, ants—is usually interpreted as symbolic of death and decay. [Correction added on 24 March 2021, after first online publication: Copyright information added.]

2.2 | Projections for 2021

Revisions to this Perspective in December 2020 follow on the heels of another major cyclone (Gati), which made landfall on 22 November near Xaafuun, northeast Somalia. It is the strongest storm on record in Somalia and it impacted the desert locust infestation in several ways. Heavy rains on the northern Somali plateau accelerated the maturation of immature swarms resulting in widespread egg-laying. In addition, winds associated with the cyclone drove some swarms southeast to the Ogaden, where they matured and laid eggs in existing breeding areas (FAO, 2020b). Predictably, numerous immature swarms have already formed in eastern Ethiopia and central Somalia, a pattern that is expected to increase progressively through late January 2021 and beyond.

3 | VISIONS IN AMERICAN POPULAR CULTURE

Preceding paragraphs touched on the factors that gave rise to current conditions. It is, as one headline put it, 'The Terrifying Science Behind the Locust Plagues of Africa' (*Wired* magazine, 2 February 2020). This expression of terror has deep roots in American popular culture. For example, the X-men comic book series featured a character named August Hopper, a professor of entomology at Metro College in New York City. Hopper turned to supervillainy when he was denied tenure, transforming himself into The Locust (Figure 4a). Using a 'Magno-Ray', he ionized eggs to produce gregarious nymphs, raising them in a wheat field to produce enlarged adults. With admirable eloquence, he describes the 'krunch!' of crop destruction as a 'song of mounting menace'. Eventually, the X-men (a subspecies of human born with superhuman abilities) subdued the giant locusts with 'high-grade pesticides'. It is an obscure episode in the annals of superheroes and supervillains, but the sequence of images and actions—of transformation, crop

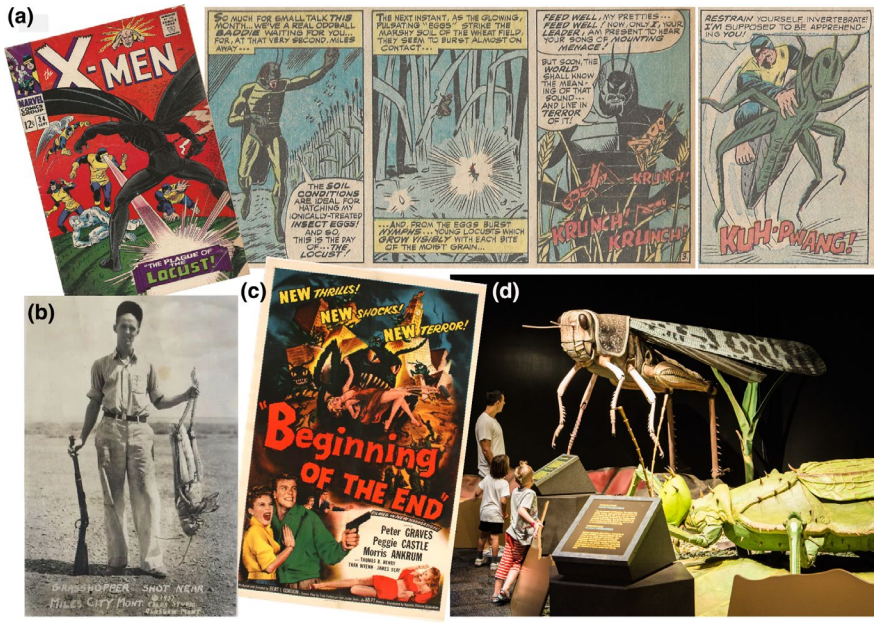

FIGURE 4 (a) X-men #24 (September 1966) and corresponding scenes with The Locust, wingless nymphs, crop devastation, and super-enlarged adults; © Marvel Entertainment, reproduced with permission. (b) Exemplary tall-tale ('whopper hopper') postcard produced and sold in the United States in 1937; the caption reads 'Grasshopper shot near Miles City Mont © Coles Studio Glasgow Mont'. (c) Theatrical release poster for the film *Beginning of the End* (1957). (d) Large model of *Schistocerca gregaria* in its gregarious phase on display at the Science Museum of Virginia, Fredericksburg, USA (produced by Kokoro Exhibits, Canoga Park, USA; photographed with consent by the Arizona Science Center, reproduced with permission)

consumption, immense size and triumph through technology—serves as a practical starting point, for it exemplifies recurring motifs in human history.

