ICCS

International Center for Cultural Studies

Working Paper Series No.43

Original Research Paper

July 2022

Why the Caged Bird Sings:

Rethinking the Anthropocene with Gallus gallus

Jeffrey Nicolaisen

National Yang Ming Chiao Tung University

Postdoctoral Scholar

jeffrey.nicolaisen@nycu.edu.tw

國立陽明交通大學文化研究國際中心
International Center for Cultural Studies
National Yang Ming Chiao Tung University
Rm.103 HA Building 2, 1001 University Road
Hsinchu, Taiwan
Tel: +886-3-5712121 Ext.58274, 58272
Fax: +886-3-5734450
Website: https://iccs.nctu.edu.tw/en/wps_list.php
Email: iccs.wps@gmail.com

Why the Caged Bird Sings: Rethinking the Anthropocene with Gallus gallus

Jeffrey Nicolaisen
National Yang Ming Chiao Tung University

Short Abstract

Gallus gallus, commonly known in American English as a chicken (*G. gallus domesticus*) is now the most common bird in the world. Because the timing of a breeding-induced deformation and rapid population increase of *G. gallus* corresponded with the explosion of the first nuclear bombs, the Anthropocene Working Group has suggested *G. gallus* as a potential stratigraphic indicator species for the Anthropocene. I argue an epoch named the Galluscene rather than the Anthropocene would disrupt a narrative of human exceptionalism that both is partially to blame for the ecological crises humanity faces and also implicit within the prospective term Anthropocene.

Long Abstract

Because the timing of a breeding-induced deformation and rapid population increase of *G. gallus* corresponded with the explosion of the first nuclear bombs, the Anthropocene Working Group has suggested *G. gallus* as a potential stratigraphic indicator species for the Anthropocene. *G. gallus*—confined in CAFOs and bound by its own hunger, thirst, and desire for survival—metabolizes maize and soy, to be slaughtered while still a juvenile. This "broiler"—a double-crossed breed defined by the way it is cooked—leads a population expansion that now claims a standing population of 22.7 billion. With a body size that has quintupled in size in less than five decades, *G. gallus*' global biomass is now approximately three times the biomass of all other birds combined, and is likely the most populous species of bird in the history of the world. The carbon ($d^{13}C$) and nitrogen ($d^{15}N$) isotypes their bodies derive from a new standardized diet along with their musculo-skeletal deformation and rapid population expansion make them a strong candidate to mark a chrono-stratigraphic boundary layer that identifies a new epoch. From a diverse history in which *G. gallus* cooperated with its *H. sapiens* companion through cockfighting, divination, timekeeping, and worship, they

emerged as a companion of African-American slaves and American farm women before transforming through the "Chicken-of-Tomorrow" competition with the support of American white men in industry and government. At the macro-level, *G. gallus* tells a story of slavery, sexism, scientific 'progress,' settler colonialism, nation building, socialist welfare programs, capitalist expansionism, plantation agriculture, and great avine suffering. Yet, at the micro level, *G. gallus* tells a story of the suffering of crippling growth rates and confinement as well as resilient agency through the subjective experience of metabolic labor; the goal-directed behavior of hunger, thirst and survival; and the resistance in the form of efforts at escape and the violence of feather pecking. All of these factors place *G. gallus* as a vanguard species in a system that is destabilizing earth's homeostasis (or more accurately accelerating its homeorhesis), whether the system is represented by a technosphere, a noösphere, or a coterminous biocenosis—an assemblage of species including maize, rice, wheat, soy, dogs, cats, pigs, cows, and humans. While the AWG has adopted the term technosphere to describe a cybernetic system with its own agency, they have centered it around the single-species agency of the human enterprise. This narrative reproduces a long line of Greek, Christian, European, and technoscientific discourse that obfuscates the complexity and interdependence of earth systems, and the agency of nonhumans. As human technology has proven to be powerful in disturbing systems but not replacing them, the way we envision the human relationship with the ecological community may determine the viability of human flourishing alongside its many companion species in the new era. I argue an epoch named the Galluscene rather than the Anthropocene would disrupt a narrative of human exceptionalism that both is partially to blame for the ecological crises humanity faces and also implicit within the prospective term Anthropocene.

Though the human and non-human are intimately linked in nature, we persistently look on them from two completely different points of view; in practice if not in theory, researchers and thinkers almost always act as if even viewed by science (although it is only concerned with appearances and antecedents) man were a certain universe, and what is not man, another.

——Pierre Teilhard de Chardin, *Hominization*, 1923[1]

Introduction

Beginning several thousand years ago, *Gallus gallus*, the red junglefowl, commonly known as a chicken (*G. gallus domesticus*) spread across six of the seven continents from its range in south and southeast Asia living in a symbiotic relationship with *Homo sapiens*, but it was not until the middle of the twentieth century that it underwent an unprecedented expansion in population and suffered a rapid deformation in body shape and size. Due to these remarkable changes, in 2018, Bennett, *et al.*, published an article called "The broiler chicken as a signal of a human reconfigured biosphere," which proposed that *G. gallus* is a marker of a new geological epoch called the Anthropocene.[2] With a standing population of 22.7 billion as of 2016, the authors estimate that it is likely the most common bird in the history of the world. In addition, during the second half of the twentieth century, body mass of the type of *G. gallus* raised for meat consumption ("broilers") quintupled.[3] Because of a dramatic change to the typical diet of *G. gallus*, the carbon (d^{13}C) and nitrogen (d^{15}N) isotypes in its bone college have also changed.[4] Considering that these changes occurred rapidly and synchronously over such a wide global distribution, Bennett, *et al.*, conclude that *G. gallus* provides a strong biostratigraphic marker for a new epoch.

Three of the ten authors on the paper are members of the Anthropocene Working Group (AWG).[1] Jan Zalasiewitcz, the chair of the AWG, also made public-facing comments promoting the AWG's work on *G. gallus* leading up to the publication of the results of their investigation.[5,6] The process of formally designating a new chrono-stratigraphic time unit such as the Anthropocene begins with the Subcommission on Quaternary Stratigraphy (SQS), a subunit of the International Commission of Stratigraphy (ICS). The AWG is a special committee commissioned by the SQS to investigate the stratigraphic evidence of a new epoch and make a recommendation regarding the formalization of such an epoch. If the AWG

1 Mark Williams, Jan Zalasiewicz, and Matt Edgeworth are co-authors and voting members of the AWG.

recommends formalizing the epoch, both the SQS and then the full membership of the ICS must approve the recommendation with a 60% majority. Finally, if the ICS approves, the Executive Committee of the International Union of Geological Sciences (IUGS) must ratify the new chrono-stratigraphic time unit. The AWG has been investigating the new time unit, but has not yet made a formal recommendation. Prior to the publication of results about *G. gallus*, on August 29, 2016, at the 35th International Geological Congress in Cape Town, South Africa, the AWG presented their preliminary recommendations on the formalization of a new geological epoch. In August of 2016, the AWG voted unanimously 34 to 0, with 1 abstention, that the Anthropocene is "stratigraphically real," and 30 of the 35 members voted to recommend to formalize the period, with three opposing and two abstaining.[7] This nonbinding vote was followed by a binding vote with results released in May 2019. In the binding vote, 29 of 34 members voted to treat the Anthropocene as a formal chrono-stratigraphic time unit with a stratigraphic signal around the mid-twentieth century.[8] The group continues to conduct research to identify the Global boundary Stratotype Section and Point (GSSP) before making a final recommendation. The GSSP, also known as the "Golden Spike," is the geological boundary that marks a new period. Of the potential primary markers proposed for the new epoch (aluminum, plastic, fuel ash particles, carbon dioxide concentration, methane concentration, oxygen isotope change, plutonium fallout, nitrate concentration / nitrogen isotope change, biostratigraphic, extinction/assemblage change, and other), the AWG's top choice for the primary marker at the 2016 South Africa meeting were plutonium fallout (10 votes) and radiocarbon bomb spike (4 votes).[9]

Yet, Bennet *et al.* (2018) was published two years following the 2016 meeting and vote, and *G. gallus* offers an alternative narrative for the potential epoch. In 2014, *H. sapiens* slaughtered 64 billion *G. gallus* individuals, with 4.2 billion in Africa, 21 billion in the Americas, 26 billion in Asia, 11 billion in Europe, and close to one billion in Oceania.[10] The process by which *G. gallus* both colonizes the land mass of six of the seven continents, and suffers the exploitation of human agents is not a simple story. It is not a story that yields to single cause explanations, or umbrella categories of *H. sapiens* intervention, but the genesis for the "Chicken-of-Tomorrow" competition, which would serve as the platform for the rapid population expansion and musculo-skeletal deformation of *G. gallus* was conceived in the same year that the first nuclear bombs exploded, the event that marked the genesis of the isotope changes, radiocarbon bomb spike, and plutonium fallout that constitute the favored stratigraphic markers for the proposed new epoch. The Food and Agricultural Organization of the United Nations keeps records of estimated numbers of *G. gallus* slaughtered each year since 1961 (only 16 years after the first nuclear bomb test). According to the FAO numbers, from 1961 to 2014, more than 1.5 trillion *G. gallus* were slaughtered, and the rate continues to increase. From 1961 to 2014 the annual rate of *G. gallus* slaughter increased nearly tenfold.[11]

The proposed new epoch corresponds with a homogenization of global biodiversity, with the rate of species loss as much as 100 times the background rate of extinction.[12] Simultaneously, there is an assembly of species that are flourishing in the new period. Some of these may be the ones with which *H. sapiens* are most familiar, such as maize (*Zea mays*), rice (*Oryza sativa*), wheat (*Triticum aestivum*), soy (*Glycine max*), dogs (*Canis lupus*), cats (*Felis catus*), pigs (*Sus scrofa*), and cows (*Bos taurus)*. However, the proposed term for the new epoch "Anthropocene" highlights one species *H. sapiens*, and a particular narrative received from Greek, Christian, European, and technoscientific origins. In this paper, I offer an alternative narrative, one that on the one hand corresponds with stratigraphic evidence, but that on the other hand reconfigures the way in which multi-species relationships and entanglements are understood. As the title of a historically contingent and culturally specific narrative of anthropocentrism and human domination, the name Anthropocene purports to name the primary cause or "anthropogenic" nature of the global change that characterizes the proposed new epoch, but at the same time, this narrative also reinforces the anthropocentrism and the human-nature dualism that perpetuates global change. Furthermore, the *H. sapiens* species itself has not been suggested as a biostratigraphic marker for any particular morphological, biochemical, or population changes that leave their own signal in the stratigraphic record. Instead, the proposed name and corresponding narrative depend on a sub-narrative of attribution of each stratigraphic signal to human agency. This logic of attribution deserves attention in itself because all signals have their own stories with multiple causes, and the selection of the particular cause to highlight creates the narrative that is conveyed by a particular name. For example, other popularly proposed names for the epoch, such as Capitalocene and Plantationocene seek to highlight economic or socioeconomic systems instead of a particular species.[13] They serve to critique the capitalist economic system, or the colonial and homogenizing systems represented by plantations. But neither capitalism nor plantations appear in the stratigraphic record directly either, but rather also involve a sub-narrative of attribution. Similar narratives could be constructed and epoch names proposed for science and technology, a factor without which none of the proposed stratigraphic markers would exist. In fact, the AWG promotes the related term for the ubiquity of technology at the earth's surface—technosphere—to recognize the culpability of technology, and less directly, science.[14,15] Similar arguments have been made for the culpability of the nation-state, a governmental structure to which most or all of the signals can also be attributed.[16,17]

At stake in this selective attribution is not only which historically contingent and culturally specific narrative we accept but also our conception of agency. In this paper, I focus on the story of *G. gallus*, not only because their story links to *H. sapiens*, capitalism, plantations, science and technology, and nation-states, as well as many other proposed causal factors associated with the proposed epoch, but also and even more so because *G. gallus* is a first-order signal in the stratigraphy. It does not require a second-order inference of selective attribution. I am not arguing that this fact makes *G. gallus* a more objective way of seeing the epoch—indeed I am still selecting *G. gallus* against other possible signals such as the AWG's preferred signal, plutonium fallout. Instead, I argue that *G. gallus* short-circuits the anthropocentrism implicit in the term Anthropocene in a way that the other signals do not, to such an extent that just the suggestion of the notion of a "Galluscene" seems comical to some people. Perhaps it is not by accident that the species who in evolutionary terms has achieved such great "success" in terms of population expansion and geographical distribution also is now commonly derided as silly and meek with rubber chickens and cross-the-rode jokes in many Anglophone cultures. I suggest that this comical space between *H. sapiens* and *G. gallus* may indeed be equal to the degree of human exceptionalism pervasive in the culture, and, thus, raising the status of *G. gallus* and putting *H. sapiens* in relation to *G. gallus* as one representative nonhumans species may be a partial antidote to the hubris that places *H. sapiens* above *G. gallus* and all of creation in some imagined hierarchy of life, a beginning of a grappling and coming to terms with human humility.

In the first section of this paper, I tell the story of how *G. gallus* suffered extreme morphological changes, and came to expand its population across the world. The story shows not only that multiple systems—such as capitalist systems, socialist systems, scientific systems, technological systems, biological systems, and multispecies co-evolutionary systems—but also that *G. gallus*' own agency were involved—including subjective experience, goal-directed behavior, power to influence, complexity, and systems thinking. In the second section, I consider the anthropocentricity of the concept of the Anthropocene including some of the theory that challenges it, and some of the alternative names that have been proposed since Paul Crutzen and Eugene Stoermer first proposed the christening of a new epoch. I particularly focus on how the AWG has characterized agency, especially in relation to the Aristotelian concept of the technosphere. Then, in the third section, I trace some of the intellectual antecedents to the Anthropocene, as referenced in the Crutzen and Stoermer proposal. These antecedents include Antonio Stoppani's Anthropozoic Era and Pierre Teilhard de Chardin and Vladimir Vernadsky's noösphere. I demonstrate that these antecedents display characteristics of a certain Western Christian heritage of human exceptionalism stemming from eschatological and teleological theories. In the fourth section, I introduce some more recent ideas that focus on the critical role of nonhuman actors in supporting earth systems, particularly James Lovelock's Gaia hypothesis and Thomas Berry's Ecozoic Era. These theories suggest that the human potential to disrupt the earth systems is great, while the human potential to manage earth systems is small, and propose reconfiguring human relationships with nonhumans. Building on these theories, I argue the narrative represented and implied by the Anthropocene rearticulates a long tradition in which humans were understood to impose their agency on a passive nature. As an alternative, I propose the concept of the Galluscene because, by evoking a species that AWG members have proposed as a biostratigraphy signal, the story of a *G. gallus* constructs an alternative narrative in which human attention is drawn to the complex systems in which humans are integrated. Implicit in my argument and my proposal is the fact that human agency is enhanced when humans recognize the feedback loops, nonhuman stakeholders, and agencies of nonhuman entities and systems, as it was the ignorance of these systems rather than the lack of belief in human agency that have accelerated global change.

The Story of G. gallus's Morphological Deformation and Population Expansion

G. gallus is native to southeast Asia and Austronesia.[18] Zooarcheologists estimate that the symbiotic relationship between *H. sapiens* and *G. gallus* in the Yellow River basin started 8000 years ago, but recent evidence suggests the relationship could go back even several millenia earlier close to the beginning of the Holocene epoch.[19] The relationship between *H. sapiens* and *G. gallus* has not always and still is not limited to human carnivory or ovivory. Depending on the particular region and historical period, groups of *H. sapiens* have used *G. gallus* for cockfighting, divination, timekeeping, and worship.[20] On the other hand, *G. gallus* has used humans for such services as provisioning of food, provisioning of shelter, and protection from predators. The rapid morphological changes and rise in population that make *G. gallus* a candidate to be a biostratigraphic signal relate to its particular history in the twentieth century United States. The story of the dramatic morphological deformation and population rise of *G. gallus* in the twentieth century involves many of the factors often cited as anthropogenic causes of the putative new epoch, along with associated or less commonly discussed factors, including slavery, sexism, science, the nation-state, capitalism, plantation agriculture, colonialism, and many others.

