

# UC Riverside

## UC Riverside Previously Published Works

**Title**

The Living Wage, "That Reproductive Ferment"

**Permalink**

<https://escholarship.org/uc/item/0pd2b9cd>

**Journal**

History of the Present, 7(1)

**ISSN**

2159-9785

**Author**

Simmons, Dana

**Publication Date**

2017-04-01

**DOI**

10.5406/historypresent.7.1.0096

**Copyright Information**

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, available at <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Peer reviewed

## The Living Wage, “that Reproductive Ferment”

Dana Simmons

How much life is in the living wage? In recent months, a number of major American cities have enacted minimum wage ordinances, offering urban working families a promise of better living conditions. Yet just as minimum wage laws attempt to ameliorate the conditions of low-wage workers, working communities appear under threat by temporary work, automation, task labor, mass incarceration, deportation, and a host of other social pressures. Shifts in capital and labor seem to have swept away any guarantees of secure, steady, and sufficient working-class employment in the global North. A decent life continues to elude even those within the reach of recent minimum wage victories. The MIT Living Wage Calculator reckons that a \$15/hour minimum wage would not suffice in a city like Los Angeles to cover a family’s basic expenses.<sup>1</sup> When one considers all the forms of life and all the living people excluded from wage work—by choice, by necessity, or by force—very little potential life appears left in the wage. The era of the wage, some two hundred years old, seems likely to fade sooner or later.

The living wage was conceived in opposition to a free market, contractual model of wage work. Scientific wage theories were tied to the mass expansion of wage labor in the mid-nineteenth century. Yet today, labor increasingly happens in contexts without stable contracts. “Freedom” appears severed from any semblance of contractual relations in the salvage economy of temporary, freelance, sharing, and foraging work that characterizes many global supply chains today. What comes next? If the wage relation is giving way to other unstable socio-economic forms, where may we search for a promise of life?

Wages are not generally thought of as a scientific question. Wage struggles are rarely imagined as epistemological battles; categories like life and labor are taken for granted. Workers

in traditional labor histories appear concerned with material conditions and disengaged from critical concepts. Labor historians tell stories of class, power, and politics. Cultural historians from E.P. Thompson to William Sewell made these stories more complex and active by debunking traditional stereotypes of workers as passive receptacles of knowledge and culture. These modifications have led to some engagement with the history of science. I am inspired by historians Michelle Murphy, Joan Scott, Emma Spary, Harmke Kamminga, Christopher Hamlin, John Bellamy Foster, and Elizabeth Wilson, who each suggest in different ways that epistemological conflicts are also often class and labor battles. John Tresch, Norton Wise, Anson Rabinbach, and Philip Mirowski have shed light on the contributions made by nineteenth-century physicists and chemists to the economic conceptions of work, energetics, and ergonomics. I am gratefully indebted to Hannah Landecker's keen and astute work on the twinned histories of metabolism and reproduction. This work builds upon their efforts.

This article outlines a scientific history of the living wage. How could a wage be *living*? What forms of life live or have lived in a wage? I look to the nineteenth century as a moment when life sciences and wage work grew in tandem—when the living wage emerged from within a paradigm dominated by scientific materialism and solvent chemistry. Nineteenth-century scientists and political theorists defined life as the “organization of matter.” Life, in this view, was production and consumption, ferment and fermentation. Life happened when matter moved.

I argue that the living wage, as it emerged in the mid-nineteenth century, was bound up with scientific materialism. In sum, materialists held that “all is matter in motion”: nothing—no mind, soul, life spirit, or God—exists independent of material bodies. The strand of materialism relevant to this story is most commonly associated with nineteenth-century German-speaking physiologists Karl Vogt, Ludwig Büchner, and Jacob Moleschott. Scientific materialists insisted

that general laws of nature, especially those of physics and chemistry, applied to all forms of matter. Matter was a unitary substance, eternally abundant and eternally consistent. Matter—a unified substance obeying universal natural laws—was all that ever existed.<sup>2</sup>

Scientific materialists saw the wage as a medium, a ferment for life itself. Differences—individual existences, distinct organisms, differentiated forms of life—were produced through labor. Matter, the basic stuff of nature, was undifferentiated. An active intervention, labor, was necessary to produce difference from this mass of chemical elements. While organisms assembled matter into individual parts and organs, human labor produced difference in the social and natural world. Labor organized matter, and thereby created different forms of life. Wages served as a medium for the work of organizing matter into multiple existences.

Science can function as a neutralizing space in the conflictual terrain of labor struggle. In the early twentieth century, governments and unions used the sciences of ergonomics, physiology, work, and nutrition to objectify and defuse labor conflicts.<sup>3</sup> In the nineteenth century, however, these institutional spaces had not yet congealed; natural science did not neutralize labor conflict, but rather widened its scope. Scientific materialists sought to override existing social relations. Matter itself, they argued, contained a form of relation, to which social institutions must conform. Scientific materialists elevated workers to a key position in the natural flow of matter and the scientific organization of life: nature shaped the conditions of labor, and workers produced nature with their labor. Debates over matter were also debates over social and political value. Politics, as in the present moment, happened in an epistemological key: what is, what is true, collapses into what matters.

<T1HD>Organization of Matter

<TXT>“A worker needs a wage that lets him live from his work. He cannot produce without consuming. Whoever employs a worker owes him food and upkeep, or an equivalent wage. That is the basis of all production.”<sup>4</sup> Pierre-Joseph Proudhon, in his 1840 tract *What is Property?*, was one of the first to name the living wage as a political object. Proudhon’s vision of the living wage was tangled up with scientific conceptions of life. For Proudhon and many of his contemporaries, the wage was living because life and labor were one and the same. The two terms, life and work, described the same activity: to live, to work, meant to direct the flow of matter and to reproduce oneself.

The living wage represented a politics of scientific materialism and of the conservation of matter. All matter belonged to a unitary substance, created at the beginning of time and perpetually conserved in an eternal circulation. Matter was set into circulation by nature and harnessed by science and industry. The flow of stuff continued forever; the task of human labor was to harness and direct this flow towards life.

This vision of immortal matter was developed by scientists in the late-eighteenth century. Naturalist Georges Louis Leclerc, comte de Buffon proposed the unity of all nutritive substances. All matter, he thought, originated at the beginning of time: matter was continually passing from one body to the next, from plants to animals to humans and back again.<sup>5</sup> As historian Emma Spary tells us, “Buffon was effectively arguing for eternal life, at any rate at the molecular level. His ethics of eating also functioned on the natural, not human, scale. The death of individual living beings was a matter of balancing nature's *oeconomic* books, rather than an issue of moral justice [...] This accountancy of living matter rested on a natural *oeconomy* conceived as a model of circulation and exchange.”<sup>6</sup> Spary uncovers many instances of this philosophy in the late-eighteenth century, including a marvelous passage from Diderot’s 1769 “Conversation

between Diderot and D'Alembert" in which Diderot jokingly described the passage of matter into life. He proposed to eat a statue by pulverizing it, mixing the dust with soil and growing peas in it. "I like this passage from marble to humus, from humus to the plant kingdom, and from the plant kingdom to the animal kingdom, to flesh," quips a bemused D'Alembert.<sup>7</sup>

Diderot's fantasy of converting marble to flesh shows us that, already in the eighteenth century, the conservation of matter was understood as a key to human life and labor. If all the universe was made of a singular, unitary substance, and if all matter has existed since the beginning of time, then it must have been continuously changing form. All changes, and thus all of history, came from modifications of this unitary basic matter.

