Introduction

Laura Hollsten, Suvi Rytty, Otto Latva, Sanna Lillbroända-Annala and Tuomas Räsänen

"Here, in these small, and […] so despised creatures, we can find the greatest masterpieces of nature." Thus wrote Carl von Linné in 1739 in a speech where he admired the remarkable talents of insects. Insects have been living on our planet for more than 400 million years, and, according to entomologist Karl Kjer, they did everything first: "They were the first to form social societies, farm, and sing – just about anything you can imagine."[1] Termites and ants, as well as some species of bees and wasps, build societies that exhibit social behavior and a division of labor. Leaf cutter ants carry out agricultural work: they can cut leaves without digesting them but feed the leaves to their fungus garden and eat the fungus. For many insects, such as crickets and cicadas, sound is an important form of communication: some insects squeak, scratch or hiss while others rattle and beep.

Insects are among the most abundant organisms on Earth, with about 1.4 billion for every human. Together with arachnids and other invertebrate animals, they form the biological foundation for all agricultural production, and without them ecosystems would not be able to flourish. Insects are responsible for the pollination of about 80 percent of the trees and bushes on Earth and they play a crucial role in the dispersal of fruit and seeds from plants. Arachnids are equally essential to biodiversity. Spiders are the most important predatory invertebrates living in rural and urban areas, thereby affecting human cultures. The predaceous habits of arachnids are vital to humans, as they can serve as an environmentally-friendly form of pest control by keeping the populations of flies, mosquitoes, and aphids in check. Mites are another group of arachnids, and they live in a variety of ecosystems and play an important role as they decompose animal and plant matter, thereby enabling the release of nutrients that are later utilized for growing plants. Some species of mites also serve as natural pest controllers, in that they manage types of fungus gnats and soil pests.

1 M.D. Trautwein et al., "Advances in Insect Phylogeny at the Dawn of the Postgenomic Era," *Annual Review of Entomology* 57 (2012). See also Brandon Bryn, "Insects Evolved with Earth's First Land Plants," American Association of the Advancement of Science, https://www.aaas.org/news/science-insects-evolved-earths-first-land-plants.

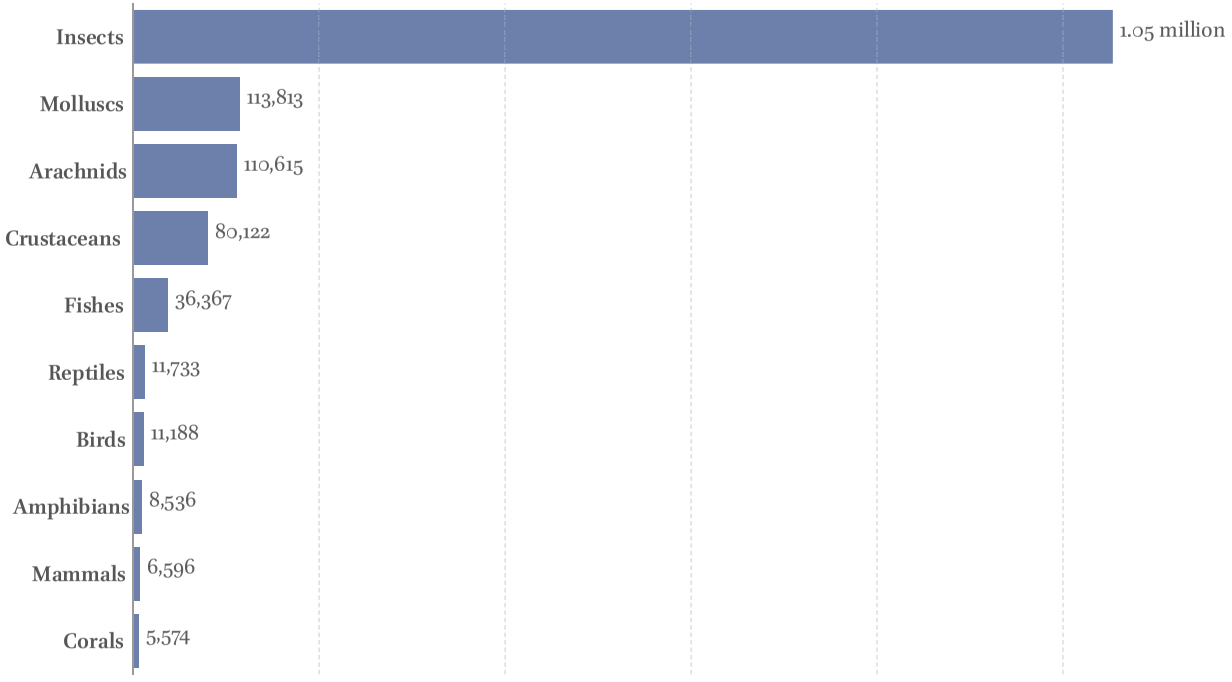

FIGURE 1.1 The vast majority of species on Earth are insects or arachnids. "Data Page: Number of described species", part of the following publication: Hannah Ritchie, Fiona Spooner and Max Roser (2022) – "Biodiversity"
DATA ADAPTED FROM INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN) RED LIST. RETRIEVED FROM HTTPS://OURWORLDINDATA.ORG/GRAPHER/NUMBER-OF-DESCRIBED-SPECIES [ONLINE RESOURCE]

While invertebrates have been sustaining ecosystems for millions of years, humans are latecomers. During our short spell on Earth, we have been dependent on insects and arachnids for food and sustenance. Yet, as our numbers have grown and human ways of life have evolved, we have invaded ecosystems to the point where insect populations are in global decline. The columnist George Monbiot, of *The Guardian*, coined the term "insectageddon" to highlight the implications of the global decline in insect populations.[2]

Until recently, insect biologists and entomologists, who focus on insects and their relationship with humans, have been almost the only group of researchers to be concerned about the ongoing collapse of insect populations. For other scholars, not to mention the general public, the decline in insect populations has been less visible. Often, the absence of bugs that sting, bite and contaminate our bodies, homes, and fields, and terrorize our companion and farm animals, has been a cause of relief rather than alarm. Those of us who are neither biologists nor entomologists do not always appreciate the vast variety of insects on the planet. Our attitude towards them is often characterized by a value judgment based on social, cultural, religious, economic and health reasons, through which we define insects and arachnids as either good or bad, useful or harmful, beautiful or disgusting.

These dichotomies have a long history. Some insects and arachnids have been regarded as sacred beings in certain cultures. The dung beetle was worshiped as the earthly manifestation of the sun, as well as the symbol of rebirth and resurrection in ancient Egypt. The scarab beetle rolls a ball of manure, which created a belief among the Egyptians that a god would reset the sun and roll it out into the sky every morning.[3] Spiders, for their part, have been associated with creation myths as their ability to weave webs can be seen as a metaphor for creating new worlds. Female spider figures feature in many cultures. A spider grandmother, for example, plays an important role in the Navajo creation myth, while the female spider figure of Jorogumo appears in Japanese folklore.[4] Spiders also carry meaning in today's popular culture, both

2 George Monbiot, "Insectageddon: The Scale and Speed of Environmental Collapse is Beyond Imagination," *The Guardian*, October 20, 2017; Jeroen P. van der Sluijs, "Insect Decline, an Emerging Global Environmental Risk," *Current Opinion in Environmental Sustainability* 46 (2020), doi:10.1016/j.cosust.2020.08.012.

3 Mohamed A. Kenawy and Yousrya Abdel-Hamid, "Insects in Ancient (Pharaonic) Egypt: A Review of Fauna, Their Mythological and Religious Significance and Associated Diseases," *Egyptian Academic Journal of Biological Sciences. A, Entomology* 8, no. 1 (2015): 22.

