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Wound-Up Lives: A Capitalocene Critique of Paolo Bacigalupi's The Windup Girl

Yiqi Liu. Xu Chang
Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu, China

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Abstract

Paolo Bacigalupi's The Windup Girl (2009) depicts a dystopian future shaped by climate change, fossil fuel depletion, genetic engineering, and corporate control over biological resources. Moving beyond an Anthropocene reading that attributes ecological crisis broadly to human activity, this article adopts Jason W. Moore's concept of the Capitalocene and draws on eco-Marxist theories to examine how capitalist accumulation transforms both nature and life into instruments of production. Through close textual analysis, the article explores three interconnected dimensions of capitalist ecological crisis: the commodification of life through Emiko's genetically engineered body, the persistence of capitalist relations amid the transition from fossil fuels to calorie-based energy, and the monopolization of genetic resources through corporate control over seeds. It argues that the novel exposes the contradictions of capitalist development, in which technological progress and economic accumulation intensify ecological instability and social inequality. Ultimately, the novel's ambiguous ending invites reflection on ecological commons and alternative forms of coexistence beyond capitalist domination.

Keywords

The Windup Girl; Capitalocene; Eco-Marxist

Introduction

Since the beginning of the twenty-first century, climate fiction has increasingly explored not only ecological degradation but also the economic and political structures underlying environmental crises. Paolo Bacigalupi's The Windup Girl (2009), set in a post-petroleum world marked by rising temperatures, crop failures, and genetic plagues, depicts a society where food, energy, and biological resources become objects of intense competition. Through its representations of genetic engineering, multinational corporations, and energy scarcity, the novel exposes the contradictions between capitalism, technological development, and ecological survival.

This article adopts Jason W. Moore's concept of the Capitalocene as its primary framework, locating ecological crises within capitalism's historical organization of

human and extra-human nature (Moore, 2015). It also draws on Foster's (2000) theory of metabolic rift, Malm's (2016) concept of fossil capital, and O'Connor's (1998) second contradiction of capitalism to examine how capitalist accumulation disrupts socioecological relations and undermines its own ecological conditions of production.

Building on these theoretical perspectives, the article argues that The Windup Girl presents capitalist ecological crisis through three interconnected dimensions: the commodification of life, the reproduction of capitalist relations through energy systems, and the monopolization of biological resources.

Through close textual analysis of the novel's characters, recurring images, and narrative conflicts, this article seeks to demonstrate that The Windup Girl is not merely a dystopian projection of environmental catastrophe. Rather, it exposes the structural contradictions of the Capitalocene, revealing how the commodification of life, the exploitation of energy, and the privatization of nature are interconnected mechanisms of capitalist ecological crisis.

1. The Wound-Up Girl: Alienated Life and the Reconstruction of Subjectivity

1.1. The Mechanization of Life: Emiko and the Commodification of the Body

In The Windup Girl, Emiko's body represents one of the most direct manifestations of capitalist control over life. As a genetically engineered New Person, she is designed to serve human needs through her physical appearance, bodily functions, and behavioral characteristics. Her body is not simply modified by technology. It is constructed according to the expectations of those who purchase and use her. Originally brought to Bangkok as part of a Japanese delegation, Emiko is eventually abandoned by her former employer and forced to work in Raleigh's sex club. Her transformation from a personal assistant into a sexual commodity reveals how technological advancement can become an instrument of exploitation when it operates within unequal economic relations. Emiko's bodily characteristics illustrate this process of commodification. Her smooth skin, enhanced physical abilities, and programmed sexual responses are all products of genetic engineering.

Marx's theory of alienated labor offers a useful framework for understanding Emiko's condition. In Economic and Philosophic Manuscripts of 1844, Marx observes that the worker becomes a commodity under capitalist relations of production. Although Emiko is not a conventional wage worker, her situation extends this critique from labor to the human body itself. She is treated as an object that can be purchased, exchanged, controlled, and exploited. Her biological characteristics function like productive assets, while her individual feelings and desires are excluded from the calculation of her economic value. In this sense, the novel presents an intensified form of alienation: not only is the product of labor

separated from its producer, but the living body itself becomes a product designed for another person's consumption.