Transformations and modifications were the stuff of life. Life itself could be found in the circulation of matter. Dutch physiologist Jacob Moleschott, one of the best known of the nineteenth-century scientific materialists, defined life as "the passage of matter from one form to another, in the exchange of matter."<sup>8</sup> He further elaborated: "The movement of elements, their combination and separation, absorption and elimination, this is the content of all activity on earth."<sup>9</sup> The living wage was a political and practical expression of this worldview.

The *organization of matter* was a key nineteenth-century biological-political concept.<sup>10</sup> Historian John Tresch brilliantly describes an influential group of "mechanical romantics" who were invested in a unified vision of life, spirit, technology, and the circulation of matter. These scientists, industrialists, and workers gave the eighteenth-century materialism of Buffon and Diderot a romantic, dynamic inflection. In their hands matter turned lively, was always shifting shape, and was in a constant state of production and reproduction.

The stuff of life is all alike, suggested naturalist Etienne Geoffroy Saint-Hilaire. Geoffroy posited the unity of all living matter.<sup>11</sup> Nature, acting on matter, generates specific organs and

organisms. Like his colleague Jean Baptiste Lamarck, Geoffroy thought that natural forces constantly pushed living organisms to change shape and develop new organs. Living nature was undifferentiated and unified; differences and individuals resulted from specific forms of organization. Tresch calls Geoffroy's world view an "ecstatic materialism," wherein "each animal was simultaneously itself and an abstract field of potentialities acting within it."<sup>12</sup> Geoffroy showed that scientists could intervene—via embryological techniques—to change the course of this transformation. Man, like nature, took on the task of organizing matter.

This unitary view of matter fed directly into scientific-political theories about subsistence, labor, wages, and production. Physiologists in the mid-nineteenth century applied a mechanical analogy to both plants and humans: plants were "machines" that absorb and transform matter carried through the atmosphere in order to supply animals with food, and humans were "machines" that organize and fix matter to supply the greater social good. In this model, the living wage was an instrument for converting labor into food and back again.

The flow of matter appeared as a great productive machine that men must shape and direct to serve human ends. Scientific expertise would act in the service of the state and of social stability. French chemist Jean Baptiste Dumas proposed that the task of agriculture is to "remake, with men's urine, and by means of carbonic acid in the air, the wheat that man eats."<sup>13</sup> Man's urine releases ammonia into the air and soil, matter which then enters the wheat that later provides for man's daily subsistence. Dumas implied that by ejecting chemicals into the atmosphere a man could, in a certain sense, reproduce himself.<sup>14</sup>

Dumas quantified a basic subsistence diet in measures of carbon and ammonia, and he calculated the wages required to buy it. He identified two types of animal product essential to the cycle of matter and of life: exhalations and urine. Urine carried ammonia back into the

atmosphere, ready to serve once again as the building block for plant life. Exhalations released carbonic acid, the byproduct of animal combustion, into the air: “Man is a marvelous machine [...]; for he rejects back into the general [natural] economy the products which serve to reconstitute the fuel that he has consumed.”<sup>15</sup> Through the intermediary of plants, all of the nitrogen and water released by animals’ urine is converted back into “precisely the amount of carbon that they have consumed.”<sup>16</sup>

This is a circular view of production, one in which matter constantly flows between the living and the non-living. Production, in this ever-transforming universe, binds the labor of men to the flow of nature. Economic production coincides with natural regeneration, and production and reproduction are unified.

#### <T1HD>Distribution

<TXT>If matter was both unified and unitary, what then produced difference? Scientific materialists, following Geoffroy, believed that differences were produced by labor. Workers organized matter into distinct objects and lives. If the universe was composed of a fixed, eternal and unified matter, then the question became how to organize and distribute it. Man played a unique role in the eternal recycling of all matter in the universe. All other things, living and non-living, received and transmitted matter passively. Man alone—and the gendered term was poignant—appeared capable of shaping, directing and organizing the flow of matter. Man appeared here as a conductor of material circulations, directing matter toward rational and generative ends.

This ideal of organized matter spread from science to politics. Geoffroy’s ideas deeply influenced romantic socialists from the Saint-Simonians to Pierre Leroux. The Saint-Simonians,



a group of industrial romantics who played a central role in France's nineteenth-century industrialization, sought to "increase their society's state of 'organization,' and its control over its milieu. The goal was to progressively incorporate that which surrounded society into society itself."<sup>17</sup> Socialist Louis Blanc proclaimed, on the eve of the Revolution of 1848, that the greatest task of a workers' government would be the "Organization of Labor."<sup>18</sup>

This, for nineteenth-century scientific labor activists, was the ultimate goal of society: the beneficial organization of matter toward useful ends. Matter must be harnessed, channeled toward the health and well-being of society. In the midst of the French Revolution, chemist Antoine Laurent de Lavoisier suggested that physicians alone should set workers' wage rates, on the basis of their bodily expenditures.<sup>19</sup> Chemists and republicans echoed Lavoisier's argument across the nineteenth century: they believed that scientists should play a central role in setting the most beneficial distribution of matter according to the laws of nature. The agents of this distribution, those who should benefit from it and who should draw from it to regenerate their own bodies, were the workers.

The distribution of matter was not predetermined. Matter should be modified, operated upon, transformed, by human labor. Workers should direct matter according to the principles of science, justice, and reason, with the goal of moving toward the regeneration of society. Specifically, matter must be directed toward regenerating the health and well-being of laborers. Through labor, men shape the flow of matter. Labor was thus the first of all natural rights. It was the foundation of the society—and, by extension, the world.

Jacob Moleschott, writing in the aftermath of the 1848 revolutions, sought freedom and justice for matter; he was deeply committed to the 1848 revolutionary moment. He dedicated his professional life to promoting scientific materialism, popular scientific education, social

democracy, and rational eating.<sup>20</sup> For Moleschott, the key to social justice lay in the fair distribution of matter: “A free and just distribution of matter, that is the goal which recent movements have tried to achieve.... The distribution of matter is what makes labor possible, and through labor, an existence worthy of human beings.”<sup>21</sup> Through labor, humans direct matter in the service of life. Social justice demanded that matter be allowed to flow towards those who could use it.

In Moleschott’s scientific labor activism, life and labor expressed the same process. Just as Geoffroy defined life as the organization of a unitary substance into particular organs and organisms, each with their own function, Moleschott viewed labor as the organization of raw materials into particular products. Labor shaped the stuff of life, both at the individual and collective levels. Workers directed the generative flows of matter to produce subsistence, their own bodily substance, and society. The laborer, the lively organism at the center of these flows, was an active male worker and a political organizer. He assembled matter and people toward a rational, unified, scientific goal: the organization of society. As Moleschott explained: “All the labors of men point, like rays, toward the circle that matter must follow. Depending on the degree of our knowledge, our struggles may be closer or distant from that center. To work toward the highest development of humanity, we must judiciously combine carbonic acid, ammonia, salts, humic acid and water. The more clearly we understand this, the more noble our struggle and our work will become, as we seek to establish the shortest path into the circle, the rotation of the elements.”<sup>22</sup>

Scientists and political economists created a natural, rational hierarchy of value according to which matter should flow. Scientists from Lavoisier to Moleschott saw their role as a kind of *Ur-laborer*—one who established the principles by which matter and people might be organized

most rationally. Proudhon and Louis Blanc understood the role of the political theorist in exactly the same manner. According to them, a theorist was responsible for establishing guidelines, which would permit the social order to function most rationally in favor of labor, and thus of life.