4 Abba A. Abba, "Transcending Cultural Boundary: Renegotiating the Significance of the Spider Folktale," *Journal of Literature, Languages and Linguistics* 27 (2016); Gene Kritsky and Ron H. Cherry, *Insect Mythology* (San Jose, CA: Writers Club Press, 2000); Natalie E. Duffus, Craig R. Christie and Juliano Morimoto, "Insect Cultural Services: How Insects Have

as villains, such as the spider-like monster Shelob in *The Lord of the Rings* and as heroic figures such as Spiderman.[5]

Pollinators, such as bees, have long been perceived as useful. Human interaction with them by robbing wild bees of their honey began in the prehistoric period, possibly even before the appearance of *Homo sapiens*. The oldest evidence of true beekeeping comes from ancient Egypt.[6] Insects and arachnids, as well as products made by and out of them, have played a role in the global economy as they have been traded as useful global commodities, the most famous of which is arguably silk, produced by the larvae of the mulberry silkworm (*Bombyx mori*). Natural historians, merchants, and agriculturalists have been involved in the acquisition and development of other beneficial insects in European countries, engaging in what could be termed as practical entomology.

Medicine was an important area of use in ancient and early modern times. Ants have been used in folk medicine and were recommended in some early modern pharmacopeias.[7] Spanish flies (*Lytta vesicatoria*) are beetles, which the Spanish exported to pharmacies throughout Europe and which thereafter figured in pharmacopeias up until the beginning of the twentieth century. The active substance cantharidin these beetles contain was believed to increase blood circulation and to alleviate toothache, muscle pain, fever, and rheumatism.[8] Crushed spiders and spider oil have been used as amulets in folk medicine. Insects containing carminic acid have been important ingredients in red dyes. Crushed Kermes lice were used until Europeans began importing cochineal from Central and South America, where the lice were farmed on plantations from the sixteenth century.[9] Another red dye imported to Europe from

---

Changed Our Lives and How Can We Do Better for Them," *Insects* 12, no. 5 (2021), doi:10.3390/insects12050377.

5 Emily A. Geest, Ashley R. Knoch and Andrine A. Shufran, "Villainous Snakes and Heroic Butterflies, the Moral Alignment of Animal-Themed Characters in American Superhero Comic Books," *Journal of Graphic Novels and Comics* 13, no. 5 (2022).

6 Gene Kritsky, "Beekeeping from Antiquity Through the Middle Ages," *Annual Review of Entomology* 62, no. 1 (2017), doi:10.1146/annurev-ento-031616-035115.

7 I. Svanberg and Å. Berggren, "Ant Schnapps for Health and Pleasure: The Use of Formica rufa L. (Hymenoptera: Formicidae) to Flavour Aquavit," *Journal of Ethnobiology and Ethnomedicine* 15, no. 1 (2019), doi:10.1186/s13002-019-0347-7.

8 Aleksander Karol Smakosz, "Bug as a Drug. Lytta vesicatoria L. Applications in Nineteenth Century Official Medicine," *Pharmacognosy Reviews* 16, no. 31 (2022).

9 Abraham Rowe, "Global Cochineal Production: Scale, Welfare Concerns, and Potential Interventions," (2020), doi:10.31219/osf.io/t57w2; Carlos Marichal, "Mexican Cochineal, Local Technologies and the Rise of Global Trade from the Sixteenth to the Nineteenth Centuries," in *Global History and New Polycentric Approaches Europe, Asia and the Americas in a World*

Southeast Asia was shellac, a resin that is formed in the bark of trees where the female lac bug (*Kerria lacca* or *Lacifer lacca*) secretes it. Shellack was used as a dye, a binding agent in pigments and for various types of polish.[10]

Humans and social insects have both developed divisions of labor, but the human farming of silkworms, bees and edible insects create a relation of insect subordination, where insects can be viewed as slaves, laborers, or domestic animals, depending on our perspective.[11] Farming insects for dye, fabric, medicine, and food has in recent years raised questions of insect welfare and ethical concern. Recent research shows that adult dipterans, cockroaches, bees, grasshoppers, butterflies, and some beetles feel pain. As for arachnids, the research on the subject is so far inconclusive.[12]

The raising and killing of insects in food production is less regulated than that of conventional livestock. Insect farmers and consumers of edible insects now face questions about what insect welfare means, and how it might differ from vertebrate welfare. A further question concerns the treatment of insects in entomology and using insects in experiments, which often means causing them pain or killing them. Generally speaking, the discussion about human ethical obligations towards insects is nothing new, for some religions, such as Jainism or Buddhism, have for centuries forbidden harming or killing insects.

Ethical thinking extended to insects is complicated by the fact that many of them are harmful from a human perspective. Various pests, lice, and bedbugs have annoyed and troubled people since antiquity and biblical times. Locusts, grasshoppers, and crickets, for example, have been perceived as threats to agricultural productivity. Some insects and arachnids are harmful as they pose a threat to human and animal health, although the awareness that insects can spread diseases only grew with the development of bacteriology. For example, it was not until the end of the nineteenth century that the transmission of the causative bacterium of plague from rodents by flea bites was shown.[13]

Network System, ed. Manuel Perez Garcia and Lucio De Sousa (Singapore: Palgrave Macmillan, 2018).

10 Edward D. Melillo, "Global Entomologies: Insects, Empires, and the 'Synthetic Age' in World History," *Past & Present* 223, no. 1 (2014).

11 Jennifer Bonnell, "Occupational Hazards: Honeybee Labour as an Interpretive Device in Animal History" in *Traces of the Animal Past: Methodological Challenges in Animal History*, ed. Jennifer Bonnell and Sean Kheraj (Calgary: University of Calgary Press, 2022).

12 S. Kralj-Fišer and M. Gregorič, "Spider Welfare," in *The Welfare of Invertebrate Animals*, ed. Claudio Carere and Jennifer Mather (Cham: Springer, 2019).

13 T. Butler, "Plague History: Yersin's Discovery of the Causative Bacterium in 1894 Enabled, in the Subsequent Century, Scientific Progress in Understanding the Disease and the Development of Treatments and Vaccines," *Clinical Microbiology and Infection* 20, no. 3 (2014): 202.

Today, it is known that bloodsucking insects and arachnids, such as mosquitoes, ticks, and fleas, act as vectors transmitting infectious pathogens, such as parasites, bacteria, or viruses, between humans, or from animals to humans. Vector-borne diseases, the most well-known of which include malaria, dengue, chikungunya fever, yellow fever, the Zika virus, West Nile fever, Japanese encephalitis, tick-borne encephalitis and Lyme borreliosis, are a real threat for millions of people throughout the world. Vector-borne diseases account for more than 17% of all infectious diseases and cause more than 700,000 deaths annually. The burden of them is highest in tropical and subtropical areas, and they tend to affect the poorest populations.[14]

Climate change has increased the geographic spread of vector-borne diseases since vectors, such as mosquitoes and ticks, are climate-sensitive and benefit from a warmer climate and changing rainfall patterns. Ticks (*Ixodes*), which transmit a wide variety of pathogens not only in the tropics but also in temperate North America, Europe, and Asia keep proliferating and moving into northern areas that were once too cold for them. As a result, the problem of tick-borne diseases has extended to new areas such as Canada and northern Europe, but ticks have also spread to higher altitudes in Central Europe and in the Greater Alpine Region.[15]

Another example of a species that has spread as a result of anthropogenic environmental change is the spruce bark beetle (*Ips typographus*), which is causing considerable damage to European and North American forests because it benefits from higher temperatures and storm damage. It also thrives in monocultural spruce forests favored by the wood processing industry. Hitherto, human attitudes toward insects and arachnids that are considered to be harmful to humans and their economical endeavors have been marked by hostility. The perceived necessity to annihilate insects has even been expressed in terms of warfare.