Moore's concept of the Capitalocene further clarifies the relationship between technological development and the commodification of life. Rather than treating capitalism and nature as separate domains, Moore argues that capitalism should be understood as "a world-ecology of capital, power, and re/production in the web of life" (Moore, 2015, p. 14). This perspective suggests that capitalist power operates not only through the exploitation of human labor but also through the reorganization of biological processes. Emiko's body is a product of this capitalist organization of nature. Genetic engineering transforms biological life into something that can be designed according to market demand, while commercial institutions determine how that life should be used. Her experience therefore reveals that the commodification of nature does not stop at external resources. It can reach into the human body and reshape the conditions of biological existence itself.

1.2. The Mutation of Nature: Genetic Engineering and the Alienation of Life

Emiko's experience also reflects a broader transformation of nature in the novel. In the post-petroleum world of The Windup Girl, ecological disasters and genetic diseases have made biological survival increasingly uncertain. In response, corporations invest in genetic engineering to produce organisms that can withstand environmental pressures and serve commercial interests. The development of New People is part of this technological response to ecological instability. Yet the novel does not present genetic engineering as an uncomplicated solution to environmental problems. Instead, it exposes the unequal power relations embedded in the technological control of life.

This process can be understood through Marx's discussion of the relationship between human beings and nature. Marx argues that the worker can create nothing without nature, without the sensuous external world. Nature is not merely an external resource but the material basis of human existence and productive activity. However, in the world of the novel, this relationship is increasingly distorted by the attempt to control biological processes for economic purposes. The same logic that turns natural resources into commodities also transforms living organisms into designed products.

The novel also complicates the distinction between the natural and the artificial. Emiko is biologically engineered, but she experiences fear, desire, humiliation, and hope. Her feelings cannot be dismissed simply because her body has been technologically constructed. The prejudice directed against New People depends on the assumption that their artificial origins make them less human. Yet the narrative repeatedly challenges this assumption by presenting Emiko's inner life and emotional responses.

From a Capitalocene perspective, this contradiction reveals that the problem is not technology itself but the capitalist relations governing its application. Genetic engineering could potentially contribute to adaptation and survival, but under corporate control, its benefits are distributed according to ownership and profitability. The novel therefore questions the assumption that technological progress automatically leads to social or ecological improvement. When biological innovation is subordinated to market demand, it may deepen existing inequalities and create new forms of domination. Emiko's existence exposes the limits of a system that seeks to manage nature while refusing to acknowledge the autonomy and complexity of living beings.

1.3. Beyond the Windup: Emiko's Resistance and the Reconstruction of Subjectivity

Although Emiko is initially presented as a product designed to satisfy human desires, her character gradually challenges the identity imposed upon her. Her resistance develops through her growing awareness of exploitation, her desire to escape, and ultimately her willingness to act against those who control her. These moments are important because they reveal that her programmed identity does not completely determine her behavior. The novel thus moves beyond representing Emiko as a passive victim and explores the possibility of reconstructing subjectivity under conditions of technological and economic domination.

Emiko's position in Raleigh's club exposes the limits of the identity assigned to her. She is expected to remain obedient and to accept the violence directed at her body. Her fear of punishment and social rejection initially restricts her ability to resist. Moreover, the behavioral programming that makes her movements appear mechanical also produces an internal conflict: she experiences impulses that challenge her assigned role, yet she is conditioned to regard disobedience as something unnatural and frightening. Her struggle is therefore not simply a physical attempt to escape exploitation. It is also a struggle against the internalized rules through which others have defined her existence.