Oversized grasshoppers, 'whopper hoppers', were a favourite subject of American tall-tale postcards of the early 20th century (Morgan, 1981; Rubin & Williams, 1990). In one example from 1937 (Figure 4b), a grasshopper falls victim to a farmer and his Model 94 Winchester rifle, twin icons of technical innovation and industry. It is no coincidence that 1937 was a year of steep economic recession and severe privation across the high plains of the central United States. An upsurge of grasshoppers—the worst since 1874–1876 (Lockwood, 2004)—only worsened the effects of the Dust Bowl, an ongoing environmental catastrophe of unprecedented heat, drought and soil loss (Egan, 2006). To give weight to the humour of this forced-perspective image, we used the length of the rifle (37.5 inches) to estimate the length of the insect's tibia (≈35.5 cm), a structure that scales predictably with body mass (Katz & Gosline, 1992). Our body mass calculation of 3.3 kg speaks to the appetite of this species (*Melanoplus sanguinipes*), which eats one-half of its body weight in green forage per day (Lockwood, 2004).

If the size of this trophy was meant to embody the anxieties of American farmers, it was secondary to the overarching message of resilience through technology. A problem with this example of techno-optimism is that insects have a low-pressure circulatory system and fast-clotting hemolymph. A hole in the exoskeleton, even from a 30-calibre rifle, will bleed little and seal quickly. More effective, perhaps, was the solution, also in 1937, of the US National Guard—soldiers used flamethrowers and slow-moving trains to battle swarms of locusts in Colorado (Lockwood, 2004). They deployed other technologies too, including large tractor-drawn rollers, used to crush insects on the ground, and massive amounts of pesticide, including arsenic, up to 175 tons per acre (Egan, 2006).

Locusts grew still larger during the 'Big Bug' era (1954–1958) of Hollywood filmmaking (Figure 4c). In the film *Beginning of the End* (1957), a USDA test of radioactive fertilizers produced, as Tsutsui (2007) put it, 'a swarm of school-bus-sized locusts that ate much of downstate Illinois'. The insects reached Chicago despite military intervention and the use of chlordane, a powerful pesticide that was banned in the United States in 1988. Deploying a stronger pesticide was ruled out by entomologist Ed Wainwright (played by Peter Graves): 'Despite the fact that we have developed powerful insecticides, the locust still inflicts damages to the tune of $25 million in the United States alone'. Technological escalation was necessary to save American agriculture, so the army favored use of a nuclear weapon to destroy the beasts and Chicago.

The film is notorious but edifying camp. It alludes to the social behaviour of locusts by recognizing their gregariousness—indeed, the A-bomb is the ultimate density-dependent solution (Berenbaum & Leskosky, 1992). At the same time, it is a parable on the limits of techno-optimism, suggesting that some solutions (chlordane) can lose their potency, whereas others (nuclear weapons) provide a cure worse than the disease. The 'Big Bug' movies of the 1950s and 'Creature Features' of the 1960s are usually interpreted as symbolic manifestations of prevailing Cold War anxieties (Leskosky, 2006; Mertins, 1986; Sontag, 1965), but Tsutsui (2007) has argued that they reflected growing misgivings about the safety and effectiveness of modern insecticides, a prelude to the era of silent springs.

In *Giant Insects*, a touring exhibit now at the Science Museum of Virginia, Fredericksburg, USA (*18 January–30 August 2020*), there is a model of *S. gregaria* with a 20-foot wingspan (Figure 4d). This choice of species and phase would win the prize for timely outreach if not for the COVID-19 pandemic and closure of the museum. Outsized models are useful for making small details visible and potentially explaining the size limits set by the respiratory system of locusts (Harrison et al., 2013). The tracheal system is a series of tubes for gas exchange, and the rate of oxygen diffusion is proportional to the concentration gradient, inversely proportional to length, and directly proportional to cross-sectional area. But, as insects increase in size,

the demand for oxygen will increase in proportion to length cubed, whereas the diffusion rate will only increase as length squared. Thus, as frightening as it is to imagine such a massive locust, the body sizes in Figure 4 lie well behind the physical limits imposed by current atmospheric conditions (Whitman, 2008).