Pesticides have been used for centuries to fight off harmful insects. The increase in commerce and transport, together with the expansion of monoculture, contributed to the global spread of insect pests. In turn, this led to the use of pesticides, such as arsenic compounds and nicotine, and, after the Second World War, synthetic pesticides. Their use intensified after the second half of

14 World Health Organization, "Vector-borne diseases," https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases.

15 Shlomit Paz, "Climate Change Impacts on Vector-Borne Diseases in Europe: Risks, Predictions and Actions," *The Lancet Regional Health – Europe* 1 (2021): 1, doi:10.1016/j.lanepe.2020.100017; Patricia A. Nuttall, "Climate Change Impacts on Ticks and Tick-Borne Infections," *Biologia* 77 (2022): 1503, doi:10.1007/s11756-021-00927-2.

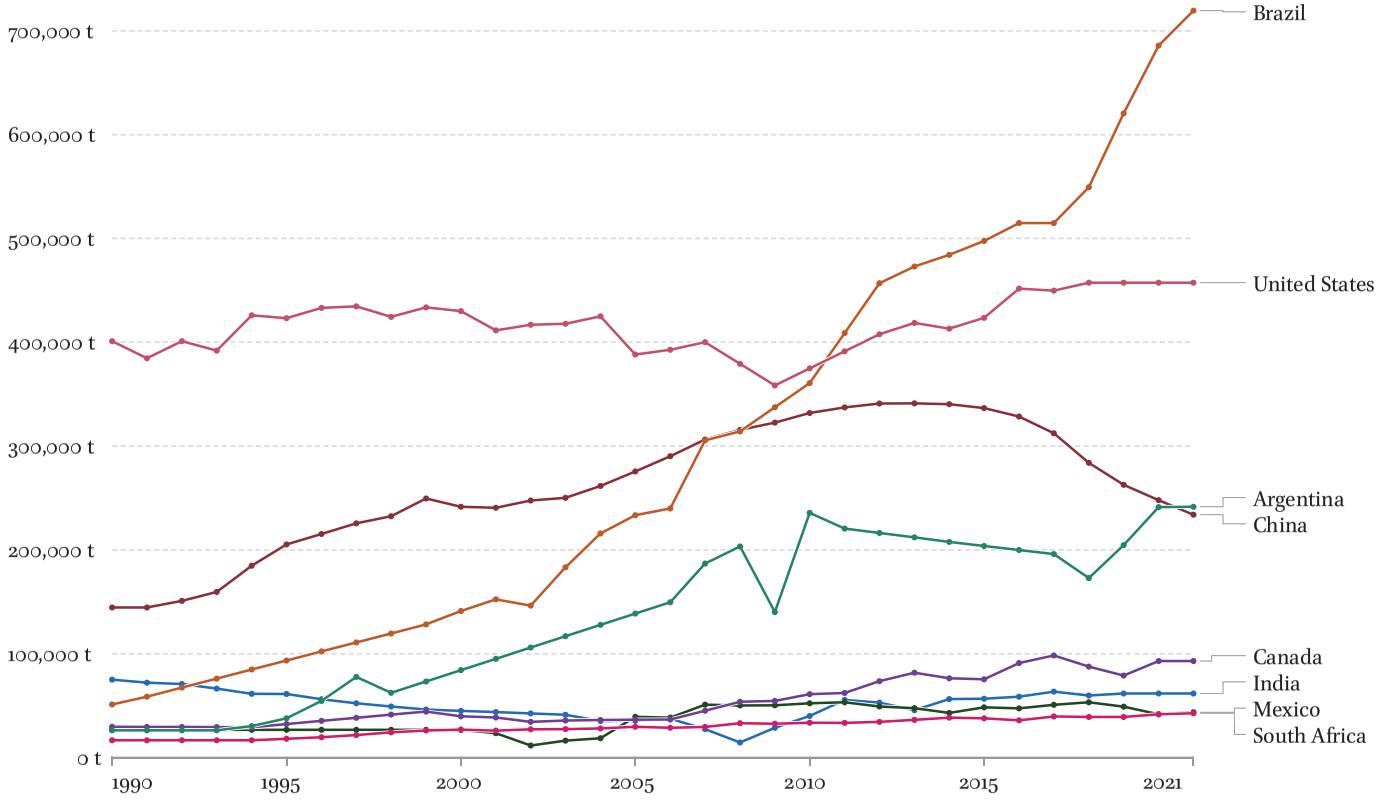

FIGURE 1.2 Graph showing pesticide use in Europe, Asia, Africa, Australia and North and South America from 1990 to 2020. "Data Page: Total pesticide use", part of the following publication: Hannah Ritchie, Pablo Rosado and Max Roser (2023) – "Agricultural Production" DATA ADAPTED FROM FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. RETRIEVED FROM HTTPS://OURWORLDINDATA.ORG/GRAPHER/PESTICIDE-USE-TONNES [ONLINE RESOURCE]

the nineteenth century, reaching new heights in the 1990s (see Figure 1.2).[16] According to José Ramón Bertomeu-Sánchez, factors contributing to the global circulation of DDT in the 1950s and 1960s included intensive monoculture farming, the involvement of chemical industry, and experts who advocated its use in public health and pest control, but also the geopolitical strategies of the Cold War and transnational institutions.[17] The consequences of DDT are now well-known: in 1948 D.E. Howell discovered DDT in human fat, and soon biologists found that fish feeding on insects had also been killed.[18] In 1962, Rachel Carson brought attention to the lethal impact of DDT on birds – and possibly on humans. These interrelated developments began to demonstrate the workings of multispecies ecological networks and their fragility.

Insects and arachnids often represent an aspect of the natural world we wish to keep at a safe distance. Nevertheless, they invade our homes, both as unwanted vermin and as harmful guests buzzing around our windows. The idea that home is a human place excluding nature is fundamental to Western conceptualizations of domestic space. The Australian scholar Emma R. Power writes that pests appear as nonhuman species that disrupt people's experiences of home and their sense of security and purity.[19] Human border-making and narratives that depict human habitat as an inappropriate abode for pests are significant in these discussions.

Bugs not only occupy our homes, but they also invade our bodies. Besides various bacteria, worms and lice, intrusive creatures, such as Deer fly and ticks attach themselves to human bodies. Consequently, they cross, intersect and break the boundaries between humans and animals and humans and nature. An alternate view of pests emerges through a stance whereby pests become

16 José Ramón Bertomeu-Sánchez, "Introduction. Pesticides: Past and Present," *HoST-Journal of History of Science and Technology* 13, no. 1 (2019). For general overviews on the history of pesticides, see Frederick Rowe Davis, *Banned: A History of Pesticides and the Science of Toxicology* (New Haven: Yale University Press, 2014); Graham A. Matthews, *A History of Pesticides* (Boston, MA: Cabi, 2018).

17 Bertomeu-Sánchez, "Pesticides: Past and Present". See also Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (Cambridge: Cambridge University Press, 2001).

18 Frank N. Egerton, "Understanding Food Chains and Food Webs, 1700–1970," *Bulletin of the Ecological Society of America* 88, no. 1 (2007).