Archeological evidence dated to between 1304 and 1424 AD suggests that *G. gallus* first arrived in the Americas in present day Arauco Peninsula in Chile along with Polynesian seafarers prior to Columbus.[21] Subsequently, *G. gallus* arrived with Spanish and Portuguese ships on the east coast of South America, and then in North America on the Mayflower and later with Jamestown colonists.[22,23] In North America, for the most part, white human colonists preferred to eat beef and pork, but *G. gallus* was a specialty of black slaves. In the American South, local laws, local customs, and individual landowners sometimes granted limited degrees of autonomy and power to black slaves to raise and sell *G. gallus*, and there are some reports that black slaves monopolized *G. gallus* trade in some parts of the American South during the eighteenth and nineteenth century.[24]

On the other hand, in elite white society in the nineteenth-century United States, fanciers bread *G. gallus* as a collector’s item, but after the fancier’s market bust in the 1870s, breeders redirected their attention to egg production, publishing more than 350 poultry journals between 1870 and 1926.[25] As egg production developed, women rather than men tended to be in charge of *G. gallus* production, but raising *G. gallus* was denigrated by men as women’s work. Despite the stigmatization of the industry, in 1897 the poultry industry already ranked third in value in the United States after cattle and maize. While many women also helped with cash crops, they tended to gardens and *G. gallus* flocks—the diverse subsistence crops that fed families when cash crops failed or prices dropped during the 1920s and 1930s.[26]

However, as described by Boyd in 2001, rather than women and black slaves, it was primarily government-funded university scientists who planted the seeds for the twentieth-century musculo-skeletal deformation and great population expansion of *G. gallus.* Researchers as early as Louis Pasteur in his vaccine research in the 1870s and 1880s found *G. gallus* to be well-suited to laboratory research due to shorter life spans, higher fertility, and greater genetic diversity relative to other species. One of the first major breakthroughs was the discovery of the vitamin D and cod liver supplementation in the early 1920s, which alleviated a disease known as "leg weakness" that occurred when *G. gallus* was confined without access to ultra-violet light. Rural electrification completed in the 1940s and 1950s then enabled the industry to take advantage of the efficiency enabled by confinement. With the number of private hatcheries rapidly expanding, the United States Department of Agriculture's Bureau of Animal Industry launched the National Poultry Improvement Plan (NPIP) in 1935 with the aim of eliminated pullorum and related diseases. The public-private partnership including government at the state, local, and national level nearly eliminated pullorum by the mid-1950s by creating uniformity in the poultry industry. While *G. gallus* remained susceptible to viral diseases like New England castle disease and avian influenza, vaccines were developed for viral diseases such as fowl pox, Newcastle disease and Marek's disease. University research in the 1930's and 1940's demonstrated that high-carbohydrate, high-protein, and low-fiber diets increased feed-conversion, and maize and soybeans were determined to be the highest-production efficiency crops for carbohydrates and protein, respectively. These nutritional discoveries occurred at the same time that genetic hybridization and production enhancements in maize dramatically increased yield and reduced the production footprint to allow for more land area to be devoted to soy production. Similarly, maize production gains through hybridization provided a model for *G. gallus* hybridization. By the 1950's commercial high-protein, high-carbohydrate feeds were available. In the 1940s and 1950s, the American Cyanimid Laboratory showed that antibiotic supplementation enhanced weight gain by at least 10%, so by the 1970's nearly all chickens were receiving antibiotics. Antibiotics have enabled the use of crowded and high-stress confinement environments that facilitate the evolution of antibiotic resistant bacteria for the birds. Due to these various innovations, from 1940 to 1955, the number of human-hours required to bring 1000 chicken to market declined from 250 to 48 hours. After the public sector provided a foundation of profitability for the industry, integrated firms, primary breeders, and animal health companies dominated research in the industry by the 1960s.[27]

While these government programs formed a backbone for an emerging industry, the great accelerator for "boiler" production, was the "Chicken-of-Tomorrow" competition. In 1945 when Howard C. Pierce, the Poultry Research Director at the Great Atlantic and Pacific Tea

Company (A&P), suggested that the poultry industry develop a *G. gallus* variety similar to the broad-breasted turkey (*Meleagris gallopavo*). He convinced his company, the largest grocery store chain in the United States, to fund the program that came to be known as the "Chicken-of-Tomorrow" program. Pierce convinced the ten major poultry industry groups, two poultry magazines, and the United States Department of Agriculture all to join the program committee. The competition involved a three year cycle of state competitions in the first year, state and regional competitions in the second year, and a national competition in the third year. The judging bodies accept 100 chicks from each contestant, raised them under uniform conditions for 12 weeks, and judged them for Economy of Production and Dressed Carcass. Vantress Poultry Breeding Farm's Cornish-New Hampshire cross-bred won the overall competition in both 1948 and 1951. Arbor Acres Farm's White Plymouth Rocks breed won second place in 1948, and Nichols Poultry Farm's New Hampshire breed won second place in 1951. By 1950, 67 percent of *G. gallus* sold commercially traced their lineage to the competition winners.[28]

By 1959, Charles Vantress of Vantress Farm outcompeted Nichols Poultry Farm by developing a white-feathered version—a trait valued for its clean appearance—of its male line and captured 60% of the male broiler stock market. While competitors were occupied with breeding a white version, Henry Saglio of the second-place Arbor Acres Farm, whose birds were already white, used the 1950s to develop double-cross hybrid techniques. These hybrid techniques are what Bugos calls natural intellectual property protection in his 1992 article. A separate line called the Hubbard New Hampshire, which was not entered in the competition, helped Arbor Acres to catapult to a 25% market position among female lines. According to state tort law, Arbor Acres could protect the process of hybridization as trade secret, but not the actual hybrid bird. As a result, to prevent customers from breeding their own hybrids from Arbor Acres own genetic stock, Arbor Acres developed a double-cross *G. gallus* hybrid called the Arbor Acres 50 Female Broiler. The double-cross method—in which a purebred grand-parent generation was crossed before the hybrid parent generation was also crossed—used Mendelian genetics to produce a uniform female *G. gallus* line that would produce reliable characteristics when crossed with a male in the next generation. The line would produce heterogenous characteristics in the third generation if a farmer tried to breed their own flocks. Taking around three years to develop a new trait, the research and development of double-cross hybrids involved a time consuming process relative to breeding a purebred or even a single cross hybrid, but it provided a type of intellection property protection that would require customers to return to Arbor Acres for stock hens every year. While purebreds offered a quicker breeding process that public university researchers preferred, their breeding led to disease susceptibility and infertility. Heterosis, or "hybrid rigor," presented a more resilient bird, in addition to the intellectual property protection of complex crossbreeding methods. The profits involved in increasing economies of scale and industrial consolidation attracted free white men to a way of making a living traditionally denigrated as women's work or consigned to slaves. [29]

At the same time, government-led research and socialist programs for the benefit of poor farmers transformed first into vehicles for the promotion of capitalism and then full-blown international neoliberal profit-making enterprises. In the depression era 1930's, Franklin D. Roosevelt's New Deal aimed to deconstruct plantation systems in the American South to re-build the agricultural system for the "century of the common man." The Roosevelt Administration accomplished this through collective government mechanisms such as the Tennessee Valley Authority that provided an infrastructure for the provision of electricity, fertilizer, transportation, farm credit, and other resources to small-scale farmers. In turn, the Roosevelt Administration encouraged the Rockefeller Foundation to implement similar policies in Mexico for the common man there. Nelson A. Rockefeller first visited Latin America in 1935 to oversee his family's operations of Standard Oil. He was so enamored by Latin culture and the plight of farmers in Latin America that he returned to the U.S., took a crash course on Spanish, and returned as director of Creole Petroleum Corporation, a subsidiary of Standard Oil, in 1937. In response to the nationalization of petroleum production in Mexico in 1938, Roosevelt appointed Rockefeller the coordinator of the Office of Inter-American Affairs (OIAA) as part of his "Good Neighbor Policy" in Latin America. At the same time, Henry A. Wallace, the Secretary of Agriculture, encouraged Rockefeller to use the resources of the Rockefeller Foundation to support Mexican farmers. The Rockefeller Foundation had experience supporting the government development programs in the American South in coordination with both government and private programs, and it launched the Mexican Agricultural Program in 1943. The program included funding for breeding high-yield varieties of wheat. According to the historian Shane Hamilton, "One consequence of the Cold War's impact on U.S.-led rural development programs was the increasing acceptance of technology as an inherent and universal good." Simultaneously, these programs fulfilled the vision of Herbert Hoover, who as the Administrator of the U.S. Food Administration during World War I, declared strategic food policy to be an anti-Bolshevik strategy. Rockefeller's OIAA similarly aimed to prevent Nazi expansion and influence in Latin America during World War II, and Rockefeller internalized these capitalist forms of preemption as the "Cold War Farms Race" employed a stable food supply to quell revolutionary foment. Taking these lessons, Nelson Rockefeller opened a supermarket called International Basic Economy Corporation (IBEC) in Venezuela in 1947. IBEC aimed to lower food costs for peasant classes vulnerable to socialist messaging, in particular through technologies of distribution. The venture proved immensely profitable, and the chain spread across South America and to southern Europe by the 1960s. Henry Saglio, the founder of Arbor Acres, convinced IBEC management that the flesh of *G. gallus* was the meat of tomorrow in 1960, at a point when "broilers" bred from Arbor Acres lines already constituted 50% of commercially sold *G. gallus*. IBEC purchased Arbor Acres incrementally in 1962 and 1963. Arbor Acres marketed its company to IBEC to leverage its international reach, while IBEC was persuaded by the potential for a capitalist solution to cheap meat in the developed world. With the inauguration of Donald F. Meads as CEO in 1965, Rockefeller's anti-communist vision gave way to a single-minded focus on profit-making. Saglio hired his first geneticist from the Connecticut Agricultural Extension Service in 1939, but as internationalization required IBEC to operate in countries where close government research connections had not been established, the company had to refocus its breeding programs through privately funded and operated research channels.[30]

While IBEC consolidated breeding and distribution, integrators consolidated much of the rest of the supply chain in the United States. The American South used a system similar to sharecropping in which the integrator provided chicks and possibly other supplies on loan to farmers who paid the integrators back when they sold the grown-out *G. gallus* back to the integrator at a contracted price. For example, one early integrator, Jesse D. Jewell, took advantage of a boll weevil infestation in 1936 to attract cotton farmers whose crops had been eradicated by the boll weevil. By the 1950's, the consolidation of firms such as J. D. Jewell, Inc. in the South attracted Connecticut-based Arbor Acres to established operations in Blairsville, Georgia and Carthage, Mississippi in 1954 and Vantress's California operations to entirely relocate to Georgia in 1956. The 1957 Poultry Products Inspection Act required a full-time inspector to inspect all "broilers", which increased the cost to entry for processing plants and eliminated small operations that could not afford to upgrade and scale-up their operations. As poultry production scaled up, American producers sent their *G gallus* to new markets such as Europe. The increased market concentration invited corporations to build brands based on product differentiation such as Perdue's yellow skin, and later Tyson's uniform breast cuts, which were obtained from the Cobb Company's Cobb 500 female line. While cross-breeding introduced uniformity, uniformity also increased risk. Peterson Poultry Breeders Company's customers culled 3 million birds in 1972 because the breed proved susceptible to a new variant of Newcastle Disease. Similarly, the Hubbard line showed low immunity to Marek's disease in 1965. By 1989, 62% of "broilers" were produced by crossing an Arbor Acres female with a Peterson male. All breeders after the Chicken-of-Tomorrow competition traced their pedigrees to established firms. By 1989, Arbor Acres, Cobb, and Hubbard supplied 90% of female stock, and Peterson, Vantress, and Ross supplied 90% of male stock. After the 1980 decision in Diamond v. Chakrabarty, which allowed patenting of transgenic organisms, Arbor Acres and Amgen patented a DNA sequence that signaled select genes such as growth hormone to express themselves, but as of the time of writing, the double-cross breeding techniques have proved more effective than transgenic engineering.[31]

While Boyd and Bugos—from which I have drawn much of history of the "broiler" industry—provide detailed descriptions of the development of the industry, they have also treated *G. gallus* primarily as a product. Bugos's article appears in *Business History Review* to describe the "broiler" industry's intellectual property protection. Boyd refers to *G. gallus*, as a "highly efficient machine for converting feed-grains into cheap animal-flesh protein" (114). Les Beldo, on the other hand, argues that *G. gallus* retains a type of agency and "excess life" through its "metabolic labor," even in a factory farming situation.[32] What Beldo means by "excess life" is the ability of captive animals to produce something in excess of human inputs to "predictably exceed the power of human industrial arts" (110). In the case of factory farms, confinement restricts agency, and some scholars argue that a confined animal can only express agency through resistance to the repressive conditions in which they find themselves—for example, by banging their head against a cage. However, Beldo argues that this interpretation only recognizes the macrobiotechnological mode of agency, in which agency is voluntary. Beldo suggests that agency and labor can be both voluntary and involuntary and both microbiotechnological and macrobiotechnological. This distinction is expressed in what he calls "metabolic labor," the labor of involuntary growth at the microtechnological level in which an organism expends energy while experiencing and feeling this growth subjectively. The animal converts feed into meat or eggs in such a way that human labor would be incapable of reproducing the product. This form of metabolic labor is beyond the macrobiotechnological agency of refusal, but rather is suffered involuntarily. "The unending monotony experienced by the pig or chicken in this setting adds to the physical stresses of the microbiological processes within it to form the entirety of its lived reality. We might say, then, that that (six) these animals are made hostage to their own reproductive or metabolic labor: they are held captive and their voluntary movements severely restricted while their bodies labor in spite of their suffering" (119). Beldo suggests that with his definition of labor, we can not only talk about metabolic labor, but also reproductive labor and photosynthetic labor.

Beldo conducted observation of nineteen *G. gallus* at a hobby farm in rural Michigan in the summer of 2015. The *G. gallus* were Cornish-Rock "broilers", except for one white leghorn "layer" that the distributor had accidentally mixed with the clutch. While within the first few days, the chicks were similar in size, the Cornish-Rocks were distinguishable by their slightly larger feet and voracious appetites. By three weeks, the Cornish-Rock broilers were twice the size of the white leghorn. The white leghorn displayed normal behaviors for chickens: "she was preening gracefully, scratching and digging for insects, taking dust baths, and jumping on top of twenty-four-inch galvanized food canisters" (123). However, at three weeks the Cornish-Rock animals already experienced labored breathing, and had outgrown their feather patterns. By four weeks, they could no longer stand for more than 15-20 seconds without falling over. By five weeks, they could not stand long enough to feed, so they fed while laying on their bellies. By seven weeks, they could not chase after grapes, one of their preferred foods, without stopping to pant or stumbling after a few steps. Just before slaughter, the birds had rubbed their underbellies raw from excessive lying on the ground, they panted frequently, and on hot days, they mainly sat panting open-beaked on their bellies with their eyes closed. By eight weeks, the birds were ready for slaughter, in half the time of a "normal" bird that was not bred to be a commercial broiler.

Through ethnographic observation, Beldo's research illustrates the rather stunning suffering of the new commercial crossbreeds of *G. gallus* who embody the musculo-skeletal deformations and led the population explosion that marks the proposed epoch. The new breeds were designed for maximum production efficiency, even though the welfare declined and mortality increased. Zuidhof *et al.* found that between 1957 and 2005 the feed conversion ratio—a measure the industry uses to measure the amount of animal weight produced relative to the amount of input of feed—declined by 50%, while growth rates increased by more than 400%.[33] Similarly, Havenstein, Ferket, and Qureshi found that a 2001 breed fed a diet representative of 2001 practices weighed nearly five times more than a 1957 breed fed a diet representative of 1957 practices (2672 g v. 539 g), while mortality of the 1957 breed was half that of the 2001 breed.[34] With this massive increase in body mass and increase in population, the worldwide biomass of birds of raised for human consumption (≈0.005 Gt C) –the vast majority of which are *G. gallus*—is approximately three times the biomass of all other birds combined (≈0.002 Gt C).[35] Concomitant with this exponential expansion, the genetic diversity of *G. gallus* has fallen by 50% as a small number of commercial breeds have replaced previous individual variation.[36]

These selected traits produce breeds of *G. gallus* that must be slaughtered before reaching adulthood because they become dysfunctional before reaching maturity. Baeza *et al.* found that a 42-day lifespan maximized economics and sustainability for the males of a modern heavy broiler line.[37] While they considered production efficiency, environmental costs, and breast meat quality, the study also examined several welfare factors, and observed a major increase in severity of these factors occurred between 42 and 49 days during the fastest growth of breast size. They found a 7.4-fold increase in mortality between 35 and 63 days. By 56 days, nearly 100% of birds experienced severe walking impairments. Pododermitis and hock burns—inflammation and burning of foot and leg joint generally caused by exposure to ammonia from animal waste—increased incrementally from 35 to 63 days. At 35 days, 70% of birds laid down more than a body length from the nipple drinker, dropping to 6% by 63 days of age. In another study, use of analgesics increased how quickly *G. gallus* individuals navigating an obstacle course, suggesting that pain is a significant factor in reduced mobility.[38] Other factors, however, may also reduce mobility. Baeza, *et al.*, also report that at 63 days 26% of birds were panting, which the authors suggest is due to the inability of heart and respiratory functions to meet the demands of the birds' body size and cooling needs. Internal organs such as the heart, lungs, and intestines grow at a slower rate than total body bass of broilers, which is likely to reduce respiratory efficiency.[39] With additional environmental costs such as phosphorus and nitrogen emissions, Baeza, *et al.*, suggest additional gains in meat production do not offset bird welfare and environmental costs above 42 days of life.