3.1 | Locusts in discourse

If hyperenlargement is one means of expressing cultural anxiety (Dominy & Calsbeek, 2019), then using locusts to symbolize outsiders (or simply others) is another. Foreign armies were described as locusts in ancient Egypt (Figure 5a), whereas European settlers in Africa are equated to locusts in *Things Fall Apart* (1958), a classic novel by Nigerian author Chinua Achebe. At its worst, this rhetorical equation 'threatening outsiders = locust swarm' is used as a dehumanizing and demagogic trope in regions as far-ranging as the Levant (Lerner, 1999), Europe (Small, 2013) and East Asia (Sautman & Yan, 2015), including the recent Brexit campaign (Spinzi & Manca, 2017).

FIGURE 5 (a) Relief at Medinet Habu, mortuary temple of Ramses III (*c*. 1,156 BC, photograph by Mike Shepherd, reproduced with permission). (b) Grotesque of Jerónimos Monastery, Lisbon, Portugal (16th century, photograph by Dmitri Logunov, reproduced with permission). (c) Haematite weight, Babylonian period (© Phoenix Ancient Art SA, reproduced with permission) and a clay cuneiform tablet, Late Babylonian period, describing a locust invasion in 346 BC and a steep rise in the price of barley (no. 46,229, © Trustees of the British Museum, reproduced with permission)

In some cases, we see the effects of proportionality bias, or the tendency to assume that big chaotic events have big causes, such as divine vengeance, a common theme in Hebrew and biblical scriptures (Nevo, 1996; Thompson, 1955). In the Bible, 40 of 98 references to arthropods are focused squarely on grasshoppers, hoppers, or locusts (Kritsky, 1997), a pattern that has led some ecclesiastical institutions to transform the locust into a sober warning (Figure 5b), a symbol of angry, God-sent punishment for moral shortcoming or sin (Lockwood, 2004). Christian orthodoxy on the subject is based on the views of Thomas Aquinas, a 13th century philosopher and Dominican friar, who argued that animals are innocent of their misdeeds. Blame for locusts was therefore directed inwards; immediate repentance by a populace was the only suitable response to troublesome swarms.

'The sluggard has no locusts' is a proverb of the Lobedu (Lovedu) people (Golka, 1993), a tribe of the Sotho ethnic group with traditional homelands in Limpopo Province, South Africa. Like so many African proverbs, it has a surface meaning (scorn for the indolent, who produce nothing worth eating) and an underlying irony, a philosophical acceptance of swarms that can descend on a family plot, and, in a few frenzied minutes, lift off again fortified by a season of labour. For hand-to-mouth subsistence farmers, it is an example of dark humour in the face of calamity, but the expression of equanimity and futility sets it apart from the supernatural views above. There is no divine attribution and no potential for penance to mitigate the damage. We use the proverb in our title for two reasons. First, we appreciate the humour and economy of words. Five words are rarely so barbed. Second, it exemplifies the tension between human industry and locusts, a central theme of our Perspective. Human agriculture and the domestication of landscapes are technical achievements that fuel locust irruptions—that human techno-optimism is both cause and solution to locust outbreaks is an irony that underlies many of the examples presented here.

3.2 | Locusts as economic instruments

Another measure of social importance can be found in instruments of commerce. In ancient Babylon, the system of weights was based on the talent, or the average load that could be carried by a man or animal (about 30 kg; Powell, 1979). It is a harvest-based system of weights and measures, and it is ironic that some weighing stones were shaped into locusts (Figure 5c), the very thing that depleted yields and damaged economies. This link is explicit in the Astronomical Diaries, a series of Babylonian observations on planetary movements and historical events, including more than 20 references to locust invasions (Pirngruber, 2014). They also contain meticulous records of prices for six basic commodities, among them barley, date, and sesame. At least one locust irruption in 346 BC precedes a steep rise in the price of barley (Figure 5c). In China, the availability a thousand-year time series raises the tantalizing possibility of detecting recurring economic cycles as a direct function of climate-induced locust irruptions (of *Locusta migratoria manilensis*; Stige et al., 2007).