19 Emma R. Power, "Nature in the Home," in *International Encyclopedia of Housing and Home*, ed. Susan J. Smith (San Diego: Elsevier Science & Technology, 2012); Emma R. Power, "Pests and Home-Making: Depictions of Pests in Homemaker Magazines," *Home Cultures* 4, no. 3 (2007); Emma R. Power, "Kill'em dead!: The Ordinary Practices of Pest Control in the Home," *Antennae: The Journal of Nature in Visual Culture* 23 (2012).

part of human space and human experiences of space. As researchers Riikka Hohti and Maggie MacLure have observed, insects, like viruses, "oblige us to rethink the boundaries between inside and outside, proximity and distance, the one and the many, life and death." They argue that thinking *with* insects can reorient thought and action, open up theoretical and practical directions, and inform the development of methodologies.[20]

Eventually, how people interpret the insect worlds is influenced by the articulation of human difference due to categories such as gender, social and economic status, ethnic identity or culture. In Western culture, for example, an interest in bugs has traditionally been seen as a masculine trait, while femininity has been emphasized by a dislike of bugs.[21] The history of colonialism, meanwhile, provides an example of how political-economic interests influenced the attitudes and actions of colonial officials towards insects and how it highlighted racial inequalities. Especially in Sub-Saharan Africa, the tremendous malaria mortality figures of white settlers were the largest obstacle to colonization. Hence, the study of malaria and the development of tropical medicine in the late nineteenth century were intended to protect colonial interests, rather than to help indigenous people or to defeat malaria more broadly.[22]

Sometimes images of bugs as disgusting, pestilent or invasive intruders have been projected onto particular groups of people, such as migrants and minorities, to enhance differences and to justify inequality, discrimination or even persecution. As Miriam Ticktin has noted, the imagery about invasive others takes many forms.[23] Already in 1964, Alex Bein studied the history of the denunciation of Jews as parasites, increasingly understood not merely as metaphor but as a biological term.[24] Similarly, historian Clapperton Mavhunga has shown how freedom fighters were likened to subhuman "vermin beings" to be exterminated during the Zimbabwean War of Liberation.[25] Samuel Dolbee

20 Riikka Hohti and Maggie MacLure, "Insect-Thinking as Resistance to Education's Human Exceptionalism: Relationality and Cuts in More-Than-Human Childhoods," *Qualitative Inquiry* 28, no. 3–4 (2022).

21 See for example Michaela Fenske's chapter in this volume.

22 Jesse B. Bump and Ifeyinwa Aniebo, "Colonialism, Malaria, and the Decolonization of Global Health," *PLOS Global Public Health* 2, no. 9 (2022), doi:10.1371/journal.pgph.0000936.

23 Miriam Ticktin, "Invasive Others: Toward a Contaminated World," *Social Research: An International Quarterly, Special Issue on the Invasive Other* 84, no. 1 (2017).

24 Alex Bein, "The Jewish Parasite: Notes on the Semantics of the Jewish Problem, with Special Reference to Germany," *The Leo Baeck Institute Year Book* 9, no. 1 (1964), doi:10.1093/leobaeck/9.1.3.

25 Clapperton Chakanetsa Mavhunga, "Vermin Beings: On Pestiferous Animals and Human Game," *Social Text* 29, no. 1 (2011). See also Russell, *War and Nature*.

presents a striking example of how locusts shaped people's imagination and impacted the lives of deportees in the Ottoman region during the Armenian genocide. Along the road of deportation Armenians were not only symbolically linked with swarms of locusts, but the deportations also made the locust invasions worse, as fallow and unplowed lands formed excellent breeding grounds for these bugs. Because the locusts had consumed everything on their way, the deportees had to eat locusts in turn, which also served as a means of survival.[26]

1 Thinking about Insects and Arachnids in the Humanities and Social Sciences

Traditionally, insects and arachnids, as well as the diseases they spread have been studied in the context of natural sciences. Although bugs of all sorts have preceded, co-evolved and lived with humans in a variety of ways, and affected societal and historical developments as co-agents, human relations to them have remained rather scantily investigated from the perspective of the humanities and social sciences – except perhaps when insects have been examined as the vectors of devastating diseases. As the burden of arthropod-borne diseases has traditionally been the heaviest in the tropics, historians of Africa have since the 1970s examined human responses to disease-carrying insects and arachnids, such as tsetse flies and ticks.[27] Human attitudes to and actions against mosquitoes as the deadliest human killers in history have also been the subject of much research, particularly in the context of colonial history.[28]

---

26 Samuel Dolbee, *Locusts of Power: Borders, Empire, and Environment in the Modern Middle East* (Cambridge: Cambridge University Press, 2023). See also Jeannie N. Shinozuka, *Biotic Borders: Transpacific Plant and Insect Migration and the Rise of Anti-Asian Racism in America, 1890–1950* (Chicago: University of Chicago Press, 2022), which builds connections between transpacific plant and insect migration and the rise of anti-Asian racism in America during the early decades of the 20th century.

27 See for example Helge Kjekshus, *Ecology Control and Economic Development in East African History: The Case of Tanganyika 1850–1950* (Berkeley: University of California Press, 2022); James L. Giblin, "East Coast Fever in Socio-Historical Context: A Case Study from Tanzania," *The International Journal of African Historical Studies* 23, no. 3 (1990), doi:10.2307/219597; Paul F. Cranefield, *Science and Empire: East Coast Fever in Rhodesia and the Transvaal* (Cambridge: Cambridge University Press, 2002).

28 John R. McNeill, *Mosquito Empires: Ecology and War in the Greater Caribbean, 1620–1914* (Cambridge: Cambridge University Press, 2010); Rohan Deb Roy, *Malarial Subjects: Empire, Medicine and Nonhumans in British India, 1820–1909* (Cambridge: Cambridge University Press, 2017); Timothy C. Winegard, *The Mosquitoes: A Human History of Our Deadliest*

In the global North, where the role of disease vectors and pests has been less pronounced than in tropical regions, the interest in studying insects and other bugs from the perspective of humanities seems to be more recent. In addition to the history of medicine,[29] bugs have attracted attention in the history of science and ideas when studying for instance the history of entomology and knowledge production in natural history.[30] Climate change and the related proliferation of ticks in the Western countries have generated social debate on tick-borne diseases, which has lately drawn also the attention of sociologists and historians in Western Europe and North America.[31] As for northern Europe, by contrast, the ways in which the proliferation of ticks carrying diseases has affected human behavior and societies is still a rather unexplored subject.

Due to scientific research and ecological thinking, the value of insects and arachnids as useful parts of the ecosystem has been increasingly recognized in recent decades. There is a growing awareness of their role in the survival of the living world and human culture.[32] The global decline of insect populations and the spreading of certain disease vectors to new areas reflect how bugs are

---

Predator (New York, NY: Dutton, 2019). On empires and insects, see, Pierre-Etienne Stockland, "Statecraft and Insect Oeconomies in the Global French Enlightenment (1670–1815)" (Ph.D. diss., Columbia University, 2018).

29 Plague is perhaps one of the most studied zoonotic disease in the Western history of medicine, see for example Ole Jørgen Benedictow, *The Complete History of the Black Death* (Woodbridge, Suffolk: The Boydell Press, 2021).

30 One of the earliest historical researches on human reactions to ectoparasites was James Ronald Busvine's *Insects, Hygiene and History* (London: Athlone Press, 1976). For more recent research on "vermin" as creatures and category in the early modern literary, scientific, and political imagination, see Lucinda Cole, *Imperfect Creatures: Vermin, Literature, and the Sciences of Life, 1600–1740* (Ann Arbor: University of Michigan Press, 2016). For research on the scientific production of knowledge about insects, see for example Brian W. Ogilvie, "Order of Insects: Insect Species and Metamorphosis between Renaissance and Enlightenment," in *The Life Sciences in Early Modern Philosophy*, ed. Ohad Nachtomy and Justin E.H. Smith (Oxford: Oxford University Press, 2014); Mary Terrall, "Following Insects Around: Tools and Techniques of Eighteenth-Century Natural History," *The British Journal for the History of Science* 43, no. 4 (2010); Mary Terrall, *Catching Nature in the Act: Réaumur and the Practice of Natural History in the Eighteenth Century* (Chicago: University of Chicago Press, 2014).

31 See for example Robert A. Aronowitz, "Lyme Disease: The Social Construction of a New Disease and Its Social Consequences," *The Milbank Quarterly* 69, no. 1 (1991); P. Peretti-Watel, J. Ward, R. Lutaud and V. Seror, "Lyme Disease: Insight from Social Sciences," *Médecine et Maladies Infectieuses* 49 (2019).