Although I know of no direct evidence linking Proudhon to scientific materialists, the structural similarities between them are striking. Proudhon, like Louis Blanc, would have been exposed to Saint-Simonian ideas about the organization of life, matter, and society. Members of Proudhon's circle—Russian exiles in Paris in the late 1840s—were close to the materialist physiologist Karl Vogt and may have served as points of passage.<sup>23</sup> Proudhon and Jacob Moleschott also shared very similar ideas about life, labor, and matter. The purpose of work, in their view, was to reproduce life and labor. The living wage, in this model, served as the primary instrument of reproduction. “The worker must guarantee his future subsistence from his production, in addition to his daily subsistence,” wrote Proudhon. “Work perpetually must be reborn out of work that has already been accomplished: this is the universal law of reproduction.”<sup>24</sup>

The dyad of life and labor involved movement, direction, and putting things in their place. It involved expending and replacing, ejecting and consuming, outputs and inputs. Labor took up matter and shaped it, directed it, organized it toward a higher purpose. Labor was a political force. Labor guaranteed that society followed the laws of nature and harnessed the eternal circulation of matter. Man's natural role was to labor, to participate in this natural cycle. The goal of labor was to mobilize matter, to reproduce itself, to sustain and replace the collective of living laborers, the working class.

Production was both a collective and dynamic cycle: at stake was not just the survival of individual bodies, but also the survival of the collective effort and collective resources for

transforming matter. Useful lives were those, usually male and active, who were engaged in a larger social-economic project of social reproduction. Individual reproduction, the replacement of bodily matter, had use value only when it was enrolled in a project of social reproduction.

Through labor, individual bodies joined, fed, and partook from the collective. Individual needs drew from and contributed to social use-value in a circular movement. Bodily substance was converted into products of work, and thus into social use-value. Through the wage and the subsistence it could purchase, individual workers were able to restore themselves from the storehouse of collective, social goods. Labor represented this movement of matter from the individual to the collective and back. Through labor, pieces of the individual body were subsumed in the service of social reproduction.

This social-political space is also where individual workers, in the scientific-materialist labor theory, melded into a collective class. The society of workers—a class, assembly, or mutual association—directed the flow of matter to ensure its collective reproduction. Individual laborers' bodies were mortal and finite. But the laborer as a social collective, the mass of labor, drew from the universal supply of matter and replaced itself eternally.

#### <T1HD>Reproduction

<TXT>The living wage described a strange sort of life. This kind of life was neither birthed nor extinguished. Rather, it was created, sustained, destroyed, and replaced in bits and parts. The life contained in the nineteenth-century living wage was the opposite of stillness, not death. Death itself, claimed Moleschott, did not stop the flow of matter: “The individual who falls dead is only a sacrifice to the species; death itself is only the eternal circulation of matter.”<sup>25</sup> At stake

was not sickness and death, but rather a seizure in the flow of matter. To live meant to mobilize matter, to create objects of value, and to sustain bodies at work.

In nineteenth-century physiology and social thought, wages were instruments of reproduction. Workers' wages provided the material for reproduction and for the replacement of labor. Wages furnished subsistence, which in turn restored body parts worn down in work. German chemist Justus von Liebig viewed reproduction and nutrition as analogous processes, which he called the "vegetative functions."<sup>26</sup> Plants assimilated nutrients and reproduced; when animals performed the same functions, they needed to use plant matter. Eating appeared as a form of reproduction—a transfer of matter from plants and animals to human bodies. Reproduction, in this worldview, took place primarily through the organization of chemical matter in plants. Through eating, the material of life appeared to perpetuate itself sexlessly. Nutrients supplied material to reproduce labor, understood as bits of bodily substance expended in work.

In this scenario, women and children appeared as temporary waypoints for the transit of matter toward the fructifying function of labor. Wages supplied goods necessary to raise a child, whose labor would eventually replace his father's when the latter was finally expended. As Ludmilla Jordanova suggests in her analysis of eighteenth-century political economy, children themselves could be seen as commodities or instruments in the service of social reproduction.<sup>27</sup> Reproduction, in this world view, did not take place in the private, family sphere, but rather it occurred in the public sphere of social production. This was a masculine, adult sphere.

The dyad of life and labor signified reproduction without birth. These ideas echoed earlier dreams of sexless, masculine reproduction through natural accidents or automata and artificial life.<sup>28</sup> The real task of reproduction, material expenditure and replacement, appeared to take

place in a purely masculine realm. This form of reproduction involved the flow of inputs and outputs. It was collective: unlike sexual reproduction, this material form of reproduction was the work of an entire society. Also, it was not generational: bits of individual bodies were replaced as soon as they were expended. Development, education, maturation, and growth were not relevant terms to this form of reproduction.

Historian Joan Scott has mapped the fundamental terms of nineteenth-century French political economy: birth/ subsistence, raw materials/ products of value, nature/ worker, mother/ father. In each pairing, the feminine terms lose value and become mere instruments for the masculine labor of production and reproduction. Women appear as vessels and care-takers, men as producers.<sup>29</sup> The material production of workers' bodies—and their children's—takes place in the process of labor itself. Life, the material for its subsistence and replacement, is located in the wage. Men alone are imbued with the “life” of the “living wage.”

Early minimum wage legislation was explicitly designed to “protect” industries from cheap female labor. The minimum wage was designed to distinguish between those who did and did not have a right to exist as workers. The first minimum wage laws, enacted beginning in the 1880s in New Zealand and Australia, in the 1900s and 1910s in Europe, were specifically crafted to exclude women and immigrants from industrial employment. When the International Working Men's Association held its founding Congress in 1866, its first substantive resolution pledged to gather comparative statistics on wages in different regions. Some at the Congress anticipated that statistics would allow workers to arbitrate wage rates across various countries. English workers, in particular, hoped that public knowledge of common wage rates would discourage continental workers from undercutting locals in the British labor market.<sup>30</sup> Many French labor activists

likewise hoped that a fixed minimum wage would drive out cut-rate foreign and women workers.<sup>31</sup>

The trajectories of those minimum wage movements did not necessarily coincide with the politics of a living wage as I describe them here. But that scientific-political worldview certainly was used to legitimate misogynistic theories of wage labor. Proudhon staked an extreme misogynist position. Women were “instruments of reproduction,” he wrote in a vicious polemic against nineteenth-century feminists.<sup>32</sup> Women, to Proudhon, were lively tools: they had no motive or intelligent design of their own, but rather served as instruments for male labor. Proudhon understood production, and therefore reproduction, to involve three components: tools, raw materials, and a directing intelligence. Tools were what effectuated the labor of life. Tools were not distinct from bodies but were instead part of them; the body itself appeared as an instrument of labor-life. Tools were engaged by the directing force of the worker; they were expended and replenished or replaced.