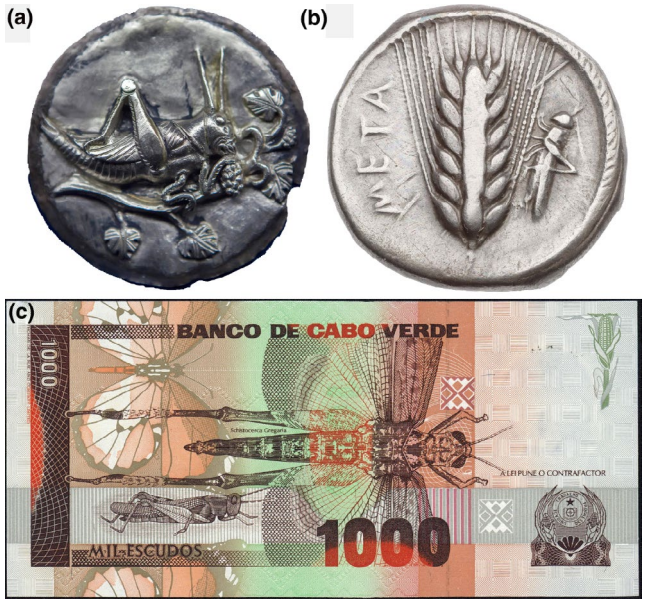

FIGURE 6 (a) Silver medallion dating to the 4th century BC, Nahavand, Iran. The insect resembles a brachypterous (short winged) adult grasshopper and it appears to be eating grapevine blossoms while stridulating (Leitmeir, 2017); that is, producing sound from the hindlimbs (photograph by Renate Kühling, reproduced with permission). (b) Silver stater of Metapontum, a city state of Magna Graecia in modern-day Italy. The reverse shows an adult locust and ear of barley, *c*. 500–473 BC. (c) Reverse side of the Cape Verde 1000 Escudo banknote issued in 1989, showing *Schistocerca gregaria* in profile and flight and facing a maize stalk in the upper right corner

In some cases, the act of economic damage is portrayed directly on currency. A few ancient medallions and coins illustrate interactions between locusts and important food crops (Figure 6a), including barley (Figure 6b). This puzzling pattern of locust imagery would repeat itself 2000 years later in Cape Verde, which issued a banknote in 1989 that practically invites two gregarious adults of *S. gregaria* to consume a stalk of maize, a vital food crop for the country (Figure 6c). It is difficult to decipher this image, but we assume it was intended as a daring symbol of defiance and resilience.

4 | CONCLUSIONS

Representations of locusts span millennia, and most have roots in the natural life cycle of locusts—they transform, they swarm, they devastate specific crops. American examples tend to exaggerate individual body sizes and overestimate the effectiveness of control efforts. Expressions of human futility are rare, except in the form of gallows humour, which begs the question: *why do we imagine locusts, and why so large?* Sontag (1965) argued that people imagine disaster to normalize and inure themselves to what is psychologically unbearable. This explanation fits many of the images and discourses described here, but we would add that many human–locust interactions are fuelled by techno-optimism, and that this exercise in imagination is important for driving human innovation. If positive affirmation is the first step towards creation, then imagining oversized locusts and human countermeasures serves an important practical purpose: it becomes the wellspring of creative anti-locust technologies. Recent examples include remote monitoring tools, computational models, citizen science cell phone apps and a fungus (*Metarhizium anisopliae*)-derived toxin marketed under the name Green Muscle (Chudzik et al., 2020; Cressman, 2008; Enserink, 2004; van Huis et al., 2007).

The efficacy of these tools is debated, however, and none should replace the need for preventative infrastructure in recession areas (Sword et al., 2010). Monitoring and control efforts tend to suffer amid armed conflicts, a key contributor to large outbreaks of *S. gregaria* between 1986 and 2002 (Showler, 2003). The present upsurge is no exception. Techno-optimism has many benefits, but it is a potential problem if it privileges reactionary technologies over proven management plans, most of which require sustained resources during recession periods. Still, the need for technical advances is likely to increase in lockstep with increasing cyclone trends in the northern Indian Ocean (Murakami et al., 2020; Salih et al., 2020), suggesting that desert locusts will continue to invade the fertile fields of our collective imagination as they transform into a metaphor for climate change.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

N.J.D. and L.D.F. conceived the essay and wrote the manuscript. Both authors contributed to revisions and gave final approval for publication.

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This paper does not include any data.

ORCID

Nathaniel J. Dominy https://orcid.org/0000-0001-5916-418X
Luke D. Fannin https://orcid.org/0000-0003-4810-4442

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