32 Timothy D. Schowalter, *Insects and Society* (Boca Raton, FL: CRC Press, 2019); Uli Beisel, Ann H. Kelly and Noémi Tousignant, "Knowing Insects: Hosts, Vectors and Companions of Science," *Science as Culture* 22, no. 1 (2013), doi:10.1080/09505431.2013.776367.

affected by and entangled with the most threatening and debated global environmental changes, often referred to with the catchphrase the Anthropocene. These include climate change as well as the complex issues of biodiversity crisis and human-animal relations. These are problems that science alone cannot solve, because they are dependent on human behavior directed by social and cultural values and conventions, political and religious ideas as well as how people see themselves in relationship to the world around them.[33]

Consequently, investigating interactions between humans and insects/arachnids is essential within the humanities and social sciences. A fitting perspective is provided by the environmental humanities, which approaches ecological crises by taking seriously cultural differences and divergent histories, values and ethical frameworks, as well as questions of socioeconomic inequality,[34] but also by the human-animal studies investigating the relations and interactions between humans, nonhuman animals, society and culture. In the West, there is a burgeoning interest in studying insects from the perspectives offered by these research trends,[35] but as researchers within the area of human-animal studies have noted, the field has been characterized by a certain bias toward vertebrates, in particular mammals.[36]

Humans tend to be more likely to feel an affinity or kinship with other animals that are perceived as similar, whereas insects are perceived as different and difficult to understand or sympathize with. Nevertheless, we do share several characteristics with insects. For example, 60 percent of the DNA code of fruit flies and humans is identical,[37] most of the enzymes made by insects

33 Sverker Sörlin, "Environmental Humanities: Why Should Biologists Interested in the Environment Take the Humanities Seriously?," *BioScience* 62, no. 9 (2012), doi:10.1525/bio.2012.62.9.2.

34 Ursula K. Heise, "Introduction: Planet, Species, Justice – and the Stories We Tell About Them," in *The Routledge Companion to the Environmental Humanities,* 1st ed., ed. Ursula Heise, Jon Christensen and Michelle Niemann (London: Routledge, 2017), 2.

35 For example how poison and honey draw bee and beekeeper together in uneven gift relations, and how beekeepers make their bodies and their selves vulnerable to bees have been examined by Kelsey Green and Franklin Ginn, "The Smell of Selfless Love: Sharing Vulnerability with Bees in Alternative Apiculture," *Environmental Humanities* 4 (2014). Brian Morris's book *Insects and Human Life* (London: Routledge, 2006) studies how differently people respond to, make use of, and relate to insects in non-Western cultures. In *A Philosophy of the Insect* (New York: Columbia University Press, 2019) Jean-Marc Drouin has explored the question of what insects are as well as their scientific, aesthetic, ethical, and historical relationship with humanity.

36 Lisa Jean Moore and Rhoda M. Wilkie, "Introduction to *The Silent Majority: Invertebrates in Human-Animal Studies*," *Society and Animals* 27, no. 7 (2019), doi:10.1163/15685306-00001903.

37 University of Cambridge, "How Close Are You to a Fruit Fly."

and humans are very similar, both humans and insects possess brains, hearts, digestive tracts and reproductive organs, and human muscles and nerve cells work in a similar way to those of many insects. There are also similarities in behavior: many insects give gifts or sing to potential mates.[38]

Due to their unquestionable significance for humans and the global ecosystem, it is time to counteract the bias towards mammals and to bring insects into the humanities and social sciences. We urgently need deeper and more nuanced insights into insects and arachnids as parts of natureculture,[39] a concept illuminating the inseparability between nature and culture in ecological relationships, which are both biophysically and socially formed. This anthology aspires to provide this by examining the numerous ways in which human lives intersect with, influence, and are influenced by insects and arachnids as part of a wider network of species, but also of social and cultural interpretations and perceptions.

The overarching theme of the volume is the various ways insects and arachnids have acted as agents of change in diverse eco-social networks, consisting of humans, other classes of non-humans and inanimate nature. In this vein, the authors in this book investigate how the agency and actions of insects and arachnids have been perceived and interpreted, seen or remained unseen, from the early modern period to the present day. This includes how these perceptions and interpretations have been intertwined or collided with, as well as influenced by, ecological and social factors, such as climate change and the population dynamics of wildlife, financial and political interests, and different cultural conceptions.

The authors in this volume also examine various forms of knowledge, ranging from scientific studies to everyday awareness and experiences. Another point of focus is how these conceptions have been narrated and negotiated, and how they have affected our everyday practices and interactions with insects, arachnids, and their host animals, as well as the wider natural environment. Finally, the volume sheds light on questions concerning how to live together with insects and arachnids and how to nurture a new ethics that incorporates insects into the sphere of moral evaluation.

• • •

38 Arizona State University, "Ask a Biologist."

39 Donna J. Haraway, *When Species Meet* (Minneapolis, MN: University of Minnesota Press, 2008).

The starting point for this publication has been a research project entitled *Humans and Ticks in the Anthropocene* (330762),[40] funded by the Research Council of Finland between 2020–2024. The research team of this project consists of historians, ethnologists and social scientists from the University of Eastern Finland, Åbo Akademi University and the University of Turku. The project aims to examine the multi-faceted relationship between humans and ticks, and seeks to provide a comprehensive analysis of the discussions about ticks in the Finnish society from the late nineteenth century to the present. Therefore, several chapters in this volume examine human relations to ticks in the Finnish context, starting from the observation that human attitudes towards ticks have been largely determined by the awareness that ticks can spread many harmful pathogens.

In Finland, it was realized already in the latter part of the 19th century that these previously harmless pests could actually be spreading diseases to domestic animals. However, it was the knowledge that ticks could also spread serious diseases to humans that changed people's attitudes towards them. Tick-borne diseases of public health importance throughout Europe including Finland, are borreliosis (Lyme disease)[41] and tick-borne encephalitis (TBE).[42]

40 "Humans and Ticks in the Anthropocene."

41 Borreliosis or Lyme disease, caused by the bacterium *Borrelia burgdorferi*, is the most common vector-borne disease in Europe and in North America. The infection can affect the skin, nervous system, joints, and heart. No vaccine against borreliosis is currently available, but most cases can be treated successfully with a few weeks of antibiotics. An estimated 65,000–85,000 Lyme borreliosis cases per year were reported in Europe in 2006, although the disease is suspected to be significantly underreported. Based on clinical symptoms, more than 5000 Lyme disease cases were reported in Finland in 2022. See Leah Burn et al., "Incidence of Lyme Borreliosis in Europe from National Surveillance Systems (2005–2020)," *Vector Borne Zoonotic Dis.* 23, no. 4 (2023), doi:10.1089/vbz.2022.0071; The Finnish Institute for Health and Welfare, "Borrelioosin seuranta ja esiintyvyys Suomessa", last modified December 15, 2023, https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/taudit-ja-torjunta/taudit-ja-taudinaiheuttajat-a-o/borrelia/borrelioosin-seuranta-ja-esiintyvyys-suomessa.

42 TBE is a viral infectious disease that attacks the central nervous system and can even lead to death. It can, however, be prevented with a vaccine. The disease is widespread from central Europe through Siberia to Japan. It is caused by a flavivirus which includes three subtypes: European, Far-eastern, and Siberian. In 2020, there were over 3700 confirmed TBE cases reported in Europe. In 2022 the number of confirmed cases in Finland was 123. European Centre for Disease Prevention and Control, "Tick-Borne Encephalitis," in *ECDC, Annual epidemiological report for 2020* (Stockholm: ECDC, 2022); The Finnish Institute for Health and Welfare, "Puutiaisaivotulehduksen esiintyvyys Suomessa," last modified January15,2024,https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/taudit-ja-torjunta/taudit-ja-taudinaiheuttajat-a-o/puutiaisaivotulehdus/puutiaisaivotulehduksen-esiintyvyys-suomessa.