These controlled experimental results support Beldo's ethnographic observations and demonstrate the scale of the global change represented by *G. gallus*. Beldo's analysis expands the possibilities for thinking about agency, by breaking agency down into component parts to account for the excess life of metabolic labor. He associates the macrobiological level with voluntary agency and the microbiological level with the involuntary agency of subjective experience. However, his analysis can be pushed even further. Much of the macrobiological behavior that he describes involves voluntary agency, not of resistance but of submission. The birds in his ethnography, while unable to stand, laid on their bellies to feed, and, while they could no longer effectively run, they chased after grapes. Beldo not only differentiated the Cornish-Rocks from the white leghorns by their larger feet, but also by their voracious appetites. The voluntary behavior driven by hunger and thirst is presumed by the methods of Baeza, *et al.* when they measure physical disability by distance birds move away from the nipple drinker. In addition to the physical limitations of excess growth, the birds voluntary choice to stay close to the nipple drinker and to case after grapes is determined by at least two subjective desires—hunger and thirst—and a subjective aversion toward pain. The fact that the Baeza, *et al.*,'s heavy broiler line grows so quickly confirms that their appetites are commensurate with such growth, just as Beldo notes the voracious appetite of the Cornish-Rocks relative to the white leghorn. This voracious appetite must indeed be selected by the breeding and cross-breeding process, and so it is also directly linked and influenced by the agency of the human scientists involved in breeding. The efforts of the human scientists are directed toward satisfying human hunger and food preferences, but also must address the problem of avine hunger and food preferences in the process. In both cases, the capitalist system in which they operate encourages them to innovate new ways to influence hunger, thirst, and food preference. In the case of human hunger, the system introduced innovations such as breeding of larger breasted avine individuals, white breeds that look more appealing, reduced feed conversions to lower costs, and many other innovations that increased human desire for the product. For avine individuals, the system used complex cross-hybrid breeding techniques that increased avine appetite, and feeds that met avine food preferences in such a way that it also enhanced their metabolic labor. This increased appetite locked Cornish-Rocks and other hybrids into a system of production that employed their own agency as represented by their desires, aversions, and pain to bind them into a system in which they offer what Beldon calls excess life, or what Marxists may call surplus labor.

This minimum level of voluntary macrobiotic agency—to eat, drink, and survive—is the same voluntary agency that compels *H. sapiens* to remain in a system of slavery or exploitative wage labor. *G. gallus*, when given the opportunity to escape or resist, will do so. *G. gallus* (i.e. Red

Junglefowl) observed in an unconfined environment tend to form flocks of between 1 and 20 individuals.[40] Because *G. gallus* cannot recognize all individuals and develop a stable hierarchy in flocks of greater than thirty individuals, guidance provided by agricultural extension offices in the United States recommends against intermediate size flocks where social hierarchies become unstable, instead recommending flocks so large that *G. gallus* no longer attempts to maintain a social hierarchy.[41] However, even in these large flock environments, *G. gallus* on average experiences bird densities of greater than 19 birds per m^2 as aversive.[42] When given the opportunity to move to a compartment with lower densities, *G. gallus* "broilers" traversed barriers designed to challenge the physical capabilities of highly motivated individuals.[43]

G. gallus also displays resistance when its needs are not met in confined or deprived spaces. The "broilers" described above only typically live 6-7 weeks until they are slaughtered while still juveniles, and during that short life, their size severely restricts their behavior and limits their opportunities to resist. Forms of deprivation-induced destructive behavior are more common in "layers"—the industry term for *G. gallus* raised for their eggs. White leghorns are the most common "layer" breed, and the white leghorn that displayed normal foraging behavior in contrast to the panting and lameness of the Cornish-Rocks in Beldo's ethnography illustrates why "layer" breeds are more capable of resistance. Layers are also allowed to grow to adulthood and live a year or more until they are slaughtered when their high egg production period wanes. These avine individuals frequently express harmful behavior through pecking of their avine cohorts. Some forms of pecking such as gentle pecking and feather pecking may not be aggressive, but feather pecking can lead to more invasive pecking and consumption of flesh, or what the poultry industry calls "cannibalism". Additionally, aggressive pecking (which is usually aimed at the head) and vent pecking (which is aimed at the cloaca) are often aggressive behaviors that cause harm to the victims. This behavior is learned and, once established, can spread through a flock. One of the leading theories of why confined avine individuals feather peck is that they lack opportunities for foraging behavior.[44] Access to litter over the entire life cycle in order to accommodate foraging behavior substantially reduces feather pecking.[45] Reduced stocking density and enrichment designed to accommodate pecking also reducing feather pecking.[46] Other factors such as high temperatures and older age also play a role.[47] Human caretaker attitudes play a significant role in the amount of plumage damage and bloody wounds that occur in avine flocks. Caretakers who consider intensive care to be important, do not see their work as challenging, and evaluate *G. gallus* to have positive characteristics produced safer environments for birds as indicated by plumage damage and bloody lesions.[48]

Rather than mitigating or eliminating the conditions that lead to harmful pecking behavior, farmers frequently use beak searing to reduce the level of harm. Beak searing involves searing off approximately one third of the beak. This procedure not only causes pain when the beak is seared but also limits the activities of individuals, as the beak is a sensorial organ used by *G. gallus* to interact with the environment, much like the human hand. Searing can also lead to a painful nerve tumor called neuroma. In the United States, virtually all poultry farms use beak searing, even organic certified and humane certified farms.[49] On the other hand, several European countries have banned beak searing. For example, the United Kingdom banned beak searing beginning in 2011, and the UK Department for Environment, Food and Rural Affairs issued guidance in 2005 to allow farms to prepare to comply in advance of implementation.[50] The guidance recommends resilient and uniform breeds, calm and competent caretakers, and environments that allow for dust bathing and litter scratching, while reducing stressors such as intense light, vermin and mites, and sudden environmental changes.

While these various forms of harmful pecking are generally not aimed at human caretakers, the conditions of confinement limit the choices of birds to behave in less harmful ways. Birds may not know how humans were part of creating these conditions, and the causes of the violent behavior are very complex, involving overcrowding and the inability to establish pecking orders, the inability to express foraging behaviors, and various psychological stresses resulting from changes to the environment, lighting conditions, temperatures, and even attitudes of human caretakers. This complexity in responses to various conditions is also a component of how agency is commonly understood, and the responses of various avine individuals also vary according to their inherited traits, their upbringing, and their particular experiences within the system. This form of resistance is not consciously directed toward a perceived and personified oppressor, rather it is a diffuse violent response not so much to a system of confinement and deprivation that was constructed to take advantage of avine metabolic labor, but even more so to a greater system in which both avine and human agencies are intertwined in such a way that both human and avine individuals are oppressed, and both human and avine individuals play a role in constructing the system. In the United States, human labor involved in farming, slaughtering, and rendering *G. gallus* also often involves low wages, exploitation of women and migrants, dangerous and stressful working conditions, and sexual harrassment.[51] Some humans in the poultry industry directly harm other humans, just as some birds directly harm other birds in a poultry farm. Other humans such as vegetarians or vegans refuse to participate in the system, just as many birds do not cause harm to other birds. Recognizing the agency of *G. gallus* provides a more accurate and nuanced model of how complex biopolitical systems work, whether we are addressing capitalism, the nation-state system, or the practices of science and technology.

This understanding of agency—which includes subjective experience, goal-directed behavior, power to influence, complexity, and systems thinking—challenges the anthropocentric sub-narrative of attribution that pervades much of the Anthropocene literature. For example, as part of their paper presenting *G. gallus* as a candidate biostratigraphic marker for a new epoch, Bennet, *et al.*, write, "Breeding by natural selection has been modified by human-directed selection" (7).[52] What is the difference between natural selection and human-directed selection? If humans are part of nature, then whatever they do would be considered natural, and whatever selection occurs based on their behavior would fall under the category of natural selection. Instead, the distinction between natural selection and human-directed selection appears to depend on an *a prior* assumption regarding something special about human agency that separates the randomness of nature from the intentional behavior of humans. However, the story of the morphological deformation and increase in population of *G. gallus* relies on the contingencies of a narrative involving the wresting of control of breeding from women and slaves; the research of predominantly white, male scientists in the United States; the profit interests of a company called A&P; the participation of the United States Department of Agriculture in the development of the Chicken-of-Tomorrow competition; the anti-communist strategy of Nelson Rockefeller and IBEC; and the neoliberal ideology of Donald Meads and Arbor Acres. *G. gallus*'s story includes the avine metabolic labor that is maintained by the agency of *G. gallus* to eat, drink, and survive, and the systemic adaptations required to respond to avine resistance to a system that restricts avine foraging behavior, dust-bathing behavior, and the ability to establish pecking orders. Furthermore, the double-crossbreeding systems that developed did not involve any newly engineered genes or any transfer of genes from other species. Humans added nothing new to the *G. gallus* genome. While not fully developed in this paper, other nonhuman evolutionary pressures such as viral diseases like New England castle disease, avian influenza, fowl pox, Newcastle disease and Marek's disease continue to effect *G. gallus*, and exceed the limits of human intervention to deter or prevent. Human government officials, scientists, and businesspeople involved did not direct the downstream consequences. For instance, breeders unlikely considered the eutrophication caused by phosphorus and nitrogen in concentrated animal feeding operations (CAFOs) that would develop. There was indeed a role of human agency, but how and what it produced relied on the mediation of capitalist systems, socialist systems, scientific systems, technological systems, biological systems, multispecies co-evolutionary relationships, and their interactions. These complex interdependent systems selected which individuals survived, and are still in the process of doing so. It is not at all clear that human-directed selection is a better term than natural selection in multifactorial systems in which human agency is only one factor that itself is derived from often conflicting interests and impulses of diverse groups.

The Anthropocentricity of the Anthropocene

Paul Crutzen spontaneously coined the term Anthropocene in February 2000 at the International Geosphere-Biosphere Panel (IGBP) meeting in Cuernavaca, Mexico.[53] He became frustrated with an exchange about global change in the Holocene and interjected that we were in the Anthropocene not the Holocene. Following the meeting, Will Steffen, the executive director of the IGBP, invited Crutzen to write an article about the idea for the *IGBP Newsletter*. Crutzen learned that Eugene Stoermer had used the term informally for years, and invited him to coauthor the paper, which appeared in the newsletter the same year. A shortened version of the article appeared in *Nature* in 2002 with only Crutzen listed as author. Crutzen and Steffen have continued to develop the concept as an informal earth system sciences designation. Their vision of the Anthropocene is one in which humans overwhelmed the "great forces of nature," and they treat human impact as an engineering problem for earth systems scientists to address "concerns about the future of Earth's environment and its ability to provide the services required to maintain viable human civilizations."[54,55] On the one hand, they see the utilitarian value of earth systems as supporting human civilization, and on the other hand, they see human artifice as the tool to accomplish this goal.

The term Anthropocene arose in a reverse chronological order from the designation of any other geological epoch.[56] In all other cases, the geological evidence of potential unique biostratigraphic or chronostratigraphic units preceded consideration of the designation of a new epoch.[57] As a result, in the past, the naming of a new epoch reflected the information gained from the particular stratigraphic markers of the new epoch. Geological time units are ordinarily defined by biostratigraphic markers. While the ICS convened the AWG to assess the geological evidence and provide a recommendation about formally recognizing a new epoch, this group formed only after Crutzen's proposal for a new epoch. Although Crutzen now sits on the AWG, he initiated the debate on the Anthropocene as an outsider, as an atmospheric chemist in the IGBP.

Apart from the question of formal designation in the geological community, the Anthropocene has sparked vigorous interest and debate in the humanistic disciplines, often detached from the technical geology involved in the AWG's mandate. Some scholars have embraced both the term and the concept as collapsing the human-society distinction.[58] Other scholars have argued that the term Anthropocene dehistorizes the complex socio-ecological antecedents leading to global change and conceals the culpability of specific cultures by distributing blame across all of humanity.[59] As a result, humanists and social scientists have proposed alternative terms to describe a new epoch. These alternatives include such diverse terms as Capitalocene,[60] Plantationocene,[61] Chthulucene,[62,63] Necrocene,[64] and Sociocene.[65] Of these terms, Capitalocene and Plantationocene have receive the most attention because they identify institutions that provide a more nuanced explanation of the socio-ecological antecedents to the new epoch. Andreas Malm, a graduate student at Lund University, coined the term Capitalocene in a conversation with the sociologist Jason Moore in 2009.[66] Moore and his collaborators provide a Marxist analysis that attributes agency to capital itself, and explains the new epoch in terms of the exploitation of both human and nonhuman resources for surplus value.[67] A group of cultural anthropologists at the University of Aarhus collectively coined the term Plantationocene in 2014 to describe the exploitative systems of slavery, mono-crop agriculture, assembly-line factory production, and factory farming that replaces biodiverse ecosystems.[68] The Capitalocene and Plantationocene concepts both link global change to exploitative systems that originate in Europe and spread through colonialism to the rest of the world. These terms, thus, name narratives that recognize the differential culpability of human actors within socio-ecological systems. These narratives also include space for the agency, value, and interests of nonhuman actors.

In a 2015 article, Donna Haraway proposed the term Chthulucene—a term derived from the Greek terms "khthôn" and "kainos"—to describe the new epoch.[69] The Greek "khthôn" is the earth, and "kainos" often glossed as "recent" points to a "thick, ongoing presence" for Haraway: in other words, the term means "the thick, ongoing presence of the earth" (2).[70] This represents an ontological description in which the "anthropos" are not overwhelming "the great forces of nature" as Steffen and Crutzen suggest, but rather are interlocked in a constant becoming with all earthlings. Rather than communicate the awesome power of humans in contradistinction to nature, Haraway talks about "making kin" with the rest of the planet. Haraway is consciously crafting a narrative which must be true of all geological time units consistent with systems thinking, while short-circuiting the Anthropocene narrative that splits humans as consumers of ecological services and the rest of nature as the ecological services that humans consume. Rather than naming socio-ecological antecedents like Capitalocene and Plantationocene, Haraway provides a corrective to the Anthropocene narrative that is both descriptive and aspirational. However, the Chthulucene does not name anything specific to the new epoch, the term could be equally true of all epochs as the earth is always a thick, ongoing presence.

Justin McBrien coined the term Necrocene in a 2016 essay on the Capitalocene from the Greek "nekros" for corpse and "kainos" for "becoming extinction" to link the Sixth Mass Extinction to capitalism.[71] Jesse Ribot coined the term "Sociocene" alongside "Democene" to highlight the need to consider the sociological characteristics that generate human vulnerability and the need for greater democratic empowerment in the Anthropocene.[72] Many other fascinating terms have arisen within the natural sciences community as well. The oceanographer Daniel Pauly coined the term "Myxocene" ("recent slime") to describe cascading ocean habitat destruction and regression of biodiversity to a state dominated by jellyfish and algal slime.[73] Michael Samways coined the term Homogenocene in 1999 to describe the homogenization of the biosphere by translocation of species.[74] here are many more such terms that have been informally or formally suggested either as serious proposals to name a new epoch or simply in service of drawing attention to some form of global change. All of these terms are shorthand for a story that is being told. Together they form a story mosaic illustrating a new epoch.

In terms of the geology, there is still debate about whether there is any new epoch to name. Ratification is far from certain. Some scientists have argued that other than the radiocarbon bomb spike there is little that marks the proposed beginning of the Anthropocene Epoch.[75]

Crutzen and Stoermer's proposal that the invention of the steam engine at the end of the eighteenth century mark the beginning of the new epoch provides no geological marker. While the AWG's proposal to use the radiocarbon bomb spike provides the needed global synchronous signal that could constitute a GSSP, that point in time does not correspond with significant diachronous global changes that occurred previous to the signal and ones that may occur after the signal. The late Pleistocene-Early Holocene megafauna extinction occurring between 50,000 and 12,500 years ago, the development of plant agriculture beginning 11,000 years ago, the development of animal agriculture beginning 9000 years ago, the clearance of forests beginning 7000 years ago, and the concomitant increase in soil erosion, carbon dioxide emissions and methane emissions all are related to human activity, and ocean acidification and mass extinction are likely to follow the GSSP point.[76] Even what Steffen and Crutzen call the Great Acceleration following 1945 is not a discontinuous break from the pre-World War II period but rather part of a continuous exponential increase in carbon dioxide emissions extending back for centuries.[77] The geologists Charles Lyell and Paul Gervais coined the term Holocene in the 1860s to coincide with what they understood to be the emergence of humans and the rise of civilization according to their Greco-Christian cosmologies regarding human dominion over the earth more so than merely the geological evidence of the retreat of the last glaciation.[78] Thus, the Holocene itself contains the story of the Anthropocene within it, and designating the Anthropocene at a later date may only retell the same story.