Women were to be engaged, directed, worked with, and worked upon. This is a contorted politics, which places men in charge of reproduction. Nature imbued men, not women, with the faculty of regeneration. This is because in the organization of matter, nature itself was indistinguishable from the material of labor and life. The laborer organized matter, shaped it, moved it, fixed its path, so that it formed new life-giving products. Matter was worked upon, controlled, and directed by an intelligent and generative male spirit. The male worker, the organizer of matter, guaranteed that matter remained fertile and productive and was neither sequestered nor blocked.

In this chemical-physical world, men alone reproduced and created value in the cycle of nature. Life, in this context, involved channeling the eternal flow of matter in the service of the

whole. By this logic, only those capable of labor, of directing matter with their strength and intelligence, truly deserved to live. The living wage was designed to sustain a masculine, national collective.

This model served as a physiological analogy to the political economy of wages. Proudhon suggested that only male bodies were capable of true reproduction: “Man is gifted with a generative faculty by which, before engendering a fellow creature, he engenders himself. He maintains a level of potency, which woman will never achieve.”<sup>33</sup> Women’s responsibilities—of giving birth and performing childcare—appeared in this model like the actions of a machine: they moved matter in the direction indicated by the male laborer’s generative power. That great organizer of stuff, the worker, gave shape to replacement material for labor—that is, the child who will one day replace his father. The power of male life-labor did not stop at the limits of the individual body. He created the conditions for his own replacement.

#### <T1HD>Ferment

<TXT>Proudhon called the living wage a reproductive ferment: “That reproductive ferment, that eternal germ of life, that basis, provisions and instruments needed for production, this is what the capitalist owes the producer, and never pays. The misery of the worker, the luxury of the lazy, and the inequality of social conditions are all due to that fraud and that denial.”<sup>34</sup>

Ferment and fermentation were evocative figures for life, matter, and labor. The process of fermentation produced key components of the working-class diet, namely wine and leavened bread. Fermentation converted one substance (grape juice, grain) into another, more powerful one (alcohol, bread). The fermentation process produced surplus force and nutrients for workers. What could Proudhon have meant by conflating wages and ferments?



Fermentation was a key site for modern scientific debates over the nature of matter, life, and labor. Chemist Antoine Laurent de Lavoisier formulated his famous aphorism, “nothing is created, nothing is lost” in an essay on fermentation, that is, the transformation of matter into nutritive substance. “Nothing is created, in art as in nature,” he wrote. “There is an equal quantity of matter before and after every operation; the quality and quantity of principles remains the same and there are only changes and modifications.”<sup>35</sup> This is Lavoisier’s best known statement on the conservation of matter. A vintner must ensure that the right materials are gathered together and that the right combinations of matter, the right products, result. Fermentation, like all transformations, required a specific kind of labor: the goal was not to create matter out of nothing, but to organize matter, to direct it and to change its form.

Proudhon equated wages and ferments at the very time when fermentation science was at a critical juncture. Physicists, physiologists, and chemists were engaged in a bitter debate in the late 1830s over the causes of fermentation. Was fermentation the result of work performed by living organisms, or the result of mechanical-chemical reactions? Justus von Liebig maintained that fermentation resulted from chemical processes devoid of life. French engineer Charles Cagniard de Latour and German physiologist Theodor Schwann argued that microscopic life forms caused fermentation as they drew in nutrients and reproduced. Cagniard and Schwann viewed fermentation as a form of labor, a digestive process carried out by small, plant-like organisms. Fermentation was, they argued, a byproduct of vital work.<sup>36</sup>

Liebig ridiculed the notion that ferments could be living and that living animals could cause fermentation. In 1839, in one of the scientific journals under his control, Liebig published a bizarre anonymous satire of Cagniard and Schwann’s theories.<sup>37</sup> This document speaks to Proudhon’s conflation of wage work, reproduction, eating, and fermentation. In his satirical

account, Liebig pretended to have observed, in a liquid solution of sugar and yeast, little animals hatching from eggs. These animals had a mouthpiece shaped like a tiny bottle brush. Their bladders, when empty, looked like little knobs; when full they took the shape of champagne bottles. In sum, Liebig designed his fictional animalcules as living versions of the technological apparatus involved in the labor of wine making.

The point of his ridicule was to show just how preposterous the idea was that fermentation could be the result of organic digestive processes. “In a word, he joked, “these infusoria feed on sugar, discharge spirits from the intestinal canal, and carbonic acid from the urinary apparatus.” The creatures excrete liquid alcohol, “while a stream of carbonic acid spurts in brief intervals from their enormously large genitalia.”<sup>38</sup> When the animals have no more sugar to eat they devour each other, leaving behind only their eggs, by which the process begins again. With this description, Liebig mocked Cagniard and Schwann’s suggestion that animal work could convert matter from one form to another. Liebig’s satire implied that value resulted only from mechanical-chemical processes.

Quarrels on fermentation were part of larger debates on the nature of digestion and nutrition. Fermentation was a powerful analogy for understanding how animals extracted nourishment from food. Emma Spary suggests that eighteenth-century physiologists understood digestion as a form of fermentation. Spary points to the influence of solvent chemistry in modern sciences of eating and digestion. Fermentation, cooking, and digestion were understood as chemically analogous: they all served to attenuate the nature of plants and to bring them closer to animal matter. The closer a food came to the nature of animal matter, the less work was required to digest it.<sup>39</sup> So fermentation, eating, and digestion, worked to transform and organize matter in the service of men.

At stake was the question of whether animal bodies were able to transform matter, and how. Some chemists argued that animals absorbed and used matter in the same way that they ingested it. Meat products became muscles; fatty foods produced animal fat and beeswax; only sugars burned to produce heat; like remained like. Others countered that animal bodies performed transformative work, such as converting sugars into fats. Liebig proposed that animals could transform the matter that they ingested, but only in the form of a simple chemical reduction—a reaction with oxygen resulting in oxidation.<sup>40</sup> Chemist Théophile Jules Pélouze suggested that animals performed more complex transformations. In the 1840s, Pélouze’s lab found that sugar, fermented in animal matter, could be converted into lactic acid. Fats could be converted into butyric acid, then to glucose. Transformations of one substance to another could result from any number of interactions between a ferment and animal matter.<sup>41</sup> For Pélouze, animal bodies did transform matter, through processes of fermentation.

This is also the moment when scientists began thinking about nutrition and work in terms of metabolism. Hannah Landecker traces a scientific history of metabolism to the fermentation debate and its aftermath. Fermentation was a model for living organisms’ transformative power. Physiologist Theodor Schwann coined the adjective *metabolic* to describe chemical changes that took place within living cells. Landecker writes: “For Schwann, the metabolic denoted the power to change the character of substances brought into contact with cells.”<sup>42</sup> Metabolism challenged Buffon’s unitary theory of matter. Matter did not circulate eternally but changed within animal bodies. Metabolic processes did more than organize matter; they altered its very substance.

The fermentation debate dealt with the nature of matter, life, and labor. If processes of fermentation really were purely mechanical in nature, they would result from the simple combination of chemical ingredients. In the mechanical model, human labor operated on an inert

substance to produce the stuff of life. Vintners and brewers provided the active labor; they combined elements to produce sustenance for other laborers. But if fermentation resulted from the action of animalcules, organic beings were capable of transforming matter entirely within themselves. In this organic model, matter was a medium for life's transformative action. Fermentation illustrated the key roles that eating and excreting played in the production and reproduction of life.

Anthropologist Larisa Jasarevic suggests that ferments are uniquely suited to a gift economy. Ferments create surpluses, unexpected and abundant mixtures and connections.<sup>43</sup> Fermentation is an ecological, multi-organismic process that binds yeasts, bacteria, grains, grapes, milk, and humans. Rather than a straightforward transit of matter, or an exchange of one thing for another, fermentation effects transformations in both eater and eaten.<sup>44</sup> Fermentation describes a political ecology, a collective labor of transforming, fructifying matter, creating nourishment.

If wages were ferments, as Proudhon suggested, what kind of work did wages perform? Did Proudhon mean to imply that wages in and of themselves effect transformations and put matter in motion? Did he mean to suggest that wages serve as a catalyst for transformations, in the same way that Pélouze understood ferments as catalysts for organic reactions?

Proudhon's wage theory did not account for the full consequences of the fermentation debate. His wage-ferment analogy seems to take up a mechanical view of fermentation. Proudhon understood the basis for production in the same way that Liebig understood fermentation. Like ferments, wages were a sort of medium for the transit of nutrients and other matter. Wages—and the materials purchased with them—allowed workers to move and ingest matter, and thus to live. The fermenting power of wages came from the “basis, provisions and instruments needed for production.”<sup>45</sup> Wages served to buy food, which was consumed to replace the bodily substance

that workers lost to work. In a similar vein Moleschott suggested that fermented alcoholic drinks helped with digestion, allowing workers to extract the maximum sustenance from their food. For this reason, Moleschott called beer and wine “savings boxes.”<sup>46</sup> Like ferments, wages stimulated the transit of matter in the service of life.

In Proudhon’s wage theory, wages appeared as an inert medium with no particular character or history. The analogy with Leibig’s fermentation theory suggests that Proudhon was less interested in organic transformations than in mechanical conversions. Wages served as instruments for converting matter into replacement parts for worker’s bodies.

#### <T1HD>Sacrifice and Extraction

<TXT>For Proudhon, wage labor produced life. The products of labor carried the “germ” of life, a potential that was realized in the exchange of products for wages. Workers traded their labor for wages and traded those wages for other products: food, clothing, or other items. The natural value of these products, for Proudhon, was exactly equal to the value of labor. This was how workers reproduced their own life, and why wages functioned as a “reproductive ferment.” Proudhon directed his politics toward a living wage.

Karl Marx, by contrast, saw wage labor as a sacrifice of life. Marx and Frederick Engels repudiated the scientific materialists’ unitary view of matter and proposed instead an evolving, historically determined matter. For Marx and Engels, labor under capitalism represented extraction and sacrifice, a loss of matter and energy, a waste of life. Marx attacked Proudhon’s unitary theory of labor; Engels attacked the scientific materialists’ unitary theory of matter.

Marx, in *The Poverty of Philosophy* (1847), harshly rebutted Proudhon’s vision. Marx rejected Proudhon’s theory that matter and labor were exchangeable. Proudhon’s construct relied

on the equivalence of life and labor, production and consumption. Marx paraphrased Proudhon's claim, that "a certain quantity of labor is equivalent to the product created by this same quantity of labor."<sup>47</sup> This universal exchangeability, for Proudhon, derived from the unitary character of matter. One quantum of life and labor could substitute for another. Only when society recognized this equivalence—between labor and the products of labor—would wages become living wages.

Marx argued that Proudhon got things completely backwards. Proudhon saw the eternal equivalence of matter, of products, as a universal natural law. But for Marx such an eternal flow could not exist. Proudhon's dream of free and equal exchange rested upon a profound misunderstanding of life, labor, and human history. Instead of being a force for emancipation, "relative value, measured by labor time, is inevitably the formula of the present enslavement of the worker."<sup>48</sup>

*The Poverty of Philosophy* does not, however, directly engage with the natural-scientific ideas embedded in Proudhon's wage theory. A critique of scientific materialism appeared more fully several decades later in one of Engels's texts on natural science, *Ludwig Feuerbach*. There Engels directly attacked the unitary theory of matter, and he criticized scientific materialism in the same terms as Marx had Proudhon: "The materialism of the last century was primarily mechanical.... The limitation of this materialism lay in its inability to comprehend the universe as a process, as matter undergoing uninterrupted historical development [...] Nature, so much was known, was in eternal motion. But according to the ideas of that time, this motion turned, also eternally, in a circle and never moved from the spot: it produced the same results over and over again."<sup>49</sup>

Engels identified this as the scientific materialists' crucial error: they subjected matter to an eternal, cyclical law of nature. In their model, matter transits across a fixed and unchanging path.

Scientific materialists subjected everything, from human digestion to wage economies, to the natural laws of physics and chemistry. Engels named Jacob Moleschott, alongside Karl Vogt and Ludwig Büchner, as inheritors of this “shallow, vulgarized” form of materialism.<sup>50</sup> This idea was also the basis of Proudhon’s labor theory and its eternal exchangeability.

As Marx refuted Proudhon’s labor theory, so Engels attacked scientific materialists. In place of universal natural laws, Marx and Engels put forth a model of historical development, arguing that nature and society emerged through constant transformation, shaped by social conditions. Engels pointed to three scientific developments to show that nature was ruled by historical development: cell biology (beginning with Theodor Schwann), Darwinian evolution, and thermodynamics. These scientific advances, according to Engels, showed that change and development, not fixed matter, ruled the universe. As Marx substituted Proudhon’s products with labor power, Engels substituted the fixed matter of scientific materialism with the constant motion of energetics and evolution. Mechanical force and energy, wrote Engels, “are different forms of the manifestation of universal motion, which pass into one another in definite proportions [...] The whole of nature is reduced to this incessant process of transformation from one form into another.”<sup>51</sup> Instead of a universal matter, Engels proposed a universal transformation.

Engels further posited that nature itself was transformation. Gone was Buffon’s vision of an eternal, unitary matter. Instead, following natural historians from Charles Lyell to Charles Darwin, and physicist of electromagnetism James Maxwell, Engels described the stuff of the universe as evolution, motion, energy. A nature defined by chemical input-output equations and the conservation of matter gave way to a nature defined by energetics, evolution and transformation. Chemistry gave way to electromagnetism. Gone was Proudhon’s vision of the

laborer as the active organizer of matter. Workers did not produce difference; history did. Marx and Engels imagined that workers were moved by these transformations as much as they directed them. Historical transformations set the conditions for life.

The political consequence of this move was to uncouple workers' liberation from natural law. Under the circumstances of industrial capitalism, no model of nature, no rational scientific organization, could produce a living wage. Historical conditions led to exploitation and bare survival, not life. And wage rates were determined by the labor time required to produce labor itself—that is, the price of bare necessities, food, clothing, housing, and other material needs. As the classical political economists observed, wages would always fall toward the minimum amount necessary to keep workers able to work. Marx recounted a story told by Justus von Liebig—a tale of miners in South America who were forced to eat beans with their bread so that they would have sufficient nutrition for their heavy work.<sup>52</sup> Wage labor did not reproduce the social collective as Proudhon and others had hoped; instead it reproduced capitalism itself.

Wages were not living; they were barely not dying. Marx attacked the very idea of a living wage in *Wage Labor and Capital* (1849): labor, under capitalism, was not an expression of life. A laborer “works so that he may keep alive.” Labor ceases to be part of a worker’s life. Instead, it becomes a mere means of living. Life happens when work is finished, when one is “at the table, at the tavern, in bed.” For a worker, labor is not part of life; “it is rather a sacrifice of his life.”<sup>53</sup> Because a wage worker must sell his labor in order to be able to live, the wage could never be living.

Wage labor, for Marx, was part of a universal system of extraction. Wages were one of several means by which capital captured bits of life in the service of accumulation. Marx most forcefully made this point when writing about large-scale agriculture. There Marx returned to



chemistry and the circulation of matter. He was struck by parallels between agriculture wasting its soil, and industry wasting its workers. Both, he argued, were part of an expansive and totalizing system of extraction.<sup>54</sup>

The fertility of the soil, Marx wrote, is “closely bound up with social relations.”<sup>55</sup> It would not be a stretch to extend this claim to Marx’s position on the politics of matter more generally. For Marx and Engels, the flow of matter through all living things was closely bound up with social history. This was their fundamental disagreement with Proudhon’s labor theory and with the scientific materialists’ worldview. Matter was bound to history. Life and reproduction depended on historical conditions. In the era of capitalism, this meant that life and matter were subject to capital and its extractive logic.

The logic of sacrifice underlying wage labor had a parallel, for Marx, in industrial agriculture. Just as laborers sacrificed bits of their life in the service of wage work, the soil sacrificed its liveliness to the needs of agriculture: “Large-scale industry and industrially pursued large-scale agriculture have the same effect [...] the former lays waste and ruins the labor-power and thus the natural power of man, whereas the latter does the same to the natural power of the soil.”<sup>56</sup> Industry and agriculture participated in a common logic of extraction. The amount of nourishment available to workers, like the nourishment available to the soil, was set by historical conditions. In the modern era, conditions were determined by the need to extract just enough labor, and just enough nutrients, to produce salable commodities. Workers and soil both sacrificed bits of life and health, both in the service of accumulation. They were nourished just enough and no more. In this way, extractive capitalism “disturbs the metabolic interaction between man and earth.”<sup>57</sup>

Marx reprised and expanded the notion of metabolism, derived from the fermentation debate, to encompass all exchanges between humans and nature. Marx's metabolism had a specific, scientific and a general, social meaning. Metabolism referred to the classic scientific definition: the transformation of chemical elements within living organisms. This was a chemical and an ecological process. Marx also gave metabolism a broad social meaning: it referred to human labor, all processes by which people transformed matter.<sup>58</sup> In this too Marx echoed the terms of the fermentation debate. Labor appeared here as ferment in the fullest sense: the encounter of life and matter, transforming both living beings and the stuff of nature.

According to Marx, extractive capitalism produced a "rift" in the metabolic relationship between humans and nature. Capitalism "lays waste" to bits of life, rendering them useless for their source. Vitality is squandered. The cycle of labor, nourishment and metabolism is broken. This is not a process of circulation and equal exchange; it is a process of subtraction and violation. Instead of a cyclical flow of matter, there is only a dead end. Capitalist accumulation removes matter, stops its potential to transform and perpetuate life. Industry and agriculture "rob the worker" and "rob the soil," the two "original sources of wealth." Marx called this a logic of "theft," "ruin," "laying waste."<sup>59</sup> This was the totalizing logic of capital, a logic not of life but of sacrifice and extraction. For Marx, there could be no such thing as a living wage.

#### <T1HD>Politics of Matter

<TXT>How do competing concepts of matter and living wages reflect or reveal the conditions of life under capitalism? What are the ongoing connections between theories of matter and wage theory? Ironically, the equation of life and labor—first proposed by anti-clerical scientific materialists—was carried into the twentieth century by Social Catholics, fascists, and

corporatists. Right-wing political thinkers were attracted to static theories of natural and social order. Pope Leo XIII issued an edict in 1893 which gave workers a theological claim to a living wage.<sup>60</sup> Leo XIII's *Rerum Novarum* inspired a long debate among Catholic social thinkers about the equivalence of life and labor. Social Catholic activist Henri Lorin expounded a Christian theory of labor and claimed that *Rerum Novarum* led inescapably to a "vital wage."<sup>61</sup> The Abbé Naudet wrote, in response to the edict, "mathematically, wages = life."<sup>62</sup>

This same principle motivated fascist and corporatist economists in the mid-twentieth century. Economist François Perroux rejoiced in 1944, "Biology is erupting into politics." Everywhere, Perroux declared, "the profit economy is receding, to the benefit of an economy that satisfies needs, objectively evaluated."<sup>63</sup> The sciences of man, biological and sociological, would establish a fixed scale of human needs and wages. Corporatists imagined that individual labors and lives would meld into a collective, national body. Life existed in the service of the collective. This form of life might recall that of contemporary pro-life activists. The health of the collective would replace capitalist profit motives as the driving economic force. Society would distribute goods in the service not of profit, but of real, concrete "human life."<sup>64</sup>

Twentieth-century corporatists and fascists rejected historical materialism and refused to accept metabolism as a model for nature and society. They sought instead a stable natural hierarchy, not evolution, development, or historical change. Much fascist and corporatist wage theory was animated by misogyny and xenophobia. Like Proudhon, twentieth-century, right-wing thinkers sought a natural equation of production and reproduction, wages and needs. Wages and life should be always equivalent, always the same. Corporatists recalled Buffon's eternal flow of unitary matter, organized by labor in the service of an eternal natural order.

The living wage has a multi-faceted history in the twentieth century, of course, one that goes well beyond debates over the nature of labor and matter. In the United States, the living wage had multiple meanings.<sup>65</sup> Historian Thomas Stapleford shows that American unions at first ascribed a living wage only to skilled workers. To late nineteenth-century unionists, the living wage represented a qualitative and moral directive, bearing on employers' responsibility for their workers' livelihood. The slogan "a fair wage for a fair day's work" expressed a moral, and not a scientific, imperative.<sup>66</sup> By the early twentieth century, living wage claims spread to unskilled workers and referred to nutritional standards, family budgets, and other social statistics. Forced to submit to state arbitration in the years around the First World War, labor unions turned to scientific measures to bolster claims for expanding the living wage.<sup>67</sup> Social statistics of workers' expenses offered an index of expanding needs, which a living wage should fulfill. This is the lineage of most American living wage activism today. Theories of matter and life enter in only so far as they form the basis for the nutritional component of a basic needs index.

But questions about matter, life, and labor still continue to haunt politics and science today. Scholars are increasingly attentive to the politics of matter, where matter ends up, and what it does.<sup>68</sup> In our era of high capitalism, we are all "human capital" and bits of life are subject to intense speculation. Tissues, bacterial samples, genes, and cell lines get attached to promises of growth, regeneration and future wealth.<sup>69</sup> Living wage movements stake a claim to wages sufficient to house, clothe, and feed working families. Demographers demonstrate that mortality and morbidity rates in industrialized countries—the quantity and quality of peoples' lives—correlate strongly with income levels. Lower wages mean shorter lives.<sup>70</sup>

When I was seven or eight years old I walked door to door with my grandmother in support of her campaign for the Menlo Park sanitation board. I wore a light blue shirt embossed in fuzzy

letters with the logo, “Vote for Clean Jean.” It must not be accidental that my first and formative political experience had to do with deciding how waste and matter flowed. From the start, my political world view has been tied to the distribution of matter. Perhaps because of that history, when many years later I read Moleschott’s call for the “free and just distribution of matter” I was primed to imprint upon his phrase. This essay is an attempt to deal with that legacy.

Matter and life are unevenly distributed, and this distribution is bound up with social history. Where matter travels tells us something about social inequity and injustice. The uneven distribution of matter takes place through the sharing of resources within cities and farms, communities and families, childbearing and child rearing, and state welfare. Unequal distributions of matter leave traces in demographic data about heights and weights. The data shows that wage increases do not necessarily lead to a more equal distribution of matter. Demographic historians demonstrate that even as wages rose in Europe and the United States across the second half of the nineteenth century, most workers’ bodies did not begin to grow until the century’s close.<sup>71</sup> Some data suggest that among industrial working families, male workers’ bodies grew larger even as women’s and children’s remained frail and small.<sup>72</sup> Because of these disparities, many historians argue that biomedical markers, demographic measurements of height and weight, are better indicators than income measurements for capturing social inequality in the nineteenth and early twentieth centuries.<sup>73</sup>

We live now in an economic regime that carries the logic of extraction and sacrifice beyond the wage. Life in the sharing, temp economy is marked by insecurity and precarity. Non-wage earners, whom Proudhon and others excluded as unproductive and socially marginal, now stand at the center of economic exchange. Life under these conditions, as Anna Tsing tells us, is a salvage operation.<sup>74</sup> The dream of a fixed correspondence between production and consumption

appears impossible, when the market is “free” to offer any level of (non-)nourishment for a given task and people who are “free” to take it. Many forms of life exist outside of wage work. On one side stands surplus, disposable life, people imprisoned, unemployed, dis-abled, and otherwise excluded. On the other hand, many activities central to survival and thriving take place outside of wage work. Leisure, learning, imagination, fantasy, and hobby work are lived outside of the wage realm. Also outside are birthing, childcare, the generation of new life in people, plants, soil, and animals, community, and gift economies. The wage captures neither existing social relations nor the needs of life and reproduction. “Life” cannot be contained in the wage. The nineteenth-century fermentation debate suggests that different political ecologies of labor and life are possible.

Acknowledgements: I am grateful for the support of the U. C. Riverside Center for Ideas and Society, CHASS Mid-Career Research Initiative and its amazing participants. At U.C. Berkeley, thanks to the Center for Science, Technology, Medicine and Society, Marissa Mika, Massimo Mazotti and Angelo Caglioti for feedback and excellent conversation. Special thanks to Marissa for intellectual generosity and comradeship. At the History of Science Society annual meeting, bits of this work fed into a wonderful exchange with Hippolyte Goux, Tiago Savaira and John Tresch. A huge thanks to Jade Sasser, Chikako Takeshita and Juliet McMullin for invaluable feedback on drafts of this work. Finally, my enormous gratitude to Marissa Kantor Dennis and the two anonymous *History of the Present* reviewers for making this article better.

Dana Simmons is Associate Professor of History at the University of California, Riverside. Her book, *Vital Minimum: Need, Science, and Politics in Modern France*, was published by the University of Chicago Press in 2015.

---

<sup>1</sup> Amy K. Glasmeier, “Living Wage Calculation for Los Angeles County, California.” *Living Wage Calculator*, 2016, <http://livingwage.mit.edu/counties/06037>.

<sup>2</sup> Frederick Gregory, “Scientific Versus Dialectical Materialism: A Clash of Ideologies in Nineteenth-Century German Radicalism,” *Isis* 68, no. 2 (1977), 216.

<sup>3</sup> Charles Maier, “Between Taylorism and Technocracy: European Ideologies and the Vision of Industrial Productivity in the 1920s,” *Journal of Contemporary History* 5, no. 3 (1970).

<sup>4</sup> Pierre.-J. Proudhon, “Qu’est-ce que la propriété?,” in *Oeuvres complètes* (1926), 215.

<sup>5</sup> Georges Louis Leclerc comte de Buffon, *Histoire naturelle: Quadrupèdes* 2 (1799), 42-44.

<sup>6</sup> E.C. Spary, *Feeding France: New Sciences of Food, 1760-1815* (2014), 97.

<sup>7</sup> Spary, *Feeding France*, 99. Citing Spary’s translation of “Entretien entre Diderot et D’Alembert” (1769).

<sup>8</sup> Jacob Moleschott, *La Circulation de la vie: lettres de physiologie en réponse aux Lettres sur la chimie de Liebig*, trans. E. Cazelles (1866), 27.

<sup>9</sup> Moleschott, *La Circulation de la vie*, 67.

<sup>10</sup> John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (2012), 170.

<sup>11</sup> Etienne Geoffroy Saint Hilaire, *Notions synthétiques, historiques et physiologiques de philosophie naturelle* (1838), 59, 126-129.

<sup>12</sup> Tresch, *The Romantic Machine*, 251.

<sup>13</sup> Jean Baptiste Dumas, *Traité de chimie appliquée aux arts* (1846), 424.

- 
- <sup>14</sup> Dana Simmons, “Waste Not, Want Not: Excrement and Economy in Nineteenth-Century France,” *Representations* 96(2006).
- <sup>15</sup> Dumas, *Traité de chimie appliquée aux arts*, 424.
- <sup>16</sup> Dumas, *Traité de chimie appliquée aux arts*, 426. See Dana Simmons, *Vital Minimum: Needs, Science and Politics in Modern France* (2015), 27-32.
- <sup>17</sup> Tresch, *The Romantic Machine*, 220.
- <sup>18</sup> Louis Blanc, *Organisation Du Travail* (1847).
- <sup>19</sup> Simmons, *Vital Minimum*, 17-21.
- <sup>20</sup> Harmke Kamminga, “Nutrition for the People, or the Fate of Jacob Moleschott’s Contest for a Humanist Science,” in *The Science and Culture of Nutrition, 1840-1940*, ed. Harmke Kamminga (1995).
- <sup>21</sup> Jacob Moleschott, *La Circulation de la vie*, 214. Frederick Gregory’s translation in Frederick Gregory, *Scientific Materialism in Nineteenth-Century Germany* (1977), 191.
- <sup>22</sup> Moleschott, *La Circulation de la vie*, 68.
- <sup>23</sup> Gregory, “Scientific Versus Dialectical Materialism,” 214.
- <sup>24</sup> Proudhon, “Qu’est-ce que la propriété?”, 215.
- <sup>25</sup> Moleschott, *La Circulation de la vie*, 68.
- <sup>26</sup> Frederick L. Holmes, *Claude Bernard and Animal Chemistry: The Emergence of a Scientist* (1974), 32.
- <sup>27</sup> Ludmilla Jordanova, “Interrogating the Concept of Reproduction in the Eighteenth Century,” in *Conceiving the New World Order: The Global Politics of Reproduction*, ed. Faye D. Ginsberg and Rayna Rapp (1995), 378.



- 
- <sup>28</sup> Valeria Finucci, *The Manly Masquerade: Masculinity, Paternity, and Castration in the Italian Renaissance* (2003,) 37–78. Joan Landes, “The Anatomy of Artificial Life: An Eighteenth-Century Perspective,” In *Genesis Redux: Essays in the History and Philosophy of Artificial Life*, ed. Jessica Riskin (2010,) 96–117.
- <sup>29</sup> Joan Wallach Scott, “‘L’ouvrière! Mot impie, sordide.’ Women Workers in the Discourse of French Political Economy, 1840-1860,” in *Gender and the Politics of History* (1999).
- <sup>30</sup> Ladislav Mysyrowicz, “Karl Marx, la première Internationale et la statistique,” *Mouvement social* 69 (1969), 56.
- <sup>31</sup> Marilyn Boxer, “Protective Legislation and the Marginalization of Women Workers,” *Journal of Social History* 20, no. 1 (1986).
- <sup>32</sup> Pierre.-J. Proudhon, *De la justice dans la Révolution et dans L’église* (1858), 340.
- <sup>33</sup> Proudhon, *De La justice*, 338.
- <sup>34</sup> Proudhon, “Qu’est-ce que la propriété?”, 216.
- <sup>35</sup> Antoine Laurent Lavoisier, “ De la décomposition des oxydes végétaux par la fermentation vineuse,” in *Oeuvres de Lavoisier: Traité élémentaire de la chimie* (1864), 101. See Bernadette Bensaude-Vincent, “The Balance: Between Chemistry and Politics,” *The Eighteenth Century. Theory and Interpretation* 33, no. 3 (1992), 224.
- <sup>36</sup> James A. Barnett, “Beginnings of Microbiology and Biochemistry: The Contribution of Yeast Research.,” *Microbiology* 149. no. 3 (2003).
- <sup>37</sup> “Das enträtselte Geheimnis der geistigen Gährung.” *Annalen der Pharmacie* 29, no. 1.2 (1839): 100–3.

- 
- <sup>38</sup> Paul De Mayo, Albert Stoessel, and Melvyn C. Usselman, “The Liebig/Wöhler Satire on Fermentation,” *Journal of Chemical Education* 67, no. 7 (1990), 552-53. Translation by De Mayo et al.
- <sup>39</sup> Spary, *Feeding France*, 92-93.
- <sup>40</sup> Holmes, *Claude Bernard*, 32.
- <sup>41</sup> Holmes, *Claude Bernard*, 79-80.
- <sup>42</sup> Hannah Landecker, “Metabolism, Reproduction, and the Aftermath of Categories,” *Scholar and Feminist Online* 11, no. 3 (2013).
- <sup>43</sup> Larisa Jasarevic, “The Thing in a Jar: Mushrooms and Ontological Speculations in Post-Yugoslavia,” *Cultural Anthropology* 30, no. 1 (2015).
- <sup>44</sup> Elizabeth A Wilson, *Gut Feminism* (2015), 21-45.
- <sup>45</sup> Proudhon, “Qu’est-ce que la propriété?”, 216.
- <sup>46</sup> Kamminga, “Nutrition for the People,” 33.
- <sup>47</sup> Karl Marx, *Poverty of Philosophy*, trans. Henry Quelch (1910), 53.
- <sup>48</sup> Marx, *Poverty of Philosophy*, 55.
- <sup>49</sup> Frederich Engels, *Ludwig Feuerbach and the End of Classical German Philosophy*, trans. Progress Publishers (1946): <https://www.marxists.org/archive/marx/works/1886/ludwig-feuerbach/> Chapter 2.
- <sup>50</sup> Engels, *Ludwig Feuerbach*. Chapter 2.
- <sup>51</sup> Engels, *Ludwig Feuerbach*. Chapter 4.
- <sup>52</sup> Karl Marx, *Capital* vol. 1 (1990), 627.
- <sup>53</sup> Karl Marx, *Wage Labor and Capital*, trans. Harriet E. Lothrop (1902), 24-25.

- 
- <sup>54</sup> John Bellamy Foster, “Marx’s Theory of Metabolic Rift: Classical Foundations for Environmental Sociology,” *American Journal of Sociology* 105, no. 2 (1999).
- <sup>55</sup> Marx, *Poverty of Philosophy*. Chapter 4.
- <sup>56</sup> Marx, *Capital* vol. 1, 637-638, quoted in Foster, “Marx’s Theory of Metabolic Rift,” 379.
- <sup>57</sup> Ibid.
- <sup>58</sup> Foster, “Marx’s Theory of Metabolic Rift,” 381.
- <sup>59</sup> Marx, *Capital* vol. 1, 555.
- <sup>60</sup> Leo XIII, “Rerum Novarum. On the Condition of the Working Classes.” 2003 (1891): [http://www.vatican.va/holy\\_father/leo\\_xiii/encyclicals/documents/hf\\_l-xiii\\_enc\\_15051891\\_rerum-novarum\\_en.html](http://www.vatican.va/holy_father/leo_xiii/encyclicals/documents/hf_l-xiii_enc_15051891_rerum-novarum_en.html).
- <sup>61</sup> Henri Lorin, “Déclaration de la semaine sociale de Marseille” (1908), quoted in Barthélemy Raynaud, *Vers le salaire minimum. Etude d’économie et de législation industrielles* (1913), 16.
- <sup>62</sup> Raynaud, *Vers le salaire minimum*, 16.
- <sup>63</sup> François Perroux, *Science de l’homme et science économique* (1944), 29.
- <sup>64</sup> Jean Marchal, “Salaires et économie d’Armistice,” in *Travail et salaire* (1944), 122. See Simmons, *Vital Minimum* Chapter 7.
- <sup>65</sup> Larry Glickman, *The Living Wage: American Workers and the Making of Consumer Society* (1997).
- <sup>66</sup> Thomas A. Stapleford, “Defining a ‘Living Wage’ in America: Transformations in Union Wage Theories, 1870-1930,” *Labor History* 49, no. 1 (2008), 4,11.
- <sup>67</sup> Stapleford, “Defining a ‘Living Wage’ in America,” 6-9.
- <sup>68</sup> Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (2009).

---

<sup>69</sup> Kaushik Sunder Rajan, *Biocapital: The Constitution of Postgenomic Life* (2006); Melinda Cooper, *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era* (2008); Stefan Helmreich, “Species of Biocapital,” *Science as Culture* 17, no. 4 (2008).

<sup>70</sup> Raj Chetty et al., “The Association Between Income and Life Expectancy in the United States, 2001-2014,” *JAMA* 315, no. 16 (2016).

<sup>71</sup> John Komlos, “Shrinking in a Growing Economy? The Mystery of Physical Stature During the Industrial Revolution,” *The Journal of Economic History* (1998); MR Haines, LA Craig, and T Weiss, “The Short and the Dead: Nutrition, Mortality, and the “Antebellum Puzzle” in the United States,” *The Journal of Economic History* 63, no. 02 (2003).

<sup>72</sup> Jialu Wu, “How Severe Was the Great Depression? Evidence from the Pittsburgh Region,” and John Komlos, “On the Significance of Anthropometric History,” in *Stature, Living Standards, and Economic Development: Essays in Anthropometric History*, ed. John Komlos (1994), 150, 217.

<sup>73</sup> Robert Fogel, *The Escape from Hunger and Premature Death, 1700-2100* (2004), 36.

<sup>74</sup> Anna Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (2015), 58, 77-81.