TBE – initially known by the Finns as Kumlinge disease – was discovered already in the 1950s,[43] but it was the prevalence of Lyme disease which became apparent in the 1990s that marked a watershed period after which people's attitudes towards ticks began to be determined by fear and loathing.[44]

In order to broaden the picture of multispecies networks affecting human relations to bugs, the Finnish research team organized in March 2022 an international seminar "Humans, Ticks and Insects in Multispecies Networks" that resulted in this anthology. The chapters in this volume widen the perspective from ticks to other arachnids and insects such as spiders, violet carpenter bees, wasps, flies, ants, cockroaches, beetles, grasshoppers, mosquitoes, and ratfleas, while the geographical scope expands from Finland to Western Europe, and from North America to India, as well as to Réunion and Mauritius.

In the chapters the humans interacting with insects and arachnids include natural historians and scientists, journalists, wildlife documentarists, public health officials, colonial administrators, physicians, and hunters, but also informants both in Réunion and Mauritius discussing their encounters with mosquitoes, and in Finland describing their experiences and feelings regarding ticks. They all represent categories of human difference, which shapes how humans interpret bug worlds.

Although the authors in this volume represent different scholarly traditions, such as history, ethnology, anthropology, media studies, sociology and environmental policy, the chapters are linked to each other through themes that intertwine and intersect throughout the volume. These are the ethics of human-arthropod relations; the formation, transmission, and circulation of knowledge about insects and arachnids; different ways of seeing, perceiving and representing insects and arachnids; ways of understanding the diseases caused by insects and arachnids and efforts to manage the health risks they pose; and eco-social networks in which insects and arachnids form a part.

In the opening chapter, Michaela Fenske observes that a different, more mindful attitude toward insect rights supports the development of new human practices and new aesthetics as well as new ethics. She proposes an "ethics of situatedness," which takes into account specific circumstances, and questions binary thinking in which the arguments are either in favor of or against all insects. Minna Santaoja notes in her chapter that insects tend to be placed differently on human moral scales: the dichotomous view of the benign bee, for example, and the aggressive wasp has a long history, based on anthropomorphic constructions. By deconstructing the story of wasps as aggressive and

43 See for example Suvi Rytty's chapter in this volume.
44 See for example Otto Latva's chapter in this volume.

exploring narratives for wasp-human conviviality she proposes rehearsing multispecies narratives of animacy in order to allow us to be better prepared in human-wasp encounters.

Laura Hollsten examines scholarly knowledge, traditional knowledge and practical knowledge about spiders in connection with the use of spiders in medicine, natural history, and silk production in eighteenth-century Europe. One of the objectives of her chapter is to bring spiders into the study, not simply as objects of knowledge, but as crucial parts of knowledge networks. In a chapter about the development and decline of economic entomology, Sophie FitzMaurice discusses the intricate relationship between scientific practice, agriculture, religion, and ethics in nineteenth- and early twentieth-century America, noting that the knowledge propagated by American entomologists drew from farmers' practical experience. In a comparison between economic entomology and economic ornithology, FitzMaurice shows that representatives of both disciplines sorted the natural world into the dichotomous categories of beneficial and injurious species.

The debates about gene drive mosquitoes and the ambition to eradicate mosquitoes from the point of view of more-than-human biopolitics are discussed by Marianne Mäkelin. The development of genetically modified, so-called gene drive mosquitoes marks a new chapter in human-mosquito relations, evoking much positive interest. Mäkelin explores these ethical and political debates about the development and conditions of the possible use of gene drive mosquitoes, thereby participating in discussions on how insects shape networks of global biosciences and environmental interventions.

Knowledge about insects and arachnids has been circulated not only in the context of natural history and science, but also in various media. Otto Latva examines the relationship between ticks and people in Finland between 1889 and 1990 by studying Finnish public discussion in newspapers and magazines. His findings show that the habit of perceiving ticks as a harmless nuisance persisted in Finnish culture for a surprisingly long time. Although red water fever, which kills cattle, and tick-borne encephalitis, which causes severe symptoms in humans, were known to be tick-borne diseases, they did not cause a significant change in the way ticks were discussed in the press. It was only with the discovery of the link between Lyme disease and ticks that these arachnids began to be portrayed almost exclusively as "frightening enemies" in the public debate.

If animals are perceived as "others," invertebrates have been considered as the ultimate others, despite their many similarities to humans. The otherness of insects in cinematic representations is discussed by Concepción Cortés Zulueta and Heidi Mikkola respectively. Cortés Zulueta shows how the cliché

about insects as monstrous others was spread through representations in magic lantern slides, scientific microphotographs, and films, mixing various kinds of misconceptions about common houseflies. These appear intimately entangled with negative emotions and are often related to insect vision and to the alleged dangers they pose for humans.

The long tradition of portraying insects as monstrous others continued in horror films featuring giant or invasive insects. In her chapter, Mikkola notes how insects are associated with attributes like "monstrous" and "creepy," and how wildlife documentarists have managed to make insects appear either frightening or more relatable. One of her examples is a montage of a cockroach scurrying through pipes under a hotel building; a scene referencing film genres, such as horror thrillers of the 1990s and film noir. Both chapters exemplify the ways in which art and fiction can be used as powerful tools and mediators to imagine and relate to insects.

Although human attitudes towards insects and arachnids are greatly influenced by our understanding of the diseases they cause, these understandings are relatively young. Many of these diseases are old, even ancient, but the role of insects and arachnids as vectors has only been discovered much more recently. In her chapter, Taina Syrjämaa analyzes the slow process of uncovering the agency of ticks in spreading Babesia protozoans that caused Redwater fever in cattle from the 1860s to the 1930s. During this process, human perceptions of ticks changed in close connection with practices and daily actions in a shared and lived multispecies environment.

When it comes to tick-borne diseases, experts' risk assessments and the public's fears do not always coincide. For although diseases are essentially biological conditions, the public understanding about them is also influenced by social and cultural meanings attached to them. In her chapter, Suvi Rytty analyzes how public perceptions of TBE and Lyme borreliosis as scary diseases have been socially constructed through the image conveyed by newspapers since the 1950s. She shows how these perceptions have not only been influenced by scientific evidence, but also by changes in the disease spectrum, the health policy priorities of different eras, individual experiences and the way these diseases have been featured in the news at different times.

With the growing awareness of a health risk, tick encounters and imagined encounters with ticks have brought about protective and preventive measures. In her chapter, Sanna Lillbroända-Annala discusses tick-related practices and materiality, evoked by strong emotions, that cause people to act defensively so as to avoid tick bites and tick-borne diseases. These practices and materializations become control mechanisms for avoiding diseases and managing health risks.

Multispecifity is in some ways ingrained in all the chapters of this book, as the authors analyze how insects and arachnids have influenced the human world. Sometimes their effect takes a direct form, but often, however, insects and arachnids have an impact on the larger web of life and their actions determine how humans encounter and relate to other species. In her chapter, Emily Webster concentrates on animal experiments in the early twentieth-century Bombay (Mumbai) colonized by the British. These experiments were designed to examine the network of humans, rats, fleas and bacteria in terms of the transmission of the plague. She discusses how the experiments relied on multispecies relationships and ecologies within the city to develop and test the mechanisms of the rat-flea theory noting also how colonial sites have served as "living laboratories" for the western knowledge production.

In these constellations of the transmission of severe diseases, insects and arachnids are typically portrayed as unidirectional vectors. Karine Aasgard Jansen argues, however, that we need to understand disease-carrying insects, in her case mosquitoes, as co-participants. Thus, a multispecies approach that not only takes into account different species, but also objects and spaces, would show more respect to the research subjects. She also stresses that standardized global public health measures in the fight against arboviral diseases often fail if they do not take into consideration, how local cultural customs and practices impact on uses and management of mosquito contact zones.

Multispecies approaches are able not only to demonstrate that human attitudes toward insects and arachnids are prone to change across time and space, but also that changes in one part of the network lead to changes in the whole. In their chapter, Heta Lähdesmäki and Tuomas Räsänen demonstrate how the proliferation of ticks and tick-borne diseases in Finland has conflicted the relationship between humans and White-tailed deer, which is an important host species for ticks, and have also engendered tension between people with different views on the uses of nature.