Haraway's cyborg theory provides a further perspective on this reconstruction of subjectivity. In "A Cyborg Manifesto," Haraway famously declares, "I would rather be a cyborg than a goddess" (Haraway, 1991, p. 181). Her argument challenges fixed boundaries between human and machine, nature and technology, and natural identity and constructed identity. Emiko can be read in relation to this challenge because her hybrid existence unsettles the assumption that technological modification necessarily destroys authentic subjectivity. However, she should not be simply equated with Haraway's emancipatory cyborg. Unlike the cyborg as a figure of potential political resistance, Emiko is created within a system of commercial exploitation and racialized exclusion. Her body is technologically hybrid, but this hybridity initially serves the interests of those who own and control her. Her

resistance therefore lies not in her technological construction itself, but in her refusal to remain confined to the identity designed for her.

The ending further complicates the possibility of liberation. After the destruction of Bangkok's social order, Emiko encounters Gibbons, who offers the possibility of helping her survive and adapt. His interest in her also suggests that her body may possess biological potential beyond its original commercial purpose. Nevertheless, this possibility remains uncertain. Emiko's future depends partly on the knowledge and intervention of another person, and the novel does not establish whether she can fully escape the structures that have shaped her life. Her liberation is therefore neither complete nor guaranteed.

Ultimately, Emiko's story reveals the central contradiction of capitalist control over life. The same system that claims the power to design and improve biological existence also denies living beings the right to determine their own identities. Through Emiko's movement from bodily objectification to acts of resistance, The Windup Girl exposes the alienating consequences of treating life as a commodity while questioning whether subjectivity can emerge beyond predetermined functions. Her story does not offer a simple solution to the crisis of the Capitalocene. Instead, it suggests that reconstructing the relationship between humans, technology, and nature requires recognizing the autonomy of life and challenging the economic structures that reduce living beings to instruments of accumulation.

2. The Calorie Men: Fossil Capitalism and the Energy Crisis

2.1. The End of Oil: Fossil Fuel Depletion and the Collapse of Industrial Civilization

In The Windup Girl, the decline of fossil fuels marks more than an energy shortage; it signals the crisis of an industrial civilization built upon abundant and accessible energy. Set in a post-petroleum world, the novel depicts a society struggling with rising temperatures, crop failures, and the breakdown of established industrial systems. The scarcity of oil has disrupted transportation, manufacturing, and agricultural production, making energy an increasingly valuable resource. Through this dystopian setting, Bacigalupi reveals the vulnerability of a civilization whose economic development has long depended on fossil fuels.

Andreas Malm's (2016) theory of fossil capital helps explain the historical relationship between energy systems and capitalist development. Malm (2016) argues that the adoption of steam power was closely connected to the organization of capitalist production and the control of labor, rather than being determined solely by technological efficiency. This argument suggests that energy systems are shaped not only by technological considerations but also by the economic interests and power relations governing production. Fossil fuels enabled capital to reorganize labor, expand industrial production, and accelerate accumulation. Their decline therefore threatens not only energy supplies but also the industrial structures

historically sustained by them.

Simon-Stickley (2021) further complicates the understanding of energy by examining how the concept itself has been shaped by economic and ecological thought. She explains that resource economics established a "useful/useless divide"(2021, p. 336) through which minerals, plants, and even human labor could be understood as comparable resources. This perspective is particularly relevant to Bacigalupi's fictional world, where energy is increasingly evaluated according to its productive and economic value. The decline of petroleum does not challenge this instrumental understanding of nature. Instead, society begins to search for other forms of energy that can sustain production. The novel thus suggests that the crisis of fossil-fuel-based civilization is also a crisis of its underlying economic logic: nature continues to be understood primarily in terms of its usefulness to production and accumulation.

2.2. The Return of Petro-Capital: Energy Politics and the Expansion of Capital

Although the petroleum economy has declined, the capitalist logic associated with fossil energy does not disappear. Instead, it re-emerges through corporate competition over alternative technologies, biological resources, and the means of production. Anderson Lake, an executive of the multinational agricultural corporation AgriGen, provides an important example. Operating a kink-spring factory in Bangkok, Lake appears to be participating in the development of an alternative energy technology. However, his actual objective is to gain access to Thailand's valuable seed bank. The factory therefore functions not simply as a response to energy scarcity but also as part of a broader corporate strategy to penetrate local resources and expand control over future markets.