In response to the concerns of social scientists about the problems with the narrative that the term conveys, Jan Zalasiewitcz, the chair of the AWG, and his coauthors quote Humpty Dumpty in Lewis Carroll's *Through the Looking Glass*: "A word means what I choose it to mean, no more and no less" (22).[79] While the words of Humpty Dumpty seem to be a rather curt rejoinder to the concerns of humanists and social scientists, the authors go on to argue that the definition of the Anthropocene is "based on the evidence that the planet is on a strong trajectory out of the Holocene (and indeed out of the glacial-interglacial cycling of the late Quaternary) and that human activities are the primary driver of this trajectory" (221). It is this second part about humans as the primary driver that *G. gallus* calls into question. If humans were enough to cause a global and synchronous stratigraphic boundary, such a boundary would have occurred as soon as humans appeared on the planet several million years ago. Instead, humanists and social scientists point to particular systems such as capitalism or plantations as the driver, and increasingly emphasize the multi-species nature of this system. It is true that humans are deeply entangled in these systems, but there is a question of whether humans can imagine their way out of a narrative that does not recognize the complex interspecies relationships required for the function of life-supporting earth systems. The story that is told about the new epoch and how it addresses ethics, ontology, and agency will determine how these powerful multi-species systems respond to the unintended consequences that they create.

The AWG has made room for alternative forms of agency, particularly in the concept of the technosphere. Zalasiewicz, *et al.* (2017) define the technosphere as the "the summed material output of the contemporary human enterprise" (9)—the approximately 30 trillion tonne mass of Earth material including not only roads and bridges but also "crop plants and domesticated animals" (11).[80] Whatever is altered by the human enterprise is co-opted into the technosphere as humans and their technology co-evolve together. According to Peter Haff, a member of the AWG, the concept of the technosphere is a goal-directed, self-organizing, autonomous Earth system similar to the hydrosphere or atmosphere, which provides a non-anthropocentric description of the "geological Anthropocene" and "social Anthropocene."[81] Haff applies Aristotelian teleology to argue that the technosphere's goal, or *intrinsic agency*, is to survive. The technosphere's goal to survive is not based on Darwinian evolution, so it has not evolved a stable state and indeed tends toward an increase in energy consumption. Haff argues that humans are unlikely to be able to constrain this accelerating metabolism, but that they may be able to shape it for their own survival as long as they recognize that the technosphere has an agency of its own. While importantly recognizing the limits of human agency and the fact that it is not humans but an overarching Earth system that has created the geological conditions of a new epoch, he does not recognize the agency of any species other than humans, and primarily focuses on technologies such as social media rather than other species as participants in the technosphere.

Haff recognizes that he presents a "primitive" form of agency, but does not provide justification for why he presents humans as the only intentional entities in the system. It is also unclear why he assigns a goal of survival to a non-Darwinian system lacking metabolic regulation, especially when he characterizes the system as on a path of accelerating metabolism that is likely to extinguish the humans on which it survives. He uses the concept of welfare as a goal of the system, but it is not clear how the welfare of the system is defined without proposing the system has subjective experience. He treats humans as the only intentional entities that respond to incentive, but as I have already described above, *G. gallus* quite clearly demonstrates intentional behavior and responds to incentives in the CAFOs that are part of the technosphere. While Haff's attempt at a non-anthropocentric description of the technosphere remains anthropocentric, importantly, Haff identifies the primary problem with the concept that human activities are the primary driver and the fundamental cause: "The standard cause-and-effect (efficient) framing of the geological Anthropocene is insufficient by itself to confront this future, because other forms of causation are in play" (143).

Jarod Diamond argues that human civilization arose in the particular areas where there were 'domesticable' plant and animals.[82] For example, wheat, peas, olives, sheep, and goats provided an unusually rich selection of domesticable plants and animals in Southwest Asia.[83] Therefore, domestication of plant species occurred in Southwest Asia earlier than anywhere else in the world, which allowed sedentary agrarian nature-cultures and educated human classes that developed writing and technology to develop earlier in Eurasia, along with increased population density and the conditions for the contagion of infectious disease. In considering possible biostratigraphic assemblage zones for the Anthropocene, Anthony Barnosky, a member of the AWG, has considered that "candidate species (or subspecies) include those that humans have domesticated, such as *Equus caballus* (horse), *Bos primigenius* (cow), *Capra hurcus* (goat), *Ovis aries* (sheep), *Sus scrofa* (pig), *Canis lupus familiaris* (domestic dog), *Felis catus* (domestic cat) or crop plants such as maize (or corn as it is commonly called in the US) (*Zea mays*)" (152). According to Barnosky's language, as species that "humans have domesticated," one may infer that these species are all part of the technosphere, but given the agency of other species, one may consider the co-evolution would be a better description. The idea of co-evolution has been proposed in particular for the earliest companion species to humans, *Canus lupus* (wolves or dogs), as the co-evolution of these two species began to occur before humans possessed any form of civilization into which *C. lupus* could be domesticated.[84,] A recent analysis of the work of 844 ethnographers of human-canine relations presents evidence for multiple hypotheses related to co-evolution, co-agency and mutual personhood of 'hybrid pack families' as opposed to older unidirectional theories regarding domestication of *C. lupus* by *H. sapiens*.[85] Experimental evidence of a positive feedback loop in oxytocin levels mediated by gaze length between *C. lupus familiaris* and *H. sapiens sapiens* suggests that interspecies affiliation may have co-evolved in the two sub-species in a way that did not evolve in *C. lupus lupus* (wolves) and primates closely related to humans such as *Pan troglodytes* (chimpanzees).[86] This early evolution of interspecies affiliative behavior may have enabled *H. sapiens sapiens* to develop later companion relationships with other species such as *G. gallus*. The evolution of qualities of tameness also appears to be a primary driver of the evolution of multiple behavioral phenotypes in *G. gallus domesticus*.[87] Building on Diamond's hypothesis that civilization developed sooner in areas where companion species were present, this evidence for co-evolution of multi-species communities with interspecies agency supports the idea that multi-species assemblages enabled human expansion and development of technology, as opposed to a model in which singularly human agency incorporated all things through technological innovation.

Haff proposes to recognize the 'primitive' goal-directed agency of a technosphere, but there is a stronger case for the recognition of the more dynamic agency of *C. lupus*, *G. gallus*, and other species that not only display goal-directed behavior but also a more sophisticated agency that involves labor and subjective experience. A more accurate model of a goal-directed, self-organizing, autonomous Earth system would not limit agency to the human enterprise but would recognize the multiple agencies of the multiple species that are inseparable from human enterprise. This multi-species approach to an emerging complex system that is dramatically altering earth systems ambiguates the definition of a technosphere defined as the "the summed material output of the contemporary human enterprise," but even if the technosphere concept is kept, the *a priori* assumption that humans are the only intentional entities in the system simply does not correspond with the evidence. The assumption does, however, correspond to the peculiar metaphysics of Aristotle, who provides the underlying framework for Haff's technosphere and believed that only humans were fit for civil society.[88] These ontologies inherited both through Greek philosophy and Christian theology are particularly prevalent in the Anthropocene discourse. Although various historians and philosophers have traced the antecedents to the Anthropocene discourse,[89] it is worth briefly revisiting them here, as they provide the basis for the singular focus on human agency. In particular, the technosphere appears to be a slight reframing of an earlier concept called the noösphere.

Genealogy of the Anthropocene: Anthropozoic Era and Noösphere

In Crutzen and Stoermer's earliest proposals for the designation of a new geological epoch , the idea of the Anthropocene did not only consist of the scientific designation of a new epoch but also a framework for a political action, an urgent human enterprise:

> To develop a world-wide accepted strategy leading to sustainability of ecosystems against human induced stresses will be one of the great future tasks of mankind, requiring intensive research efforts and wise application of the knowledge thus acquired in the noösphere, better known as knowledge or information society. An exciting, but also difficult and daunting task lies ahead of the global research and engineering community to guide mankind towards global, sustainable, environmental management.[90]

Crutzen and Stoermer envision a management system where the biosphere is managed by human artifice and knowledge accumulated in a sphere of human knowledge known as the noösphere. What they do not mention is nonhuman species and the role they play in regulating earth systems. As esteemed scientists, they no doubt are aware of the role of non-human species that mitigate human-induced stresses and sustain the earth's ecosystems, but they do not focus on the critical role of these nonhuman species in their paradigm of environmental management. They focus on human research and engineering, painting a picture of an environment with problems caused by humans and solved by humans. The word *sustainable* also seems to suggest that through research and engineering, humans will be able to correct the perturbations to the earth systems in a way that we will be able to sustain current systems. This particular emphasis on humans is coupled with their proposal to name a new geological epoch called the Anthropocene, a term that omits the role of nonhuman species and processes in the nonhuman environment.

Crutzen and Stoermer's vision of the Anthropocene derive from a clear lineage of related concepts founded in Christian eschatology. In their one-page essay proposing the serious consideration of the Anthropocene in 2000, they directly reference the work of George Perkins Marsh (1801-1882), Antonio Stoppani (1824-1891), Vladimir I. Vernadsky (1863-1945), Pierre Teilhard de Chardin (1881-1955), and Edouard Le Roy (1870-1954). Crutzen's one-page essay that appeared in *Nature* in 2002 referenced a shortened list of scholars: Antonio Stoppani, Vladimir Vernadsky, and Pierre Teilhard de Chardin. [91] To examine the genealogy of the concept of the Anthropocene, I introduce the antecedent concepts and theories that these scholars represent. These groups of scholars can be divided into two groups. The first are the late nineteenth-century scholars Marsh and Stoppani, who introduced the idea of the

"Anthropozoic Era," and the second are the early twentieth-century scholars Vernadsky, Teilhard, and Le Roy, who introduced the concept of the "noösphere." Crutzen and Stoermer explicitly trace the concept of the Anthropocene to these two antecedents.[18.19]

The idea of the Anthropozoic Era[2] was proposed by Stoppani. Marsh's major work *Man and Nature* documents multiple ways that the earth was affected by humans, and references Stoppani's Anthropozoic Era in his work. Stoppani was a Catholic priest, abbot, and paleontologist.[92] He denied evolution, and advocated for Creationism. He saw his scientific work as natural theology, and had harsh words for the Evolutionists. For him, the development of the Anthropozoic Era was part of a Divine plan for the perfection of the earth and the human. The achievement of the Anthropozoic was God's teleological achievement and an opportunity for the human species to achieve its own perfection. As Matteo Gilebbi puts it, "Anthropozoic is the world made *for* man; Anthropocene is the world made *by* man." While Stoppani held an eschatological view of the Anthropozoic Era, he also made prescient predictions about the risks of human modification of the environment. He was concerned with the release of carbon dioxide and the impacts of agriculture on the earth. Human impacts on the earth's ecosystem were terrifying to him exactly because they violated the will of God. He was concerned with losses in biodiversity, but he saw humans and their divine destiny as his primary concern.[93]

Pierre Teilhard de Chardin was the first to conceive of the idea of the noösphere.[94] Vernadsky first presented his conception of the biosphere in a series of lectures at the Sorbonne from 1922 to 1923, and published his lectures as *La Géochimie* in 1924.[95] Among the guests at his lectures were Teilhard and Edouardo Le Roy. Le Roy later presented Teilhard's concepts of the biosphere and the noösphere in a series of lectures at the Collège de France in 1925 and 1926, and published the lectures in 1927.[96] In his lectures, he credited Teilhard for first creating the idea of the noösphere and even cited Teilhard's unpublished 1923 essay "L'Hominisation."[97] Vernadsky's later writing on the noösphere grew from his reading of Le Roy's published lectures.[98]

[2] An era is two hierarchical levels above an epoch: sub-age, age, sub-epoch, epoch, period, era in order of length. The Anthropocene Working Group still is considering making a new designation at any one of the levels. At their August 2016 meeting, two of the 35 members voted for a new era, 1.5 for a period, 20.5 for a sub-epoch, and 2 for an age (Scienmag, 2016). While the most recent meeting of the AWG suggests the committee is leaning toward a new period, perhaps Stoppani's original proposal of an Anthropozoic Era is still in contention.

Teilhard offers two explanations of the noösphere, one from a scientific perspective and one from a spiritual perspective. This matches with his dual identity as a Jesuit priest and as a scientist with a background in paleontology and geology. From a scientific perspective, humans were unique from the perspective that they could make tools. This ability allowed humans to adapt to many niches quickly through human artifice. For nonhumans, their tools were their bodies. Without the ability to craft their own tools, they could only adapt to new niches through the long process of natural selection. Natural selection would craft new tools out of their bodies. Because of the human ability to craft artificial tools, Teilhard even argued that the adaptability of the human may justify an entire taxonomic order consisting only of humans. To him, the evolution of the human was both continuous with natural evolution, and a disruption to it. The metaphor he uses is that of a cone. The lines of the surface of a cone intersect at the apex. At the apex, all lines that previous did not touch intersect. While the lines are still continuous, the intersection of the lines is also a disruption. In this way, human artifice was not entirely separate from nature. It evolved through the lines of evolution, but artifice was something previously unknown. It allowed humans to produce a global network of communication to share knowledge. This sphere of knowledge, or noösphere, was built *in*, but also *beyond*, the biosphere.

In the spiritual sense, the evolution of the noösphere was the preordained progress toward unity, a “unity of souls.” This realm of the souls was not completely separate from the earth, as psychic energy floating above the biosphere. Rather, the noösphere was connected to the biosphere through evolution and the animal side of humans. After all, having evolved from nonhuman animals, humans had all the characteristics of animals and were indistinguishable from them. Humans were integrated with the biosphere through evolutionary continuity, but also simultaneously exceeded the biosphere with their unique capacity of knowledge. Yet, human knowledge also brought about the problem of the ego, the knowledge of death, and the conscious fear of it. This knowledge produced a dangerous resistance to the tendency toward unity. With the proper faith in evolution and adoration and devotion to the Divine, Unity could be achieved. While Teilhard’s ideas were clearly inspired by his Catholic theology, the Church declared Le Roy’s books on Teilhard’s noösphere heretical.[99] Just as in Stoppani’s understanding of the Anthropozoic Era, Teilhard’s noösphere asserted human exceptionalism and a divine teleology.

Vernadsky's noösphere drew from Teilhard's through Le Roy's work.[100] He eliminated the spiritual terminology but adopted the anthropocentric and teleological perspective. To do this, he relied on the conceptual work of the geologists Darwin J. D. Dana (1813-1895) and Joseph Le Conte (1823-1901). Dana proposed the concept of "cephalization," and Le Conte, the "Psychozoic Era." Cephalization was a 2 billion year "irreversible" development of the nervous system in the animal kingdom with an ever-increasing global mass of nervous tissue, and the "perfection of the central nervous system" in the human. For most of his life, Dana also denied evolution on the grounds of his faith, so cephalization was a divine teleological process from which Teilhard also drew inspiration. At the end of his life, Dana did accept evolution, at which point, Vernadsky argues, his theory converged with Le Conte's "Psychozoic Era." Having first achieved perfection of the nervous system, when humans explored and colonized all parts of the planet, "Mankind became a single totality in the life of the earth" (7).[101] Vernadsky opposed religious thinking, and, until his later years, even preferred the idea of the arrival of life from other parts of the galaxy over the idea that life arose from abiotic matter on earth, as he attributed stories of the genesis of life to the prejudices of religion and philosophy.[102] His belief that life was eternal, however, did not prevent him from adopting the concept of encephalization, and the development of noösphere. While he supported evolution and eschewed spiritual terminology, he reproduced the theological elements of the noösphere in secular form, retaining anthropocentrism and teleology just like the eschatological Christian doctrines of Teilhard and Dana.

In the 1967 essay "The Historical Roots of the Ecological Crisis," Lynn White argued that several elements of Christian doctrine created the conditions for the exploitation of earth's resources. His analysis centers on the implications of a core doctrine that all of Creation was given to humanity for its use, each natural object with a particular utility for humans. White also argued the Western aspiration for progress derived from Christian eschatology, the expectation for the second coming of Christ. Finally, with the merger of science and technology in the nineteenth century, the capacity of humans, and particularly humans of the West, to manipulate the environment expanded rapidly. Although he argues that many of his contemporaries saw themselves as post-Christian, the habits of mind established in Western thought by Christianity were difficult to escape. This could be no clearer than in the case of Vernadsky's noösphere. He drops the explicitly Christian terminology, but retains human exceptionalism, eschatology, and a pseudo-Christian teleology. For Vernadsky, humans are an exceptional species, the perfection of a 2 billion year process of cephalization. Having achieved this human exceptionalism, they were able to establish a noösphere by which they were able to dominate the earth for their own purposes.

An Alternative Paradigm: Gaia, Ecozoic Era, and Beyond

The holistic thinking that Vernadsky proposed in terms of the biosphere inspired a new type of planetary level thinking, but was late to appear in English. Originally without knowledge of Vernadsky's work,[103] James Lovelock and Lynn Margulis proposed a similarly holistic idea called the Gaia hypothesis.[104] This hypothesis argues that the earth is a cybernetic system that self-regulates to maintain atmospheric chemistry suitable for life. In this system, humans are not at the center, although through technology and particularly agricultural technology, they may be on the path to upsetting the system. Arguably, there is no center in Gaia, but there are certain sensitive areas that are responsible for a variety of processes in the system. These include wetlands, estuaries, and continental shelves. For example, algae of the genus *Laminaria* (kelp) produce methyl iodide, which is transported through the atmosphere, and provides iodine to the many species that require it for survival, including humans. Lovelock does suggest that humans are the only species that is able to collect, manage, and manipulate information in a complex way. He even asks if humans may be considered the nervous system of Gaia. His theory, however, is not anthropocentric, eschatological, or teleological like the theories of Stoppani, Teilhard, and Vernadsky.

Lovelock does not see humans as the end of evolution, or the center of Gaia. He rather finds that wetlands and continental shelves are the primary critical habitats that must be protected, and a variety of organisms are necessary to maintain the global ecosystem. If there are any critical organisms, they are more likely to be organisms such as micro-organisms and *Laminaria* than humans. The prospect of humans disturbing these nutrient cycles concerns him:

> …we shall have to tread carefully to avoid the cybernetic disasters of runaway positive feedback or of sustained oscillation...This could happen if, at some intolerable population density, man had encroached upon Gaia's functional power to such an extent that he disabled her. He would wake up one day to find that he had the permanent lifelong job of planetary maintenance engineer. Gaia would have retreated into the muds, and the ceaseless intricate task of keeping all of the global cycles in balance would be

> ours.[105]

This divergence of two possibilities cannot be stressed enough. Is it possible to limit interference in the earth's systems to prevent a future in which humans must be Lovelock's maintenance engineer? Or will humans need to build systems to manage what was previously managed by a diverse and flourishing global ecosystem? Unfortunately, Crutzen and Stoermer's Anthropocene appears to be the epoch of the human maintenance engineer. They find their antecedents in the eschatological theology of Stoppani and Teilhard, as well as the secularized anthropocentric teleology of Vernadsky. Then they adopt the anthropocentric concept of the noösphere as their model, and the maintenance engineer-style management is expressed in the concluding sentence of their earliest proposal of the Anthropocene: "An exciting, but also difficult and daunting task lies ahead of the global research and engineering community to guide mankind towards global, sustainable, environmental management" (18).[106]

Crutzen and Stoermer's proposal to "guide mankind" begins with the anthropocentric hypothesis of the Anthropocene. Lovelock, on the other hand, not only attributes nonhuman species with the pivotal role in the earth's homeostasis, but he also considers the possibility that other species may be smarter than humans. Rather than locating the perfection of the process of cephalization in the human, he suggests that whales, with larger brains than humans, may be even smarter than humans:

> Perhaps one day the children we shall share with Gaia will peacefully co-operate with the great mammals of the ocean and use whale power to travel faster and faster in the mind, as horse power once carried us over the ground.[107]

Not only does Lovelock consider that other species may be more intelligent than humans, but he also suggests that we cooperate with them too. To avoid becoming maintenance engineers, humans must not only cooperate with other species, but must also cooperate with the sum of the life-sustaining systems of Gaia. Gaia cannot be subjugated. This is what is missing in Crutzen and Stoermer's Anthropocene. In the Anthropocene, Crutzen and Stoermer reproduce the human relationship with nature that White argues is one of the roots of the ecological crisis: the Western idea of human domination.

Lovelock does not only see other species as potential intelligent collaborators, but as stakeholders as well. He rejects the Cartesian notion that animals are nothing more than automatons, recognizing them as conscious feeling creatures. In his words, "total destruction of the intricate and contrived tropical forest ecosystems is a loss of opportunities for all creatures on Earth" (121-122).[108] Lovelock's inspiration for the concept of Gaia was seeing pictures of the earth from outer space. This was not only a significant moment for him, but for many that could conceive of the earth as a single entity more easily than ever before. For Lovelock:

> Still more important is the implication that the evolution of *Homo sapiens*, with his technological inventiveness and his increasingly subtle communications network, has vastly increased Gaia's range of perception. She is now through us awake and aware of herself. She has seen the reflection of her fair face through the eyes of astronauts and the television cameras of orbiting spacecraft. (140)[109]

Here I think even Lovelock has revealed his anthropocentrism, unless "astronauts" also includes the non-human astronauts that have traveled to space. Humans are neither the only nor the first species to travel to space. Most famously, Laika, the dog was the first animal to orbit the earth, and many dogs, monkeys, and chimpanzees preceded the first humans. Since the earliest missions, everything from rabbits to frogs, from rats to wine flies, from turtles to rats, from spiders to jellyfish, and even a few humans have all visited space.[110] Who the first to actually see Gaia from outer space was is hard to know as not all organisms capable of sight got window seating on their flights, but it seems that even in awakening Gaia to the "reflection of her fair face," humans were not the first.

In thinking about what to name a new epoch, Teilhard presents an apt thought experiment:

> If a palaeontologist from another planet were to land on our earth, presumed to be entirely fossilized, he would conclude from the simple inspection, recognition-and classification of our bones, without even tracing the vestigial links and constructions with which we shall have to deal, that in the Quaternary the earth experienced a biological phenomenon of which no equivalent exists at any other zoological epoch. With prodigious rapidity (considering the very slow rhythm of general events in life) man overran the earth. Like a

> fire, whose very activity made him sometimes destructive, he assimilates or eliminates all life that is not of an order of size too different from his own. (55-56)[111]

What would paleontologists from another planet observe in the fossils of the current epoch? They would find that *G. gallus* overran the earth. The population and rapidity of the expansion of *G. gallus* dwarfs that of *H. sapiens*, and the beginning of that expansion corresponds with the plutonium fallout that is likely to mark the beginning of this new epoch. That is, of course, if these aliens were *ornithoids*. But if they were *pescoids*, they may first notice the precipitous decline in fish during this epoch. Perhaps rather than extraterrestrial aliens, it will be cetacean paleontologists one million years from now that discover the sixth mass extinction, and they will find that during the sixth mass extinction, there was a rapid expansion in the fossil pollen of maize, rice, wheat, and soy, and a rapid increase in the range and population of cattle, goats, sheep, pigs, dogs, cats, and most dramatically, *G. gallus*. *H. sapiens* may be in the faunal assemblage, but will not be the largest or most numerous from what we know at this point in the new epoch. The Holocene was almost 12,000 years along when it was designated in the nineteenth century,[3] while the ¾ century of the new epoch since its most likely starting date in 1945 is insignificant in geological time. The new epoch is one in which the naming must not only designate the epoch but also forecast what occurs in it. Yet, we cannot know what will occur. If nuclear war annihilates *H. sapiens* in the next fifty years, there will be no humans to see what happens in the Anthropocene!

To consider the utility of the concept of the Galluscene, I return to the quote from Teilhard's *Hominization* at the beginning of this essay:

> Though the human and non-human are intimately linked in nature, we persistently look on them from two completely different points of view; in practice if not in theory, researchers and thinkers almost always act as if even viewed by science (although it is only concerned with appearances and antecedents) man were a certain universe, and what is not man, another.

[3] The Holocene began nearly 12,000 years ago at the end of the last glacial period, and was formally named at the International Geological Congress in 1885.

Teilhard's theory of the noösphere was an effort to bridge the divide between the universe of the human and the universe of nonhumans. He did not see the divide as one in fact, but one that plagued research and thinkers. The work of Teilhard and Vernadsky can be read as attempts to resolve this problem, a problem which was also evident in Stoppani. While Teilhard and Vernadsky found continuity with nature and the human, all three saw the human as a perfection of teleological process whether divine (Stoppani and Teilhard) or physicalist (Vernadsky). White pointed out the unconscious persistence of this theological divide between the human and Creation in the Post-Christian West. Since his landmark essay, his observations have been vigorously debated. His claim that non-Western traditions such as Zen Buddhism are less anthropocentric than Christianity have been refuted.[112] Other scholars have documented instances of Christian care and concern for nonhuman species.[113] Theologians have also developed ecotheologies addressing the emergence of ecological crises.

One of the most influential of these ecotheologies is that of Thomas Berry, who proposed the idea of the *Ecozoic Era* in 1991.[114,115] Inspired by Teilhard's work, Berry understood the problem of the separation of the universe of man and the universe of everything that is not human. He believed that the earth had already come to the end of the Cenozoic Era, not just the end of the Holocene. He compared the mass extinction of species to those at the end of the Paleozoic and the Mesozoic eras. However, for Berry, doubling down on technology was not the way forward. In addition to a sphere of the human mind, he saw a sphere of human technology called the technosphere, and believed that a technosphere that served industrial-commercial purposes may be incompatible with earth systems. The root of the problem was the desacralization of the nonhuman, which, just as Lovelock, he traced to Descartes. He looked to non-Western cultures as inspiration for a new cosmology that put the earth first. He rejected prior proposed names for a new geological era such as the Psychozoic Era, and coined the term *Ecozoic Era* to put humans in a "communion of subjects" with all the components of the universe, not just plants and animals but also atmospheric phenomena and geological forces. Each subject had its own voice and agency. For Berry, not only humans but all forms of life had consciousness, but the human sphere of consciousness was uniquely capable of intruding upon the function of earth systems. Berry's Ecozoic Era was an aspirational idea with six conditions to avert human self-destruction and irreversible damage to nonhuman species and earth systems.

1. "Communion of subjects"—Each of the components of the universe is capable of being present to the other components with its own form and voice.
2. "Integral functioning"—Parts of the whole must function together.
3. "One-time endowment"—Impacts to the earth are not reversible.
4. "Earth is primary, and humans are derivative."—Humans must rely on the earth.
5. "Single Earth community"—Humans are part of the earth community, not separate from it.
6. "…we understand fully and respond effectively to our own human role in this new era"

Like Lovelock, Berry argued that the human capacity to support earth systems were small, but the human capacity to disrupt earth systems was great. Humans must not only test technologies on whether they would cause harm to earth systems, but also because of the human capacity to disrupt, humans must be actively involved in earth systems from the perspective of one member of a community of subjects. Finally, humans must create a new language to recognize the rights of the earth in legal and economic systems, and put them prior to humans because humans depend on these systems for their own rights.[116]

Lovelock's Gaia's hypothesis was revolutionary in recognizing the earth's systems that supported stability of the biosphere, and was resisted by the academic community for more than a decade before earth systems theory took hold in the late 1980's,[117] just as Berry was developing a vision of a way forward. Nine years after Berry proposed the Ecozoic Era, Crutzen's concept of the Anthropocene and the recognition of the human as a geological force was an affirmation of these systems from a Nobel-prize-winning chemist that had the social capital in the scientific community to gain the attention of that community. The concept of the Ecozoic Era as described by Berry conveys a sense of humility in exercising caution and humility toward the science and technology that has destabilized earth systems, while at the same time showing concern for all forms of life. The concept of the Anthropocene as described by Crutzen identifies problems caused by science and technology but conveys a sense of confidence in using science and technology to engineer a solution. The scientific and technological innovations—such as agriculture and the harnessing of fossil-fuel nuclear power—have proven to have caused catastrophic consequences, but the question of whether science and technology can reverse trends remains open. Berry grasped that science and technology needs guardrails for protecting the interests of all species of the earth. Crutzen's proposed global, sustainable, environmental management may be most effective when humans recognize and accept that management is not merely a human task, but that it requires guardrails such as those envisions by Berry for an Ecozoic Era, including recognition of the reliance on nonhuman systems, recognition of the subjectivity of nonhumans, caution in unexpected side effects of technology, and humility in the capacity of human technology.

The implications of such a pivotal period in the fate of earth's systems justifies a careful reflection on the intellectual currents that led to this moment in history. Crutzen and Stoermer's conceptual antecedents were defined by eschatological theories about the perfection of the human and human dominion over the earth. Yet, the new science of earth systems points to a system of cybernetic regulation involving a vast array of non-human species, rather than the dominion of humans: the *Laminaria* that synthesis iodine compounds, the phytoplankton that produce oxygen, the tropical trees that sequester carbon, the legumes that fix nitrogen, and countless other species. These species are locked in interdependent relationships, and the challenges presented by science and technology require them to adapt together. This adaption requires a view similar to the one proposed by Haff that recognizes that there are complex systems created by technology with feedback loops that accelerate change and operate beyond the control of any particular humans or even humans as a species, but new models must also require the recognition that these systems are not bound by the human enterprise. As described by Berry, these systems involve the subjectivity, interests, and services of nonhumans. There can be no sustainability, because these systems are dynamic. Once disturbed they can only adapt in new ways. Even if we were to attempt to imagine that the climate returned to prior homeostasis after several hundred years, extinct species will be gone, and ecosystems will be altered. The species and critical habitats that supported prior homeostasis will have either gone extinct or adapted to a new set of conditions. The prior homeostasis will no longer be possible. Margulis later modifed the description of Gaia as homeorrhetic rather than homeostatic to recognize the moving nature of cybernetic setpoints in earth systems.[118]

The Anthropocene concept was built on the foundation of the concept of the noösphere, which more recently seems to have been replaced by the concept of the technosphere—a concept perhaps more amenable to geology as it is tied to concrete material objects or archeological artefacts rather than the abstract concept of knowledge. Both the noösphere and the technosphere are defined by exclusively human agency. The term *biocenosis* coined by Karl Möbius reflects an ecological unit of interdependent species.[119] Even at the level of the individual, as humans are hosts to a diverse microbiome, they are one form of biocenosis called a holobiont—symbiotic or evolutionary units that appear to be a single organism but are composites of multiple organisms.[120,121,122] Furthermore, the rapidly expanding global human population is dependent on an increasingly narrow assemblage of "domesticated" species. The term "domesticated," from the Latin *domesticatus*, means to dwell in a home or to bring into a home. Essentially, this is identical in meaning to symbiosis, which means to live together, except that symbiosis removes the suggestion that humans are the active subjects or agents of the transitive verb *domesticate*. By definition, these species live together with humans, and this symbiotic relationship can also be called a biocenosis, a sophisticated biocenosis that has spread over much of the globe. Unlike a holobiont or a superorganism (a single species group that functions as an evolutionary unit), however, it is not an evolutionary unit which stabilizes and reproduces. As Haff suggests in regard to the technosphere, the system is subject to its own feedback loops that push in directions not controlled by any one of its members, or in this case, member species. This biocenosis is coterminous with the noösphere and technosphere, at once a component and a subject to the forces of the coterminous systems through a continuous process of autopoiesis.

If we use the concept of the noösphere, it cannot be a single species *anthroposphere*. Teilhard's supposition that humans were unique for their capacity to make tools has been disproven with tool use in species as wide ranging as octopuses to dolphins.[123] The mind itself is also a multispecies phenomenon. The microbiome of the gut are neurochemically connected to the brain through the vagus nerve, and affect brain development, neuroplasticity, depression, and anxiety.[124] There is also growing evidence that parasites modify animal behaviors.[125] For example, the protozoa *Toxoplasma gondii* causes mice to seek cats,[126] and may affect human behavior as well.[127,128] Communication also occurs directly between humans and other species such as dogs,[129] and even trees have complex multispecies networks of communication that include fungi.[130] In the past, homing pigeons and postal services using horses and camels composed part of human communication networks. In the future, the possibility Lovelock imagined in which humans are able to cooperate with the large brained animals like whales may also also be realized. Brain-implanted computer interfaces that allow people to type on computers already exist.[131] It is easy to imagine that these brain-computer interfaces could be used with non-human animals. Whales and dolphins already use sound to communicate with each other, but brain-computer interfaces could make more complex forms of communication possible. Only ethical and legal restrictions may limit the potential for this technology. Dolphins are already trained for complex military purposes, if brain implant technologies with remote communication equipment were available, humans and dolphins may interact in more complex roles unless ethical objections restrict these interactions. Sperm whales (*Balaenoptera acutorostrata*), the species with the largest brain in the world, and humans may discover new ways of thinking with each other.[132,133] Anthropologists are already examining interspecies thinking with indigenous cultures such as those in the Amazon,[134,135] and the subfield of political ontology and multi-species studies promises to continue to document different ways of thinking with nonhumans. In the new epoch, a human-centric noösphere is not sufficient to imagine new ways of thinking about consciousness itself. Communication systems among biological entities such as trees and forests, neural control between animals such as *Toxoplasma gondii* and mice, AI-augmented dolphins, and anthropological studies of non-Western ecologies push us to think in new ways about multi-species cognition, minds, and consciousness.

Already anthropogenetic thinking has created speculation that *H. sapiens* will evolve into a god-like lord of nature called *Homo deus*.[136] However, the noösphere is the geological envelope of the mind, but the minds of this noösphere are not necessarily astute. In many ways, the noösphere may be better characterized by ignorance rather than knowledge. When humans invented agriculture, they were ignorant of the potential impacts: deforestation, desertification, interference in carbon cycles, and many others. When the steam engine and internal combustion engine were invented, humans were ignorant of the impact of fossil fuel combustion on air quality, climate, ocean acidification, human health, and many other areas. When Robert Oppenheimer (1904-1967) and the scientists of the Manhattan Project created the first atomic bomb, they did not realize that their invention would demark a new geological epoch. When the terms *Anthropozoic Era*, *biosphere* and *noösphere* were coined, the scholars that created them were ignorant of earth systems. While these geologists theorized the perfection of the mind or perfection of nature, they seemed to have great confidence in the power of the human mind. While humans have invented many technologies that were useful for certain purposes, it was the ignorance of the consequences that caused changes in global systems. Even today, only elite scientists have specialized understanding of earth systems, and while great progress has been made in this area, there is still much more unknown than known. A typical farmer tilling the soil and applying nitrogen, phosphorus, and potassium (NPK), along with some 2, 4-D (2,4-Dichlorophenoxyacetic acid), does not have a complete understanding of global nutrient cycles and toxicology, just as the human consumer of fried chicken does not understand the disruption in earth systems that the production of his meal causes.

This ignorance is not unlike that of *G. gallus*. *G. gallus* is immersed in the perturbation of earth systems that the global agricultural industry causes. *G. gallus* eats maize and soymeal from mono-species fields that displace diverse local ecosystems. The NPK applied to the fields and absorbed by the maize and soy become part of the body of *G. gallus* and are released in its manure. The CAFOs drain the nutrient-rich waste into local fields, where runoff carries it to rivers, lakes, and ocean where algae thrive and cause eutrophication, oxygen depletion, and dead zones where the flow meets the ocean. While ignorant of the consequences, *G. gallus* is implicated in the process, just as the human consumer of fried chicken, but if both *G. gallus* and the human were ignorant of the process, can they be held culpable for disrupting earth systems? The level of complicity and negligence depends on knowledge, intent, and degree of contribution to the disruption. The agency is distributed across many actors who are not equally responsible or accountable. Any planned adaptation must take into account the essential roles and responses of nonhuman actors, and recognize both humans and nonhumans as stakeholders. While many see the concept of the Anthropocene as a way to place responsibility on a single species, the insights of scientists researching earths systems reveals that, on the contrary, we must take into account the active roles of many other species as well as non-biological processes in maintaining and supporting earth systems. Focusing on human agency in the Anthropocene and particularly human intelligence seems to be a legacy of anthropocentrism, rather than a response to the science. This is Haff's point in attributing the technosphere with agency. There is a system, which Haff and the AWG call the technosphere, that can be influenced by humans, but is not solely constituted by humans. Our understanding of the limitations of human agency in a complex system enhances the human ability to act when the bounds of human action (boundary conditions) are not viewed independently from earth systems, because in reality they are not independent. It rejects the old Cartesian way of thinking that there is a soul cut off from the body, that there is a noösphere cut off from the planet, or that there is a technosphere cut off from the agency of nonhumans.

There are, however, human cultures that have learned to live in and adapt with their local ecosystems,[137] while those that contribute to the most to the changes producing the new epoch are a small minority. The leading markers for the beginning of the new epoch are associated with the development of nuclear bombs in the United States. As of 2017, still only nine countries possess nuclear weapons: the United States, Russia, the United Kingdom, France, China, India, Pakistan, Israel, and North Korea. Contributions to climate change—one of the most defining perturbations in the new epoch—is also associated with a small number of countries, and only a small number of humans in those countries contributed to or have control over those weapons. Nine countries and the European Union emitted 87% of global greenhouse gas emissions from 1850 to 2011. The top five emitters—the United States at 27%, the European Union at 25%, China at 11%, Russia at 8%, and Japan at 4%—emitted 75% of emissions and own 97% of nuclear warheads. The entire continent of Africa emitted less than 1% of carbon dioxide, and possesses no nuclear weapons.[138,139] The domination of the earth by humans may never have been only a European idea, but the majority of the world's people contributed very little to the geological changes in the Anthropocene. Crutzen estimated that only 25% of the human population were responsible for the problems defining the Anthropocene.[140] The cultures of the 75% of humans that remain follow traditional ecological knowledge or methods of adaptation that allow them to refrain from behaviors that may cause major perturbations to earth systems. These remaining humans are increasingly being incorporated into the systems that are accelerating global change, but they are not part of the discussion about the Anthropocene. Even now, the Anthropocene Working Group consists of 23 members located in Europe, 12 in North America, and 1 in Australia, with only two located in Asia, 1 in Africa, and none in South America. The Anthropocene concept is rarely discussed in the academic literature in Asia, Africa, and South America.[141]

In the new epoch, rather than the perfection of the human that Stoppani, Teilhard, and Vernadsky predicted, we see the ignorance and fallibility of a subset of humans that failed to foresee the greater impacts of their technology. This subset of humans stumbled into disrupting earth systems that they knew nothing about. Assigning culpability to all humans ignores the majority of humans who did not contribute to this disruption, and gives too much credit to the humans that did contribute to it. Without proper research and messaging in the developed countries most responsible for contributions to the perturbations leading to the new epoch, the old narratives of active human agents and a passive nature is likely to outweigh the science that active earth systems do not easily yield themselves to human intervention. In the past thirty years, scientists have just begun to accept and vigorously research these systems, but if we are to learn from history, we must move away from the cultural assumptions that human science and technology resolve all problems. I do not suggest abandoning science and technology. We need a robust research program to understand the earth systems, but the task of interventionist global environmental management is likely to be beyond the capacity of a species that has a poor track record in predicting the impact of technological innovation. The focus should be on consciously integrating with other species of the planet, not only recognizing their important roles in maintaining earth's systems but also recognizing them as stakeholders in the fate of the earth. Then we can reduce stress on these systems by adapting to changes in conscious interdependence with them. While it is tempting to use the term Anthropocene as a rhetorical tool to emphasize human culpability and to call humans to action, it risks propagating the narrative that all humans are equally culpable. Instead, the cultures that have contributed the most need the humility to turn to the cultures that have contributed the least to think about new ways to adapt in interdependence with the many species of the earth.

To move away from the anthropocentrism of the term Anthropocene, there could be many alternatives: the Plutoniumocene, the Carbonocene, or the Plasticene just to consider some of the potential primary signals, but none of these give the sense of living systems that sustains life, including human life. Members of the AWG and their collaborators have proposed *G. gallus* as a potential stratigraphic signal. Does *G. gallus* remind us of our interdependent relationships? Humans directly depend on *G. gallus* as a source of food, and in modern industrialized agricultural systems, *G. gallus* depends on humans for food. The human cooperation with nonhuman species in systems of agriculture are what formed what is often called human (actually multi-species) civilization, and Lovelock argued that agriculture, not urban development, was the most disruptive of human systems.[142] As described above *G. gallus* is directly involved in nutrient cycles such as the nitrogen cycle, which has been altered dramatically in the new epoch. *G. gallus* is embedded in interdependent relationships with humans and other species, agricultural systems, and earth systems.

G. gallus demonstrates a paradox. While from a biological perspective, its expansion in population and habitat in such a short period of time may be a demonstration of successful adaptation, from an ethical perspective, this expansion has occurred in cooperation with humans who have subjected the species to deformation and suffering. In industrial CAFOs, *G. gallus* experiences musculo-skeletal injury due to rapid growth, overcrowding, harmful artificial lighting regimes, poor air quality, and stress and injury during loading, transportation, and slaughter.[143] With *G. gallus*, it is easy to see the suffering caused by the paradigm of human domination. *G. gallus* is both a species which demonstrated interdependence with humans and one that is a stakeholder in adapting to the new conditions of a new epoch, and the arrival of the new epoch corresponds with the deformation and dramatic expansion of *G. gallus* itself. In only 60 years, *G. gallus* left behind 1.5 trillion skeletons, some fraction of which will become part of the biostratigraphic assemblage. The current annual number of deaths is approximately 1000 times that of humans,[144] so *G. gallus* serves as a reminder in the GSSP that a civilization of only humans is a myth. Humans need other species to survive. While the living *G. gallus* may be hidden from *H. sapiens* in corrugated iron sheds, they are ever present in civilization. The term Anthropocene evokes the hubris of a humanity advancing forward with engineering and technology to dominate the earth, but the term Galluscene automatically puts humans in relation to another species and evokes human humility. In the Galluscene, we must accept that the myriad species of the earth—*G. gallus*, cattle, maize, rice, methane-producing bacteria, *Laminaria*—and the geological and atmospheric features of the earth are part of complex systems with complex agencies.

Conclusion

G. gallus—confined in CAFOs and bound by its own hunger, thirst, and desire for survival—metabolizes maize and soy, to be slaughtered while still a juvenile. This "broiler"—a double-crossed breed defined by the way it is cooked—leads a population expansion that now claims a standing population of 22.7 billion. With a body size that has quintupled in size in less than five decades, *G. gallus*' global biomass is now approximately three times the biomass of all other birds combined, and is likely the most populous species of bird in the history of the world. The carbon ($d^{13}C$) and nitrogen ($d^{15}N$) isotypes their bodies derive from a new standardized diet along with their musculo-skeletal deformation and rapid population expansion make them a strong candidate to mark a chrono-stratigraphic boundary layer that identifies a new epoch. From a diverse history in which *G. gallus* cooperated with its *H. sapiens* companion through cockfighting, divination, timekeeping, and worship, they emerged as a companion of African-American slaves and American farm women before transforming through the "Chicken-of-Tomorrow" competition with the support of American white men in A&P, the USDA, Vantress, Arbor Acres, and eventually IBEC. At the macro-level, *G. gallus* tells a story of slavery, sexism, scientific 'progress,' settler colonialism, nation building, socialist welfare programs, capitalist expansionism, plantation agriculture, and great avine suffering. Yet, at the micro level, *G. gallus* tells a story of the suffering of crippling growth rates and confinement as well as resilient agency through the subjective experience of metabolic labor; the goal-directed behavior of hunger, thirst and survival; and the resistance in the form of efforts at escape and the violence of feather pecking. All of these factors place *G. gallus* as a vanguard species in a system that is destabilizing earth's homeostasis (or more accurately accelerating its homeorhesis), whether the system is represented by a technosphere, a noösphere, or a coterminous biocenosis—an assemblage of species including maize, rice, wheat, soy, dogs, cats, pigs, cows, and humans. While the AWG has adopted the term technosphere to describe a cybernetic system with its own agency, they have centered it around the single-species agency of the human enterprise. This narrative reproduces a long line of Greek, Christian, European, and technoscientific discourse that obfuscates the complexity and interdependence of earth systems, and the agency of nonhumans.

Haraway's Chthulucene is a way of imagining a fusion of the assemblage of species that define this epoch. In her words, the name is about "making kin." This is a vision for going forward, a moving away from the idea of human domination and a moving toward a recognition of the interdependency of the complex multi-species planetary systems that support life. As a script for the new epoch, it asks humans to recognize their kinship with, not dominance over, other species. Rather than the perfection of the central nervous system, the engineering of earth's support systems, or the triumph of human technology, the name Chthulu, like Gaia, is more in line with a concept of global systems that rely on multiple organisms to support the biosphere. The Ecozoic Era presents a similar vision. However, the interdependence of species is not new or unique to the new epoch. For hundreds of millions of years, the interdependence of various assemblages of species have supported Gaia's support systems. Every epoch is the Chthulucene! It does not define the new epoch any more than any other epoch. Similarly, every era is the Ecozoic Era. *G. gallus* is a species akin to humans, one in which sixty percent of its genes correspond to similar human genes, and these corresponding genes on average are 75% identical to human genes.[145] This kinship does not need to be *made*, but *is* already. Jason Moore's Capitalocence and Haraway, *et al.*'s Plantationocene are part of the story, but not the whole story. There is a larger system that encompasses capitalism, communism, plantations, nation-states, science and technology, democracy, liberalism, and the many other global or globalizing systems. The Galluscene does not try to name all stories and all causes but instead puts humans in relation to at least one companion species that is a party to all these systems. Haraway herself has written, "Follow the chicken and find the world." [146] And Patel and Moore have written, "the most iconic symbol of the modern era isn't the automobile or the smartphone but the Chicken McNugget."[147]

H. sapiens are indeed present in the Galluscene, but they are viewed through the enormous evolutionary "success" of *G. gallus*. Indeed, humans played a hand in the breeding and husbandry of *G. gallus*, and much of the bodies of *G. gallus* are consumed and composted by the stomachs of humans, and become part of the bodies of humans, just as they become part of the bodies of dogs, red foxes (*Vulpes vulpes*), norther foul mites (*Ornithonyssus sylviarum*), gapeworms (*Syngamus trachea*), and avian influenza. The purpose of the term Galluscene is not to depoliticize the epoch, or to center on *G. gallus*. It is to take a representative candidate of the biostratigraphic assemblage to represent the assemblage of species that characterize this epoch, and in so doing, to promote human humility and human empathy for the nonhuman. The purpose is not to reduce human culpability, but to illustrate that mitigating impacts on complex systems must involve seeing beyond the human. The anthropos cannot be forgotten in the Galluscene because the anthropos is implicated in the breeding, rearing, treatment, and consuming of *G. gallus*, as are dogs, maize, and gapeworms. The term Galluscene encompasses the co-existence of species that formed the basis of what some humans imagined as *civilization*. The basis of modern biology is adaptation and evolution. It is to recognize that even if we take *sustainability* as our goal, that this sustainability can only be achieved through cohabitation of species, not simply human management of a passive environment. But even more so, in the Galluscene as in any other epoch, no ecosystem can be *sustained*, because ecosystems are dynamic and constantly changing. The question is not how to sustainably manage the global environment with human scientific research and technology, but rather, how humans dynamically cohabitate and adapt with the assemblage of species and materials on which we rely. To do this we may apply artifice, but this artifice is not simply human. Renaming the Anthropocene the Galluscene is not to focus on *G. gallus*, but rather to encourage thinking about new ways to relate, to cohabitate with, and to adapt with other species. The AWG is evaluating the geological evidence for an epoch with a predetermined name, and evoke Humpty Dumpty in response to calls to change it: "A word means what I choose it to mean, no more and no less." Yet, the cultural history of ideas reveals that there is a stark contrast in the ways in which the new epoch is imagined and named. The historical record suggests that an ideology of human domination held by a quarter of the earth's population has led to a massive disturbance of earth systems. Would humans even survive in an Anthropozoic Era that extends the ideology of human exceptionalism? Or in an Ecozoic Era does human flourishing depend on putting the flourishing of the community of subjects before that of humans? As human technology has proven to be powerful in disturbing systems but not replacing them, the way we envision the human relationship with the ecological community may determine the viability of human flourishing alongside its many companion species in the new era. The various decisions in the present epoch will determine whether we enter an Anthropozoic Era or an Ecozoic Era. At this critical juncture, do we want to draw attention to human hubris and human exceptionalism in an epoch called the Anthropocene? Or is there another option that draws attention to the adaptive interdependence of a multi-species community? I propose the term Galluscene. The word Galluscene does not criticize or condemn any particular political ideology, but rather, it forces humans to think about how *G. gallus* achieved so much success as to become the most populous bird on the planet and a potential stratigraphic indicator species in a geological epoch. It puts humans in conscious relation to a species that is present in our daily life. This relationship between *H. sapiens* and *G. gallus* may be an indicator of whether the 25% of humanity who have disrupted earth systems cling to the hubris of human exceptionalism or move toward the humility of conscious adaptation and interdependence. In response to the words of Lewis Carroll's Humpty Dumpty, I evoke Maya Angelou: "I know why the caged bird sings."

---

[1] Teilhard de Chardin, Pierre. "Hominization." Trans. Cohen, J.M. *The Vision of the Past*. New York: Harper & Row, 1966 [1923]. 51-79.

[2] Bennett, Carys E., Richard Thomas, Mark Williams, Jan Zalasiewicz, Matt Edgeworth, Holly Miller, Ben Coles, Alison Foster, Emily J. Burton, and Upenyu Marume. 2018. "The broiler chicken as a signal of a human reconfigured biosphere." *Royal Society Open Science* 5 (12):180325. doi: 10.1098/rsos.180325.

[3] Havenstein, G. B., P. R. Ferket, and M. A. Qureshi. 2003. "Growth, Livability, and Feed Conversion of 1957 Versus 2001 Broilers When Fed Representative 1957 and 2001 Broiler Diets." *Poultry Science* 82 (10):1500-1508. doi: https://doi.org/10.1093/ps/82.10.1500.

[4] Bennett, Carys E., Richard Thomas, Mark Williams, Jan Zalasiewicz, Matt Edgeworth, Holly Miller,

Ben Coles, Alison Foster, Emily J. Burton, and Upenyu Marume. 2018. "The broiler chicken as a signal of a human reconfigured biosphere." *Royal Society Open Science* 5 (12):180325. doi: 10.1098/rsos.180325.

[5] Carrington, Damian. "How the Domestic Chicken Rose to Define the Anthropocene." *The Guardian* August 31, 2016, sec. Environment. https://www.theguardian.com/environment/2016/aug/31/domestic-chicken-anthropocene-humanity-influenced-epoch, accessed February 27, 2016.

[6] "*We Are the Meteor*." On the Media, 2017. http://www.wnyc.org/story/we-are-meteor/.

[7] Zalasiewicz, Jan, Colin N. Waters, Colin P. Summerhayes, Alexander P. Wolfe, Anthony D. Barnosky, Alejandro Cearreta, Paul Crutzen, Erle Ellis, Ian J. Fairchild, Agnieszka Gałuszka, Peter Haff, Irka Hajdas, Martin J. Head, Juliana A. Ivar do Sul, Catherine Jeandel, Reinhold Leinfelder, John R. McNeill, Cath Neal, Eric Odada, Naomi Oreskes, Will Steffen, James Syvitski, Davor Vidas, Michael Wagreich, and Mark Williams. 2017. "The Working Group on the Anthropocene: Summary of Evidence and Interim Recommendations." *Anthropocene* 19:55-60. doi: https://doi.org/10.1016/j.ancene.2017.09.001.

[8] Group, Anthropocene Working. 2019. "Results of Binding Vote by AWG." Last Modified May 21, 2019, accessed November 11, 2021. http://quaternary.stratigraphy.org/working-groups/anthropocene/.

[9] Scienmag. "Provisional Recommendations on a Potential New Geological Time Interval." *Scienmag*. Published electronically August 29, 2016. https://scienmag.com/provisional-recommendations-on-a-potential-new-geological-time-interval/.

[10] Food and Agricultural Organization of the United Nations, FAOStat, http://www.fao.org/faostat/en/#data/QL, accessed February 28, 2017.

[11] Food and Agricultural Organization of the United Nations, FAOStat, http://www.fao.org/faostat/en/#data/QL, accessed February 27, 2017.

[12] Ceballos, Gerardo, Paul R. Ehrlich, Anthony D. Barnosky, Andrés García, Robert M. Pringle, and Todd M. Palmer. "Accelerated Modern Human–Induced Species Losses: Entering the Sixth Mass Extinction." *Science Advances* 1, no. 5: e1400253.

[13] See, for example, Haraway, Donna. "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin." *Environmental Humanities* 6 (2015): 159-65.

[14] Haff, Peter. 2019. "The technosphere and its physical stratigraphical record." In *The Anthropocene as a geological time unit: a guide to the scientific evidence and current debate*, edited by J. A. Zalasiewicz, Colin N. Waters, Mark Williams and Colin P. Summerhayes, 138-155. Cambridge: New York.

[15] Zalasiewicz, Jan, Mark Williams, Colin N. Waters, Anthony D. Barnosky, John Palmesino, Ann-Sofi Rönnskog, Matt Edgeworth, Cath Neal, Alejandro Cearreta, Erle C. Ellis, Jacques Grinevald, Peter Haff, Juliana A. Ivar do Sul, Catherine Jeandel, Reinhold Leinfelder, John R. McNeill, Eric Odada, Naomi Oreskes, Simon James Price, Andrew Revkin, Will Steffen, Colin Summerhayes, Davor Vidas, Scott Wing, and Alexander P. Wolfe. 2016. "Scale and diversity of the physical technosphere: A geological perspective." *The Anthropocene Review* 4 (1):9-22. doi: 10.1177/2053019616677743.

[16] Duara, Prasenjit. 2021. "The Ernest Gellner Nationalism Lecture: Nationalism and the crises of

global modernity." *Nations and Nationalism* 27 (3):610-622. doi: https://doi.org/10.1111/nana.12753.

[17] Duara, Prasenjit. 2015. *The Crisis of Global Modernity: Asian Traditions and a Sustainable Future*, *Asian connections*. Cambridge: Cambridge University Press.

[18] IUCN. 2016. The IUCN Red List of Threatened Species. Version 2016-3. Available at: www.iucnredlist.org. (Accessed: 07 December 2016).

[19] Peters, Joris, Ophélie Lebrasseur, Hui Deng, and Greger Larson. 2016. "Holocene Cultural History of Red Jungle Fowl (Gallus gallus) and its Domestic Descendant in East Asia." *Quaternary Science Reviews* 142:102-119. doi: https://doi.org/10.1016/j.quascirev.2016.04.004.

[20] Lawler, Andrew. 2014. *Why Did the Chicken Cross the World? The Epic Saga of the Bird that Powers Civilization*. New York: Atria Books.

[21] Storey, Alice A., José Miguel Ramírez, Daniel Quiroz, David V. Burley, David J. Addison, Richard Walter, Atholl J. Anderson, Terry L. Hunt, J. Stephen Athens, Leon Huynen, and Elizabeth A. Matisoo-Smith. 2007. "Radiocarbon and DNA evidence for a pre-Columbian introduction of Polynesian chickens to Chile." *Proceedings of the National Academy of Sciences* 104 (25):10335-10339. doi: 10.1073/pnas.0703993104.

[22] Keith W. F. Stavely and Kathleen Fitzgerald, Northern Hospitality: Cooking by the Book in New England (Amherst: University of Massachusetts Press, 2011), 185. As cited in Lawler, Andrew. 2014. *Why Did the Chicken Cross the World? The Epic Saga of the Bird that Powers Civilization*. New York: Atria Books, 192.

[23] Bugos, Glenn E. 1992. "Intellectual Property Protection in the American Chicken–Breeding Industry." *Business History Review* 66 (1):127-168.

[24] Williams-Forson, Psyche A. 2006. Building Houses out of Chicken Legs: Black Women, Food, and Power. Chapel Hill: The University of North Carolina Press. (See chapter 1)

[25] Bugos, Glenn E. 1992. "Intellectual Property Protection in the American Chicken–Breeding Industry." *Business History Review* 66 (1):127-168.

[26] Jones, Lu Ann. 2002. *Mama Learned Us to Work: Farm Women in the New South*. Chapel Hill: University of North Carolina Press. (See chapter 3).

[27] Boyd, William. 2001. "Making Meat: Science, Technology, and American Poultry Production." *Technology and Culture* 42 (4):631-664.

[28] Schrader, H. L. 1952. "The Chicken-of-Tomorrow Program; Its Influence on 'Meat-Type' Poultry Production." *Poultry Science* 31 (1):3-10.

[29] Bugos, Glenn E. 1992. "Intellectual Property Protection in the American Chicken–Breeding Industry." *Business History Review* 66 (1):127-168.

[30] Hamilton, Shane. 2018. *Supermarket USA: Food and Power in the Cold War Farms Race*. New Haven: Yale University Press. Electronic edition, quote in chapter 2. See especially chapter 2 and chapter 6.

[31] Bugos, Glenn E. 1992. "Intellectual Property Protection in the American Chicken–Breeding Industry." *Business History Review* 66 (1):127-168. See also Boyd 2001.

[32] Beldo, Les. 2017. "Metabolic Labor: Broiler Chickens and the Exploitation of Vitality." *Environmental Humanities* 9 (1):108-128. doi: 10.1215/22011919-3829154.

[33] Zuidhof, M. J., B. L. Schneider, V. L. Carney, D. R. Korver, and F. E. Robinson. 2014. "Growth, Efficiency, and Yield of Commercial Broilers from 1957, 1978, and 2005." *Poultry Science* 93 (12):2970-2982. doi: https://doi.org/10.3382/ps.2014-04291.

[34] Havenstein, G. B., P. R. Ferket, and M. A. Qureshi. 2003. "Growth, Livability, and Feed Conversion of 1957 Versus 2001 Broilers When Fed Representative 1957 and 2001 Broiler Diets." *Poultry Science* 82 (10):1500-1508. doi: https://doi.org/10.1093/ps/82.10.1500.

[35] Bar-On, Yinon M., Rob Phillips, and Ron Milo. 2018. "The Biomass Distribution on Earth." *Proceedings of the National Academy of Sciences*.

[36] Muir, William M., Gane Ka-Shu Wong, Yong Zhang, Jun Wang, Martien A. M. Groenen, Richard P. M. A. Crooijmans, Hendrik-Jan Megens, Huanmin Zhang, Ron Okimoto, Addie Vereijken, Annemieke Jungerius, Gerard A. A. Albers, Cindy Taylor Lawley, Mary E. Delany, Sean MacEachern, and Hans H. Cheng. 2008. "Genome-wide Assessment of Worldwide Chicken SNP Genetic Diversity Indicates Significant Absence of Rare Alleles in Commercial Breeds." *Proceedings of the National Academy of Sciences* 105 (45):17312. doi: 10.1073/pnas.0806569105.

[37] Baéza, E., C. Arnould, M. Jlali, P. Chartrin, V. Gigaud, F. Mercerand, C. Durand, K. Méteau, E. Le Bihan-Duval, and C. Berri. 2012. "Influence of Increasing Slaughter Age of Chickens on Meat Quality, Welfare, and Technical and Economic Results." *Journal of Animal Science* 90 (6):2003-2013. doi: 10.2527/jas.2011-4192.

[38] McGeown, D., T. C. Danbury, A. E. Waterman-Pearson, and S. C. Kestin. 1999. "Effect of Carprofen on Lameness in Broiler Chickens." *Veterinary Record* 144 (24):668-671. doi: 10.1136/vr.144.24.668.

[39] Tickle, Peter G., Heather Paxton, Jeffery W. Rankin, John R. Hutchinson, and Jonathan R. Codd. 2014. "Anatomical and Biomechanical Traits of Broiler Chickens Across Ontogeny. Part I. Anatomy of the Musculoskeletal Respiratory Apparatus and Changes in Organ Size." *PeerJ* 2: e432-e432. doi: 10.7717/peerj.432.

[40] Javed, Sálim, and Asad R. Rahmani. 2000. "Flocking and habitat use pattern of the Red Junglefowl *Gallus gallus* in Dudwa National Park, India." *Tropical Ecology* 41 (1):11-16.

[41] Jacob, Jacquie. "Feather Pecking and Cannibalism in Small and Backyard Poultry Flocks." Extension, accessed May 30, 2022. https://poultry.extension.org/articles/poultry-behavior/feather-pecking-and-cannibalism-in-small-and-backyard-poultry-flocks/.

[42] Buijs, Stephanie, Linda J. Keeling, Carl Vangestel, Jeroen Baert, and Frank A. M. Tuyttens. 2011. "Neighbourhood analysis as an indicator of spatial requirements of broiler chickens." *Applied Animal Behaviour Science* 129 (2):111-120. doi: https://doi.org/10.1016/j.applanim.2010.11.017.

[43] Buijs, Stephanie, Linda J. Keeling, and Frank A. M. Tuyttens. 2011. "Using motivation to feed as a way to assess the importance of space for broiler chickens." *Animal Behaviour* 81 (1):145-151. doi: https://doi.org/10.1016/j.anbehav.2010.09.027.

[44] Grandin, Temple, and Mark J. Deesing. 2014. "Chapter 12 - Genetics and Animal Welfare." In

Genetics and the Behavior of Domestic Animals (Second Edition), edited by Temple Grandin and Mark J. Deesing, 435-472. San Diego: Academic Press.

[45] Mels, Caroline, Knut Niebuhr, Andreas Futschik, Jean-Loup Rault, and Susanne Waiblinger. 2022. "Predictors for plumage damage and bloody lesions indicative of feather pecking in pullets reared in aviaries." *Applied Animal Behaviour Science* 250:105607. doi: https://doi.org/10.1016/j.applanim.2022.105607.

[46] Zepp, Miriam, Helen Louton, Michael Erhard, Paul Schmidt, Franziska Helmer, and Angela Schwarzer. 2018. "The influence of stocking density and enrichment on the occurrence of feather pecking and aggressive pecking behavior in laying hen chicks." *Journal of Veterinary Behavior* 24:9-18. doi: https://doi.org/10.1016/j.jveb.2017.12.005.

[47] Liebers, Christopher J., Angela Schwarzer, Michael Erhard, Paul Schmidt, and Helen Louton. 2019. "The influence of environmental enrichment and stocking density on the plumage and health conditions of laying hen pullets." *Poultry Science* 98 (6):2474-2488. doi: https://doi.org/10.3382/ps/pez024.

[48] Mels, Caroline, Knut Niebuhr, Andreas Futschik, Jean-Loup Rault, and Susanne Waiblinger. 2022. "Predictors for plumage damage and bloody lesions indicative of feather pecking in pullets reared in aviaries." *Applied Animal Behaviour Science* 250:105607. doi: https://doi.org/10.1016/j.applanim.2022.105607.

[49] Singer, Peter, and Jim Mason. 2006. The Way We Eat: Why Our Food Choices Matter. Emmaus, Pa.: Rodale. See chapter 8.

[50] Department of Environment, Food and Rural Affairs. 2005. A Guide to the Practical Management of Feather Pecking & Cannibalism in Free Range Laying Hens. edited by Food and Rural Affairs Department of Environment. London: Defra Publications.

[51] Bauer, Mary, and Monica Ramirez. 2010. "Injustice on Our Plates: Immigrant Women in the U.S. Food Industry." edited by Booth Gunter. Montgomery, Alabama: Southern Poverty Law Center.

[52] Bennett, Carys E., Richard Thomas, Mark Williams, Jan Zalasiewicz, Matt Edgeworth, Holly Miller, Ben Coles, Alison Foster, Emily J. Burton, and Upenyu Marume. 2018. "The broiler chicken as a signal of a human reconfigured biosphere." *Royal Society Open Science* 5 (12):180325. doi: 10.1098/rsos.180325.

[53] The story of the origins of the term as described in this paragraph can be found in Zalasiewicz, Jan, Colin N. Waters, Mark Williams, Colin P. Summerhayes, Martin J. Head, and Reinhold Leinfelder. 2019. "A General Introduction to the Anthropocene." In *The Anthropocene as a Geological Time Unit: A Guide to the Scientific Evidence and Current Debate*, edited by Jan A. Zalasiewicz, Colin N. Waters, Mark Williams and Colin P. Summerhay, 2-4. Cambridge: New York, p. 2.

[54] Steffen, Will, Paul J. Crutzen, and John R. McNeill. 2007. "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?" *Ambio* 36 (8):614-21. Quote on page 614.

[55] Steffen, Will. 2002. "Will technology spare the planet?." In *Challenges of a Changing Earth: Proceedings of the Global Change Open Science Conference. Amsterdam, The Nether—lands, 10-13 July 2001*, edited by Will Steffen, Jill Jäger, David J. Carson and Clare Bradshaw, 189-191. Berlin, Heidelberg, New York: Springer-Verlag.

[56] Barnosky, Anthony D. 2014. "Palaeontological Evidence for Defining the Anthropocene." *Geological Society, London, Special Publications* 395 (1):149. doi: 10.1144/SP395.6.

[57] Barnosky, Anthony D. 2014. "Palaeontological Evidence for Defining the Anthropocene." *Geological Society, London, Special Publications* 395 (1):149. doi: 10.1144/SP395.6.

[58] E.g. Latour, Bruno. "Anthropology at the Time of the Anthropocene: A Personal View of What Is to Be Studied." *American Association of Anthropology Annual Meeting*. 2014, p. 8, accessed March 1, 2017, http://www.bruno-latour.fr/sites/default/files/139-AAA-Washington.pdf.

[59] Bauer, Andrew M., and Erle C. Ellis. 2018. "The Anthropocene Divide: Obscuring Understanding of Social-Environmental Change." *Current Anthropology* 59 (2):209-227. doi: 10.1086/697198.

[60] Moore, Jason W., ed. 2016. *Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism*. Oakland, CA: PM Press.

[61] Haraway, Donna, Noboru Ishikawa, Scott F. Gilbert, Kenneth Olwig, Anna L. Tsing, and Nils Bubandt. 2016. "Anthropologists Are Talking – About the Anthropocene." *Ethnos* 81 (3):535-564. doi: 10.1080/00141844.2015.1105838.

[62] Haraway, Donna. 2015. "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin." *Environmental Humanities* 6:159-165.

[63] Haraway, Donna Jeanne. 2016. *Staying with the Trouble: Making Kin in the Chthulucene*. Durham: Duke University Press.

[64] McBrien, Justin. 2016. "Accumulating Extinction: Planetary Catastrophism in the Necrocene." In Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism, edited by Jason W. Moore, 116-137. Oakland, CA: PM Press.

[65] Ribot, Jesse. 2014. "Cause and Response: Vulnerability and Climate in the Anthropocene." *The Journal of Peasant Studies* 41 (5):667-705. doi: 10.1080/03066150.2014.894911.

[66] Moore, Jason W., ed. 2016. *Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism*. Oakland, CA: PM Press, p. xi.

[67] Moore, Jason W., ed. 2016. *Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism*. Oakland, CA: PM Press, p. 1-11.

[68] Haraway, Donna, Noboru Ishikawa, Scott F. Gilbert, Kenneth Olwig, Anna L. Tsing, and Nils Bubandt. 2016. "Anthropologists Are Talking – About the Anthropocene." *Ethnos* 81 (3):535-564. doi: 10.1080/00141844.2015.1105838.

[69] Haraway, Donna. 2015. "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin." *Environmental Humanities* 6:159-165.

[70] Haraway, Donna Jeanne. 2016. *Staying with the Trouble: Making Kin in the Chthulucene*. Durham: Duke University Press.

[71] McBrien, Justin. 2016. "Accumulating Extinction: Planetary Catastrophism in the Necrocene." In Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism, edited by Jason W. Moore, 116-137. Oakland, CA: PM Press, p. 116.

[72] Ribot, Jesse. 2014. "Cause and Response: Vulnerability and Climate in the Anthropocene." *The*

Journal of Peasant Studies 41 (5):667-705. doi: 10.1080/03066150.2014.894911.

[73] Pauly, Daniel. 2010. *5 Easy Pieces: How Fishing Impacts Marine Ecosystems*. Washington, DC: Island Press, p. 61.

[74] Samways, Michael. 1999. “Translocating Fauna to Foreign Lands: Here Comes the Homogenocene.” *Journal of Insect Conservation* 3 (2):65-66. doi: 10.1023/A:1017267807870.

[75] Ruddiman William, F., C. Ellis Erle, O. Kaplan Jed, and Q. Fuller Dorian. 2015. “Defining the Epoch We Live in.” *Science* 348 (6230):38-39. doi: 10.1126/science.aaa7297.

[76] Ruddiman William, F., C. Ellis Erle, O. Kaplan Jed, and Q. Fuller Dorian. 2015. “Defining the Epoch We Live in.” *Science* 348 (6230):38-39. doi: 10.1126/science.aaa7297.

[77] Bonneuil, Christophe, and Jean-Baptiste Fressoz. 2016. *The Shock of the Anthropocene: The Earth, History and Us*. London: Verso, chapter 3.

[78] Lewis, Simon L., and Mark A. Maslin. 2015. “Defining the Anthropocene.” *Nature* 519 (7542):171-180. doi: 10.1038/nature14258.

[79] Zalasiewicz, Jan, Colin Waters, Martin J. Head, Will Steffen, J. P. Syvitski, Davor Vidas, Colin Summerhayes, and Mark Williams. 2018. “The Geological and Earth System Reality of the Anthropocene.” *Current Anthropology* 59 (2):220-223.

[80] Zalasiewicz, Jan, Mark Williams, Colin N. Waters, Anthony D. Barnosky, John Palmesino, Ann-Sofi Rönnskog, Matt Edgeworth, Cath Neal, Alejandro Cearreta, Erle C. Ellis, Jacques Grinevald, Peter Haff, Juliana A. Ivar do Sul, Catherine Jeandel, Reinhold Leinfelder, John R. McNeill, Eric Odada, Naomi Oreskes, Simon James Price, Andrew Revkin, Will Steffen, Colin Summerhayes, Davor Vidas, Scott Wing, and Alexander P. Wolfe. 2016. “Scale and diversity of the physical technosphere: A geological perspective.” *The Anthropocene Review* 4 (1):9-22. doi: 10.1177/2053019616677743.

[81] Haff, Peter. 2019. “The technosphere and its physical stratigraphical record.” In *The Anthropocene as a Geological Time Unit: A Guide to the Scientific Evidence and Current Debate*, edited by J. A. Zalasiewicz, Colin N. Waters, Mark Williams and Colin P. Summerhayes, 138-155. Cambridge: New York.

[82] Diamond, Jared M., 2005, *Guns, germs, and steel: the fates of human societies*. (New York: Norton).

[83] Ibid, 100.

[84] Schleidt, Wolfgang M., and Michael D. Shalter. 2003. “Co-evolution of humans and canids. An alternative view of dog domestication: Homo Homini Lupus?” *Evolution and Cognition* 9 (1):57-72.

[85] Chambers, Jaime, Marsha B. Quinlan, Alexis Evans, and Robert J. Quinlan. 2020. “Dog-Human Coevolution: Cross-Cultural Analysis of Multiple Hypotheses.” *Journal of Ethnobiology* 40 (4):414-433, 20.

[86] Nagasawa, Miho, Shouhei Mitsui, Shiori En, Nobuyo Ohtani, Mitsuaki Ohta, Yasuo Sakuma, Tatsushi Onaka, Kazutaka Mogi, and Takefumi Kikusui. 2015. “Oxytocin-gaze positive loop and the coevolution of human-dog bonds.” *Science* 348 (6232):333-336. doi: doi:10.1126/science.1261022.

[87] Katajamaa, Rebecca, Lovisa H. Larsson, Paulina Lundberg, Ida Sörensen, and Per Jensen. 2018. “Activity, social and sexual behaviour in Red Junglefowl selected for divergent levels of fear of humans.” *PLOS ONE* 13 (9):e0204303. doi: 10.1371/journal.pone.0204303.

[88] Aristotle. 2004. "Politics." In *Animal Rights: A Historical Anthology*, edited by Andrew Linzey and Paul Barry Clarke, 6-7. New York: Columbia University Press.

[89] For a short review of the history, see Grinevald, Jacques, John McNeill, Naomi Oreskes, Will Steffen, Colin P. Summerhayes, and Jan Zalasiewicz. 2019. "History of the Anthropocene Concept." In *The Anthropocene as a Geological Time Unit: A Guide to the Scientific Evidence and Current Debate*, edited by Jan A. Zalasiewicz, Colin N. Waters, Mark Williams and Colin P. Summerhay, 4-11. Cambridge: New York.

[90] Crutzen, Paul J., and Eugene F. Stoermer. "The 'Anthropocene'." *Global Change: IGBP Newsletter*.41 (2000): 18. (http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf, accessed March 20, 2017)

[91] Crutzen, Paul J. "Geology of Mankind." *Nature* 415 (2002): 23.

[92] Marsh, George P. *The Earth as Modified by Human Action: A Last Revision of "Man and Nature"*. New York: C. Scribner, 1898 [1864].

[93] Gilebbi, Matteo. "Antonio Stoppani and the Teleological Interpretation of the Anthropocene." *2017 AAIS/CSIS*. 2017.

[94] See Teilhard de Chardin, Pierre. *The Vision of the Past*. Harper & Row, 1966. http://archive.org/details/VisionOfThePast.

[95] Piqueras, Merce. "Meeting the Biospheres: On the Translations of Vernadsky's Work." *International Microbiology* 1.2 (1998): 165.

[96] Le Roy, Edouardo. *L'exigence Idéaliste Et Le Fait De L'evolution.* Paris: Boivin, 1927.

[97] An English translation was published in 1966: Teilhard de Chardin, Pierre. "Hominization." Trans. Cohen, J.M. *The Vision of the Past*. New York: Harper & Row, 1966 [1923]. 51-79.

[98] Hamilton, Clive, and Jacques Grinevald. "Was the Anthropocene Anticipated?" *The Anthropocene Review* 2.1 (2015): 7.

[99] See note 6. In Hamilton and Grinevald, 10.

[100] Vernadsky, W. I. "The Biosphere and the Noosphere." *American Scientist* 33.1 (1945): 1-12.

[101] Ibid.

[102] Vernadskii, Vladimir. I. 1998. *The Biosphere*. Translated by David B. Langmuir. New York: Copernicus: 38-41 ("Author's Preface to the French Edition").

[103] Ibid, 32.

[104] Lovelock, James E., and Lynn Margulis. 1974. "Atmospheric homeostasis by and for the biosphere: The gaia hypothesis." *Tellus* 26 (1-2):2-10. doi: 10.3402/tellusa.v26i1-2.9731.

[105] Lovelock, James. *Gaia: A New Look at Life on Earth.* Oxford: Oxford University Press, 2000, 123-124.

[106] Paul J. Crutzen and Eugene F. Stoermer. 2000. "The 'Anthropocene.'" *IGBP Newsletter*. 41 (May): 18. (http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf, accessed March 20, 2017)

[107] Lovelock, James. *Gaia: A New Look at Life on Earth*. Oxford: Oxford University Press, 2000, p.

142.
[108] Ibid.
[109] Ibid.
[110] "Animals in Space." Accessed December 14, 2017. https://history.nasa.gov/animals.html.
[111] Teilhard de Chardin, Pierre. 1966 [1923]. "Hominization." In *The Vision of the Past*, 51-79. New York: Harper & Row.
[112] For example, see Harris, Ian. "Buddhism and the Discourse of Environmental Concern: Some Methodological Problems Considered." *Buddhism and Ecology: The Interconnection of Dharma and Deeds*. Eds. Tucker, Mary Evelyn and Duncan Ryūken Williams. Cambridge, MA: Harvard University Center for the Study of World Religions, 1997. 377-402.
[113] For example, see Hobgood-Oster, Laura. *Holy Dogs and Asses: Animals in the Christian Tradition*. Urbana: University of Illinois Press, 2008.
[114] Swimme, Brian, and Thomas Berry. *The Universe Story: From the Primordial Flaring Forth to the Ecozoic Era—a Celebration of the Unfolding of the Cosmos*. San Francisco: HarperCollins, 1992.
[115] Berry, Thomas. "The Ecozoic Era." *Eleventh Annual E. F. Schumacher Lectures*. 1991. http://www.centerforneweconomics.org/publications/lectures/berry/thomas/the-ecozoic-era.
[116] Ibid.
[117] Hamilton, Clive, and Jacques Grinevald. "Was the Anthropocene Anticipated?" *The Anthropocene Review* 2.1 (2015): 59-72.
[118] Margulis, Lynn. 1990. "Kingdom animalia: The zoological malaise from a microbial perspective." *American Zoologist* 30 (4):861-875. doi: 10.1093/icb/30.4.861.
[119] Möbius, Karl August. 1877. *Die Auster und die Austernwirthschaft*. Berlin: Verlag von Wiegandt, Hemple & Parey.
[120] Lynn Margulis first referenced the idea of holobiont in Margulis, Lynn. 1990. "Words as Battle Cries: Symbiogenesis and the New Field of Endocytobiology." BioScience 40 (9):673-677. doi: 10.2307/1311435.
[121] The concept of holobiont appears to have been independently proposed by Adolf Meyer-Abich prior to Lynn Margulis coined the term. See Baedke, Jan, Alejandro Fábregas-Tejeda, and Abigail Nieves Delgado. 2020. "The holobiont concept before Margulis." *Journal of experimental zoology* 334 (3):149-155. doi: 10.1002/jez.b.22931.
[122] O'Malley, Maureen A. 2017. "From endosymbiosis to holobionts: Evaluating a conceptual legacy." *Journal of Theoretical Biology* 434:34-41. doi: https://doi.org/10.1016/j.jtbi.2017.03.008.
[123] Shumaker, Robert W., Kristina R. Walkup, and Benjamin B. Beck. *Animal Tool Behavior: The Use and Manufacture of Tools by Animals*. Baltimore: Johns Hopkins University Press, 2011.
[124] Evrensel, Alper, and Mehmet Emin Ceylan. "The Gut-Brain Axis: The Missing Link in Depression." *Clinical Psychopharmacology and Neuroscience* 13.3 (2015): 239-44.
[125] Despommier, Dickson D. *People, Parasites, and Plowshares: Learning from Our Body's Most Terrifying Invaders*. New York: Columbia University Press, 2013. See chapter 4 for *Toxoplasma gondii*.
[126] Ingram, Wendy Marie, et al. "Mice Infected with Low-Virulence Strains of Toxoplasma Gondii Lose

Their Innate Aversion to Cat Urine, Even after Extensive Parasite Clearance." *PLOS ONE* 8.9 (2013): e75246.

127 Flegr, Jaroslav, et al. "Increased Risk of Traffic Accidents in Subjects with Latent Toxoplasmosis: A Retrospective Case-Control Study." *BMC Infectious Diseases* 2.1 (2002): 11.

128 Flegr, Jaroslav, Pavlína Lenochová, Zdeněk Hodný, and Marta Vondrová. "Fatal Attraction Phenomenon in Humans – Cat Odour Attractiveness Increased for Toxoplasma-Infected Men While Decreased for Infected Women." *PLOS Neglected Tropical Diseases* 5.11 (2011): e1389.

129 See chapter 6 of Hare, Brian. *The Genius of Dogs: How Dogs Are Smarter Than You Think*. Ed. Woods, Vanessa. New York: Dutton, 2013.

130 Simard, Suzanne W. 2018. "Mycorrhizal Networks Facilitate Tree Communication, Learning, and Memory." In *Memory and Learning in Plants*, edited by Frantisek Baluska, Monica Gagliano and Guenther Witzany, 191-213. Cham: Springer International Publishing.

131 Vansteensel, Mariska J., Elmar G.M. Pels, Martin G. Bleichner, Mariana P. Branco, Timothy Denison, Zachary V. Freudenburg, Peter Gosselaar*, et al*. "Fully Implanted Brain–Computer Interface in a Locked-in Patient with Als." *New England Journal of Medicine* 375.21 (2016): 2060-66.

132 Fields, R. Douglas. "Of Whales and Men." Scientific American Blog Network, January 15, 2008. https://blogs.scientificamerican.com/news-blog/are-whales-smarter-than-we-are/.

133 Marino, Lori, Richard C. Connor, R. Ewan Fordyce, Louis M. Herman, Patrick R. Hof, Louis Lefebvre, David Lusseau*, et al*. "Cetaceans Have Complex Brains for Complex Cognition." *PLOS Biology* 5.5 (2007): e139.

134 Kohn, Eduardo. *How Forests Think: Toward an Anthropology Beyond the Human*. Berkeley: University of California Press, 2013.

135 De la Cadena, Marisol. *Earth Beings: Ecologies of Practice across Andean Worlds*. Durham: Duke University Press, 2015. http://dx.doi.org/10.1215/9780822375265.

136 Harari, Yuval N. *Homo Deus: A Brief History of Tomorrow*. London: Harvill Secker, 2016.

137 See, for example, Diamond, Jared M. *Collapse: How Societies Choose to Fail or Succeed*. New York: Viking, 2005.

138 World Resources Institute. "6 Graphs Explain the World's Top 10 Emitters | World Resources Institute." Accessed December 22, 2017. https://wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters.

139 International Campaign to Abolish Nuclear Weapons. "Nuclear Arsenals | ICAN." Accessed December 22, 2017. http://www.icanw.org/the-facts/nuclear-arsenals/.

140 Crutzen, Paul J. "Geology of Mankind." *Nature* 415 (2002): 23.

141 Jobin, Paul, Ming-sho Ho, and Hsin-Huang Michael Hsiao, eds. 2021. *Environmental Movements and Politics of the Asian Anthropocene*. Singapore: ISEAS Publishing, 7.

142 Lovelock, James. *Gaia: A New Look at Life on Earth*. Oxford: Oxford University Press, 2000, p. 136.

143 Humane Society of the United States. "An HSUS Report: The Welfare of Animals in the Chicken Industry." 2013.

[144] The FAO's most recent estimate for annual chicken slaughter is 62 billion chickens in 2014 (Food and Agricultural Organization of the United Nations, FAOStat, http://www.fao.org/faostat/en/#data/QL, accessed February 27, 2017), while the CIA World Factbook estimates a world death rate of 7.8/1000 people in 2016 for a world population of 7,323,187,457, or 57 million deaths (CIA World Factbook, "World,"https://www.cia.gov/library/publications/resources/the-world-factbook/geos/xx.html, accessed May 12, 2017).

[145] "Researchers Compare Chicken, Human Genomes," National Human Genome Institute, accessed May 2, 2013, http://www.genome.gov/12514316.

[146] Haraway, Donna Jeanne. *When Species Meet*. Minneapolis: University of Minnesota Press, 2008, p. 74.

[147] Patel, Raj, and Jason W. Moore. 2017. *A History of the World in Seven Cheap Things: A Guide to Capitalism, Nature, and the Future of the Planet*. Oakland, California: University of California Press. (electronic copy, Introduction)