Common to all the contributions in this anthology is the ambition to overcome dichotomies: between humans and animals, between arthropods and mammals and between those insects and arachnids that are considered benign and those that are perceived as harmful. These divisions derive from an anthropocentric perspective that has characterized – and continues to do so – relations between humans and arthropods. Still, violet carpenter bees, wasps, mosquitoes, flies, ticks, and spiders are living their lives in gardens, forests, swamps, and human homes, searching for food, making sounds, pollinating and decomposing plants, killing their prey and being killed by other species. These activities may have negative consequences for us: insects and arachnids may bite or sting humans, which may lead to an allergic reaction or a serious

illness for the human, and, in some cases, to death for both the human and the insect.

However, today we have more biological knowledge about these animals than ever before. Therefore, we know that what attracts insects and arachnids to humans in the first place is the way we smell. An entomologist cited by Minna Santaoja describes wasps as a misunderstood species. We interpret wasps as aggressive, but in fact they approach humans not in order to attack, but because they are attracted by and interested in the human smell that they sense through their sensitive olfactory system. Therefore, by simply stepping back and holding our breath we may well cause the wasp to lose interest in us. Not so in the case of the tick, which is drawn to the smell of human skin. Once it burrows into human skin, it will not let go, so we simply have to learn to avoid human – tick encounters altogether.

In order to learn to live with insects and arachnids, we all have to become entomologists and arachnologists, at least to the extent that we learn what motivates the species we loathe, fear, and wish to avoid. Whether we like it or not, our lives are entangled with, and dependent on insects and arachnids, which all play their role in ecosystems. In accordance with Donna Haraway's idea of staying with the trouble, we need to learn to co-live with insects and arachnids with as much intelligence and compassion as we can while navigating our way among our fellow species.[45] In the thick of it, with ticks, mosquitoes and the rest of our multispecies world.

Bibliography

Abba, Abba A. "Transcending Cultural Boundary: Renegotiating the Significance of the Spider Folktale." *Journal of Literature, Languages and Linguistics* 27 (2016): 22–26.

Arizona State University, "Ask a Biologist." Accessed November 20, 2023. https://askabiologist.asu.edu/insect-and-human-biology.

Aronowitz, Robert A. "Lyme Disease: The Social Construction of a New Disease and Its Social Consequences." *The Milbank Quarterly* 69, no. 1 (1991): 79–112.

Bein, Alex. "The Jewish Parasite: Notes on the Semantics of the Jewish Problem, with special Reference to Germany." *The Leo Baeck Institute Year Book* 9, no. 1 (1964): 3–40. doi:10.1093/leobaeck/9.1.3.

45 Donna J. Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC: Duke University Press, 2016).

Beisel, Uli, Ann H. Kelly and Noémi Tousignant. "Knowing Insects: Hosts, Vectors and Companions of Science." *Science as Culture* 22, no. 1 (2013): 1–15. doi:10.1080/09505431.2013.776367.

Benedictow, Ole Jørgen. *The Complete History of the Black Death.* Woodbridge, Suffolk: The Boydell Press, 2021.

Bertomeu-Sánchez, José Ramón. "Introduction. Pesticides: Past and Present." *HoST-Journal of History of Science and Technology* 13, no. 1 (2019): 1–27.

Bonnell, Jennifer. "Occupational Hazards: Honeybee Labour as an Interpretive Device in Animal History." In *Traces of the Animal Past: Methodological Challenges in Animal History*, edited by Jennifer Bonnell and Sean Kheraj, 49–72. Calgary: University of Calgary Press, 2022.

Bryn, Brandon. "Insects Evolved with Earth's First Land Plants." American Association of the Advancement of Science. https://www.aaas.org/news/science-insects-evolved-earths-first-land-plants.

Bump, Jesse B., and Ifeyinwa Aniebo. "Colonialism, Malaria, and the Decolonization of Global Health." *PLOS Global Public Health* 2, no. 9 (2022): 1–12. doi:10.1371/journal.pgph.0000936.

Burn, Leah, Thao Mai Phuong Tran, Andreas Pilz, Andrew Vyse, Mark A. Fletcher, Frederick J. Angulo, Bradford D. Gessner, Jennifer C. Moïsi, Luis Jodar and James H. Stark. "Incidence of Lyme Borreliosis in Europe from National Surveillance Systems (2005–2020)." *Vector Borne Zoonotic Dis.* 23, no. 4 (2023): 156–171. doi:10.1089/vbz.2022.0071.

Busvine, James Ronald. *Insects, Hygiene and History*. London: Athlone Press, 1976.

Butler, T. "Plague History: Yersin's Discovery of the Causative Bacterium in 1894 Enabled, in the Subsequent Century, Scientific Progress in Understanding the Disease and the Development of Treatments and Vaccines." *Clinical Microbiology and Infection* 20, no. 3 (2014): 202–209. doi:10.1111/1469-0691.12540.

Cole, Lucinda. *Imperfect Creatures: Vermin, Literature, and the Sciences of Life, 1600–1740*. Ann Arbor: University of Michigan Press, 2016.

Cranefield, Paul F. *Science and Empire: East Coast Fever in Rhodesia and the Transvaal*. Cambridge: Cambridge University Press, 2002.

Davis, Frederick Rowe. *Banned: A History of Pesticides and the Science of Toxicology*. New Haven: Yale University Press, 2014.

Deb Roy, Rohan. *Malarial Subjects: Empire, Medicine and Nonhumans in British India, 1820–1909*. Cambridge: Cambridge University Press, 2017.

Dolbee, Samuel. *Locusts of Power: Borders, Empire, and Environment in the Modern Middle East*. Cambridge: Cambridge University Press, 2023.

Drouin, Jean-Marc. *A Philosophy of the Insect*. New York: Columbia University Press, 2019.

Duffus, Natalie E., Craig R. Christie and Juliano Morimoto. "Insect Cultural Services: How Insects Have Changed Our Lives and how Can We Do Better for Them." *Insects* 12, no. 5 (2021). doi:10.3390/insects12050377.

Egerton, Frank N. "Understanding Food Chains and Food Webs, 1700–1970." *Bulletin of the Ecological Society of America* 88, no. 1 (2007): 50–69. doi:10.1890/0012-9623(2007)88[50:UFCAFW]2.0.CO;2.

European Centre for Disease Prevention and Control. "Tick-Borne Encephalitis." In *ECDC. Annual epidemiological report for 2020*. Stockholm: ECDC, 2022.

The Finnish Institute for Health and Welfare. "Borrelioosin seuranta ja esiintyvyys Suomessa." Last modified December 15, 2023. https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/taudit-ja-torjunta/taudit-ja-taudinaiheuttajat-a-o/borrelia/borrelioosin-seuranta-ja-esiintyvyys-suomessa.

The Finnish Institute for Health and Welfare. "Puutiaisaivotulehduksen esiintyvyys Suomessa." Last modified January 15, 2024. https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/taudit-ja-torjunta/taudit-ja-taudinaiheuttajat-a-o/puutiaisaivotulehdus/puutiaisaivotulehduksen-esiintyvyys-suomessa.

Geest, Emily A., Ashley R. Knoch and Andrine A. Shufran. "Villainous Snakes and Heroic Butterflies, the Moral Alignment of Animal-Themed Characters in American Superhero Comic Books." *Journal of Graphic Novels and Comics* 13, no. 5 (2022): 735–750.

Giblin, James L. "East Coast Fever in Socio-Historical Context: A Case Study from Tanzania." *The International Journal of African Historical Studies* 23, no. 3 (1990): 401–21. doi:10.2307/219597.

Green, Kelsey and Franklin Ginn. "The Smell of Selfless Love: Sharing Vulnerability with Bees in Alternative Apiculture." *Environmental Humanities* 4 (2014): 149–170.

Haraway, Donna J. *Staying with the Trouble: Making Kin in the Chthulucene*. Durham, NC: Duke University Press, 2016.