Kohei Saito's (2020) reinterpretation of Marx's theory of metabolism provides a useful framework for understanding this process. Saito examines different dimensions of metabolic rift and metabolic shift, emphasizing that the ecological contradictions of capitalism cannot be understood solely through the disruption of natural cycles. They must also be examined in relation to the social organization of production. His analysis identifies "three different levels" of metabolic shift as a way of explaining how capitalist society reorganizes its relationship with nature (Saito, 2020, pp. 3–24). Applied to the novel, this perspective helps explain why the decline of fossil energy does not necessarily weaken corporate power. Rather, corporations can reorganize their access to nature by investing in alternative technologies and appropriating biological resources. AgriGen's attempt to obtain Thailand's seed bank demonstrates how the search for new energy and productive resources becomes part of the continuing expansion of capital.

2.3. From Oil to Calories: Energy Transformation and the Reproduction of Capitalist Relations

One of the most significant features of the novel is its representation of a society in which calories have become a central measure of economic value. In the absence of abundant fossil fuels, biological energy and physical labor acquire renewed importance. The emergence of the calorie men reflects this transformation. As representatives of multinational agricultural corporations, they operate in a world where food production and control over genetic resources determine economic and political power. Their title suggests that calories are no longer merely a measure of food consumption; they have become central to the organization of the new economic order.

The novel presents this transformation through the relationship between biological labor and energy production. The decline of petroleum does not eliminate the need for intensive production. The source of energy has changed, but the relationship between capital and labor remains largely intact. In this sense, the calorie economy does not represent an escape from fossil capitalism; rather, it reproduces capitalist relations through a different material basis.

Saito (2023) further develops this argument by examining how capitalism responds to ecological contradictions through changes in social metabolism. He points out that such metabolic shifts do not resolve the fundamental contradictions of capitalist accumulation. As he explains, these shifts "never solve the deep contradictions of capitalist accumulation" (Saito, 2023, pp. 13). This argument is particularly useful for understanding the transition from petroleum to calorie-based energy in The Windup Girl. The decline of fossil fuels changes the material basis of production, but it does not necessarily transform the social relations through which energy and labor are controlled.

Recent discussions of energy transition further reinforce this critique. Tornel et al. (2026) argue that low-carbon technologies are "adding to, rather than replacing" (2026, p. 625)existing fossil-fuel-based energy systems. Their analysis demonstrates that energy transitions may reproduce extractive relations when they remain embedded in existing economic and geopolitical structures. In Bacigalupi's novel, the transition from oil to biological energy similarly changes the form of resource exploitation without fundamentally challenging the logic of accumulation. Human and animal bodies become new sources of productive energy, revealing how the exploitation of nature can persist even when the material form of energy changes. Ultimately, the calorie economy exposes the limits of an energy transition that changes the source of power without transforming the social relations governing its use.

3. The Lost Seeds: Capital Accumulation and the Crisis of Ecological Reproduction

3.1. The Seed Bank: The Commodification and Monopoly of Life

In The Windup Girl, seeds are more than agricultural materials. They represent the

basic conditions for food production and the continuation of human life. In a world devastated by climate change and crop failures, control over seeds means control over the future of food supply. This is why the Thai seed bank becomes a major target for transnational corporations such as AgriGen. Anderson Lake's presence in Bangkok is not simply an attempt to introduce new energy technology through his kink-spring factory. Behind this business is his real mission: to obtain access to Thailand's valuable genetic resources and use them to strengthen AgriGen's position in the global agricultural market.

The conflict surrounding the seed bank reveals how capitalism turns the foundations of life into commodities. Seeds, which have traditionally been preserved, exchanged, and replanted, are transformed into valuable genetic property that corporations seek to control. Their value no longer lies primarily in their capacity to sustain local communities, but in their potential to generate profit through commercial breeding and technological ownership. This process reflects Jason W. Moore's account of capitalism as a system that reorganizes the web of life around accumulation (Moore, 2015). In the novel, the struggle over seeds therefore goes beyond competition between agricultural companies. It concerns who has the power to determine access to the biological resources on which society depends. By attempting to acquire Thailand's seed bank, AgriGen seeks to turn a shared basis of survival into a source of corporate advantage.

3.2. The Genetic Empire: Capital Accumulation and the Destruction of Ecological Conditions

The power of AgriGen extends beyond its control over individual seeds. Through genetic engineering, the corporation attempts to shape the biological conditions of agricultural production itself. Its genetically modified crops promise higher productivity and greater resistance to environmental pressures, yet this apparent solution also creates new forms of dependence. When agricultural production relies on corporate-controlled genetic technologies, farmers and communities become increasingly vulnerable to the companies that own and distribute them. The ability to produce food is thus separated from the communities that depend on it and placed within a commercial system.

This contradiction becomes particularly significant in the novel's representation of genetic plagues and ecological instability. The same technological system that promises to overcome crop failures also contributes to the vulnerability of the agricultural environment. Genetic manipulation does not simply repair damaged ecosystems; under the logic of corporate competition, it can intensify the risks associated with monoculture, biological control, and the pursuit of market advantage. The resulting crisis demonstrates that technological innovation cannot guarantee ecological security when it remains subordinated to capital accumulation.

James O'Connor's theory of capitalism's second contradiction helps explain this

process. O'Connor (1988) argues that capitalist production relations and productive forces may "self-destruct by impairing or destroying rather than reproducing their own conditions" (p.14). These conditions include not only labor and infrastructure but also the natural resources and ecological processes necessary for production. AgriGen's pursuit of genetic resources illustrates this contradiction: in seeking to monopolize the biological foundations of agriculture, capital threatens the ecological conditions upon which agricultural production ultimately depends.

3.3. Beyond the Genetic Empire: Ecological Commons and the Imagination of Alternative Futures

Although The Windup Girl presents a world dominated by corporate power and ecological collapse, it also leaves room to imagine alternatives. Thailand's resistance to AgriGen is particularly important. Unlike the corporations that treat genetic resources as assets for accumulation, the Thai authorities recognize the seed bank as a strategic resource connected to national survival. Their protection of it challenges the assumption that the biological foundations of life should be controlled by private companies. However, state protection alone does not necessarily establish an ecological commons. The novel leaves open the question of whether seeds can eventually be shared and managed in ways that serve communities rather than political or commercial power.

The significance of this possibility lies in a different relationship between society and nature. An ecological commons would mean treating seeds not merely as commodities or instruments of national competition, but as resources that sustain collective life. Their preservation and use would depend on cooperation, shared responsibility, and the needs of local communities. Such an arrangement would challenge the capitalist logic that turns every aspect of nature into a potential source of profit. Tschersich et al. (2023) further develop the concept of Seed Commons, arguing that collective seed initiatives can contribute to broader social-ecological transformation by challenging the dominant principles of growth, human control over nature, and specialized expertise. Their research highlights the importance of agroecology, food sovereignty, and farmers' rights in building alternative food systems. Beyond resisting corporate ownership, protecting seeds also raises the possibility of collective access to and responsibility for the biological foundations of life.

The novel does not offer a fully developed model of ecological socialism, nor does its ending resolve the wider crisis of the world it depicts. Instead, its unresolved tensions invite readers to reconsider the relationship between technological development, ownership, and ecological survival.

4. Conclusion

Through the interconnected narratives of Emiko, the Calorie Men, and the lost seeds,

The Windup Girl exposes the ecological contradictions of the Capitalocene. The novel reveals how capitalist accumulation commodifies life, reorganizes energy systems, and monopolizes the biological foundations of food production, ultimately undermining the conditions of ecological reproduction. Yet, its portrayal of resistance and alternative relationships with nature also opens up possibilities beyond corporate control. Rather than offering a definite solution, Bacigalupi invites readers to reconsider the relationship between capital, technology, and nature, suggesting that ecological survival requires a fundamental transformation of the social relations governing life.

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