Haraway, Donna J. *When Species Meet*. Minneapolis, MN: University of Minnesota Press, 2008.

Heise, Ursula K. "Introduction: Planet, Species, Justice – and the Stories We Tell About Them." In *The Routledge Companion to the Environmental Humanities*, 1st ed., edited by Ursula Heise, Jon Christensen and Michelle Niemann, 1–10. London: Routledge, 2017.

Hohti, Riikka, and Maggie MacLure. "Insect-Thinking as Resistance to Education's Human Exceptionalism: Relationality and Cuts in More-Than-Human Childhoods." *Qualitative Inquiry* 28, no. 3–4 (2022): 322–332.

Kenawy, Mohamed A. and Yousrya Abdel-Hamid. "Insects in Ancient (Pharaonic) Egypt: A Review of Fauna, Their Mythological and Religious Significance and Associated Diseases." *Egyptian Academic Journal of Biological Sciences. A, Entomology* 8, no. 1 (2015): 15–32.

Kjekshus, Helge. *Ecology Control and Economic Development in East African History: The Case of Tanganyika 1850–1950*. Berkeley: University of California Press, 2022.

Kralj-Fišer, S. and M. Gregorič, "Spider Welfare." In *The Welfare of Invertebrate Animals*, edited by Claudio Carere and Jennifer Mather, 105–122. Cham: Springer, 2019.

Kritsky, Gene. "Beekeeping from Antiquity Through the Middle Ages." *Annual Review of Entomology* 62, no. 1 (2017): 249–264. doi:10.1146/annurev-ento-031616-035115.

Kritsky, Gene and Ron H. Cherry. *Insect Mythology*. San Jose, CA: Writers Club Press, 2000.

Marichal, Carlos. "Mexican Cochineal, Local Technologies and the Rise of Global Trade from the Sixteenth to the Nineteenth Centuries." In *Global History and New Polycentric Approaches: Europe, Asia and the Americas in a World Network System*, edited by Manuel Perez Garcia and Lucio De Sousa, 255–273. Singapore: Palgrave Macmillan, 2018. doi:10.1007/978-981-10-4053-5_12.

Matthews, Graham A. *A History of Pesticides*. Boston, MA: Cabi, 2018.

Mavhunga, Clapperton Chakanetsa. "Vermin beings: On Pestiferous Animals and Human Game." *Social Text* 29, no. 1 (2011): 151–176.

McNeill, John R. *Mosquito Empires: Ecology and War in the Greater Caribbean, 1620–1914*. Cambridge: Cambridge University Press, 2010.

Melillo, Edward D. "Global Entomologies: Insects, Empires, and the 'Synthetic Age' in World History." *Past & Present* 223, no. 1 (2014): 233–270.

Monbiot, George. "Insectageddon: The Scale and Speed of Environmental Collapse is Beyond Imagination." *The Guardian*, October 20, 2017.

Moore, Lisa Jean and Rhoda M. Wilkie. "Introduction to *The Silent Majority: Invertebrates in Human-Animal Studies*." *Society & Animals* 27, no. 7 (2019): 653–655. doi:10.1163/15685306- 00001903.

Morris, Brian. *Insects and Human Life*. London: Routledge, 2006.

Nuttall, Patricia A. "Climate Change Impacts on Ticks and Tick-Borne Infections." *Biologia* 77 (2022): 1503–1512. doi:10.1007/s11756-021-00927-2.

Ogilvie, Brian W. "Order of Insects: Insect Species and Metamorphosis Between Renaissance and Enlightenment." In *The Life Sciences in Early Modern Philosophy*, edited by Ohad Nachtomy and Justin E.H. Smith, 222–245. Oxford: Oxford University Press, 2013. doi:10.1093/acprof:oso/9780199987313.003.0012.

Paz, Shlomit. "Climate Change Impacts on Vector-Borne Diseases in Europe: Risks, Predictions and Actions." *The Lancet Regional Health – Europe* 1 (2021): 1. doi:10.1016 /j.lanepe.2020.100017.

Peretti-Watel, P., J. Ward, R. Lutaud and V. Seror. "Lyme Disease: Insight from Social Sciences." *Médecine et Maladies Infectieuses* 49 (2019): 133–139. https://doi.org /10.1016/j.medmal.2018.12.005.

Power, Emma R. "Nature in the Home." In *International Encyclopedia of Housing and Home*, edited by Susan J. Smith, 6–11. San Diego, CA: Elsevier Science & Technology, 2012.

Power, Emma R. "Kill'em Dead!: The Ordinary Practices of Pest Control in the Home." *Antennae: The Journal of Nature in Visual Culture* 23 (2012): 136–148.

Power, Emma R. "Pests and Home-Making: Depictions of Pests in Homemaker Magazines." *Home Cultures* 4, no. 3 (2007): 213–236.

Rowe, Abraham. "Global Cochineal Production: Scale, Welfare Concerns, and Potential Interventions." (2020). doi:10.31219/osf.io/t57w2.

Russell, Edmund. *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring*. Cambridge: Cambridge University Press, 2001.

Schowalter, Timothy D. *Insects and Society*. Boca Raton, FL: CRC Press, 2019.

Shinozuka, Jeannie N. *Biotic Borders: Transpacific Plant and Insect Migration and the Rise of Anti-Asian Racism in America, 1890–1950*. Chicago: University of Chicago Press, 2022.

Sluijs, Jeroen P. van der. "Insect Decline, an Emerging Global Environmental Risk." *Current Opinion in Environmental Sustainability* 46 (2020): 39–42. doi:10.1016/j.cosust.2020.08.012.

Smakosz, Aleksander Karol. "Bug as a Drug. Lytta vesicatoria L. Applications in Nineteenth Century Official Medicine." *Pharmacognosy Reviews* 16, no. 31 (2022): 27–33.

Stockland, Pierre-Etienne. "Statecraft and Insect Oeconomies in the Global French Enlightenment (1670–1815)." Ph.D. diss., Columbia University, 2018.

Svanberg, I. and Å. Berggren. "Ant Schnapps for Health and Pleasure: The Use of Formica rufa L. (Hymenoptera: Formicidae) to Flavour Aquavit." *Journal of Ethnobiology and Ethnomedicine* 15, no. 1 (2019): 68. doi:10.1186/s13002-019-0347-7.

Sörlin, Sverker. "Environmental Humanities: Why Should Biologists Interested in the Environment Take the Humanities Seriously?" *BioScience* 62, no. 9 (2012): 788–789. doi:10.1525/bio.2012.62.9.2.

Terrall, Mary. "Following Insects Around: Tools and Techniques of Eighteenth-Century Natural History." *The British Journal for the History of Science* 43, no. 4 (2010): 573–588.

Terrall, Mary. *Catching Nature in the Act: Réaumur and the Practice of Natural History in the Eighteenth Century*. Chicago: University of Chicago Press, 2014.

Ticktin, Miriam. "Invasive Others: Toward a Contaminated World." *Social Research: An International Quarterly, Special Issue on the Invasive Other* 84, no.1 (2017): xxi–xxxiv.

Trautwein M.D., B.M. Wiegmann, R. Beutel, K.M. Kjer and D.K. Yeates. "Advances in Insect Phylogeny at the Dawn of the Postgenomic Era." *Annual Review of Entomology* 57 (2012): 449–468.

University of Cambridge. "How Close Are You to a Fruit Fly." Accessed November 20, 2023. https://www.cam.ac.uk/research/features/how-close-are-you-to-a-fruit-fly.

University of Turku. "Humans and Ticks in the Anthropocene." Accessed November 20, 2023. https://sites.utu.fi/huti/.

Winegard, Timothy C. *The Mosquitoes: A Human History of Our Deadliest Predator*. New York, NY: Dutton, 2019.

World Health Organization. "Vector-borne diseases." Accessed on 17.11.2023. https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases.