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The Impact of Human Hunting Behaviour on the Evolution and Ecology of Land Mammals

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Abstract:

This paper demonstrates how human hunting has driven animal domestication and influenced the evolutionary trajectory of terrestrial ecosystems and organisms. It compares direct, selective hunting-a "super predator" signal that leads to rapid population decline and trait transformation - with indirect pressures spread through domesticated communities and wild partners, including vegetation and soil changes, greenhouse gas emissions, and pathogen transmission. The results of this paper emphasize the behavioral choices (compliance, sociality, constraint tolerance) and the welfare externalities and ecological costs of management dependence in the domestication process. The evidence also suggests that the benefits depend on the environment (such as biodiversity compatible with moderate grazing and agroforestry design). Welfare outcomes within the framework of the Anthropocene constitute a part of the human environmental footprint. The results proposed a practical comprehensive approach, which replaces single-indicator optimization with multi-objective design, while optimizing biodiversity, climate, productivity and welfare, and incorporating health monitoring into the human-machine interface of wildlife and livestock to prevent disease transmission. At the same time, it avoids selective hunting and reports animal-based indicators (such as temperament, lameness, avoidance distance) and ecosystem indicators to guide responsible management.

Keywords: Animal domestication; human hunting behavior; artificial selection; ecological impact; evolutionary trajectory.

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1. Introduction

Humans serve a dual role as apex predators and ecosystem engineers, while domesticated animals represent the direct extension and ultimate product of human hunting behavior. The shift from "hunter" to "breeder" fundamentally aimed to obtain resources like meat, milk, fur and labor—previously acquired through hunting—in a more efficient and controllable manner. Throughout history, humans have utilized nearly 15,000 vertebrate species (one-third of all vertebrates), 300 times more than other top predators' prey upon. Human hunting targets not only food but also fuels the pet trade, medicine, and entertainment, placing 40% of threatened species at risk of overexploitation [1]. This has created species entirely dependent on humans for survival, such as high-yield dairy cows and domesticated cats and domesticated dogs. What responsibilities do humans bear toward them? This responsibility extends beyond the welfare of domesticated species to include wildlife threatened by human activities. Thus, domestication is a two-way process: humans shape the evolution of domesticated animals through selection, while these animals in turn reshape human societies, economies, and even cultural practices [2].

However, existing studies often focus on either the ecological impacts of human hunting and domestication or the welfare of individual domesticated species in isolation—few have systematically linked the "dual role of humans" (apex predators and ecosystem engineers) to the definition of this responsibility, nor have they clarified how the "two-way nature of domestication" shapes the boundaries of human responsibility to both domesticated species and wild ecosystems. Against this backdrop, how should people comprehensively define human ecological and ethical responsibilities in the context of the hunting-to-domestication transition? What theoretical framework can support the construction of a mutually beneficial relationship between humans, domesticated species and nature? These questions remain to be addressed by an in-depth analysis of the historical and ecological context of domestication.

The relationship between humans and nature is not confined to exploitation or conservation alone; it can also be mutually beneficial. Understanding this new paradigm can help humans coexist harmoniously with nature, designing ecosystems where humans function as positive, beneficial components. By tracing the journey from hunting to domestication, this study reveals that humans are not gods outside nature, but rather humans within nature possessing extraordinary power. Through domestication, people have deeply inscribed cultural will into Earth's tree of life, creating unprecedented symbiotic relationships while also incurring a heavy ecological debt. This compels us to abandon anthropocentric arrogance and disillusion ourselves from romantic notions of dualistic opposition with nature. Instead, people must soberly recognize our role as the most influential agent within Earth's ecosystems and thereby shoulder the immense ecological and ethical responsibilities that accompany it. Understanding this history is not merely a retrospective; it provides a crucial mirror for how we construct a future ecosystem where humanity can function as a responsible member.

2. The Transition from Hunting to Domestication

The domestication of organisms by humans can be roughly divided into two pathways, both aimed at transforming „uncontrollable wild resources" into „stable usable resources," which is the core goal of the transition from hunting to reproduction. The first approach is based on the domestication of prey, which stems from the demand for stable food resources. It involves selecting and managing wild prey to continuously obtain products such as meat and milk, ultimately achieving complete domestication. Mitochondrial DNA analysis shows that the earliest origin of modern wild boar (Sus crofta) is located in the Southeast Asian Islands (ISEA) region, which also has the highest level of genetic diversity [3]. Therefore, researchers speculate that the ancestors of modern wild boars may have come from Southeast Asia and were scattered throughout the Eurasian continent. However, domestic pigs were not the first to be domesticated in the ISEA region. On the contrary, the domestication process occurred independently in multiple regions (such as Europe, India, and China), and the domestic pigs in each region were passed down from the local wild boar population (Sus crofta). The second approach is demand-driven directed domestication, driven by non-food needs such as transportation and the traction of labor. For example, modern horses and camels have a long history of domestication for transportation [4,5]. Humans even crossbred horses and donkeys to cultivate mules - a hybrid species specifically designed for labor due to its strength and endurance. The earliest record of human-induced crossbreeding of livestock can be traced back to Mesopotamia in the 3rd century BC: ancient people crossbred female donkeys with male Syrian wild donkeys (Hemippus) to produce „Kunga", a type of draft animal used for chariots. This case demonstrates that ancient humans systematically adopted the crossbreeding technique of horses and actively accelerated species evolution to meet their own needs[6].

Domestication is not a one-sided process of „humans taming animals"; it also involves animals reshaping human society, which is a key characteristic of its two-way

nature. For example, domesticated dogs (Canis familiaris) not only provide hunting companions and protectors for humans, but also change their hunting strategies. With the help of dogs, humans can target larger prey or hunt in more complex environments, thereby expanding their food sources and promoting the formation of larger human communities[6]. Similarly, the domestication of cattle and sheep transformed human society from nomadic hunting and gathering groups to settled agricultural communities, and the need to manage livestock drove the development of land ownership systems. The stable supply of meat and milk supported population growth and division of labor. This bidirectional interaction is also reflected in genetic coevolution, where dogs have evolved more copies of the amylase gene (AMY2B) to adapt to the starchy diet of agricultural humans [7]. On the contrary, the labor of dogs reduces human energy consumption, allowing humans to allocate more resources to the development of tools and culture. This mutual adaptation confirms that domestication is a co-evolutionary process between humans and animals, rather than unilateral manipulation[8].

3. Genetic and Physiological Adaptations Driven by Selection

Human selection pressure drives the rapid evolution of domesticated animals in terms of morphology, physiology, and behavioral characteristics. These changes are not only reflected in the phenotypic differences between domesticated animals and their wild ancestors, but also encoded within their genomes. Livestock selection typically revolves around traits related to resource output. Taking cows as an example, the DGAT1 gene, closely related to lipid synthesis, is a key target for artificial selection [9,10]. The mutation in the coding region of the DGAT1 gene is called K232A (lysine (K) replaced by alanine (A)), which directly affects milk fat content and other milk characteristics. The K allele can promote higher milk fat percentage and fat production, but it can reduce milk and protein production. The A allele can increase overall milk yield, making it the preferred allele in breeding strategies that focus on yield [9,10]. This directional selection leads to genetic differentiation between cows and their wild ancestors (such as European bison), and modern cows exhibit extreme specialization in milk production.

Dogs, as one of the earliest domesticated animals, have also undergone significant genetic adaptations due to human selection. Analysis of the genetic phylogenetic tree suggests that the mtDNA diversity of modern dogs originated from at least 51 different lineages of female wolves (possibly more), indicating that wolf domestication was a widespread cultural practice rather than an accidental event [7]. The domestication of dogs did not originate from a few randomly domesticated wolves, but involved a large-scale, culturally driven process that included hundreds of female wolves. Further genome sequencing of dogs and wolves revealed that dogs have more copies of the amylase gene (AMY2B) than wolves, which enhances their ability to digest starch. Other genes involved in starch and glucose metabolism, such as MGAM and SGLT1, also exhibit adaptability to the agricultural social dietary environment [7]. This genetic change is closely related to the transition of humans from hunting and gathering societies to agricultural societies (where grains became the staple food), confirming that human dietary habits drive genetic adaptation in dogs.

4. Behavioral Adaptation: Compliance and Human Centered Sociality

In addition to genetic and physiological characteristics, human selection also focuses on behavioral traits, especially obedience and tolerance towards human interactions, as these traits directly affect the manageability and welfare of livestock. For cows, the industry will use standardized behavioral indicators such as „flight speed/time“, „exit score“, and „avoidance/close range“ to measure their response intensity (i.e., temperament) to humans [11]. These indicators can be repeatedly measured on pastures to select cows that are less sensitive to humans. Cattle with higher levels of gentleness not only exhibit better production performance, such as lower milk production losses due to stress, but also have better welfare conditions, such as reduced risk of injury during handling [11]. In contrast, wild cattle species such as European bison have a much greater avoidance distance from humans, which reflects a lack of selection for docile traits in wild populations.

Dogs exhibit more obvious human-centered behavioral adaptation. Compared to wolves raised under the same conditions, dogs are able to understand human commands earlier and more stably. Their ability to interpret human gestures and willingness to approach humans have existed since childhood, indicating their attachment-based social patterns towards humans. Wolves, on the other hand, are more afraid of humans and are less willing to approach them, even when raised in captivity. These behavioral differences are not only caused by individual learning, but also the result of long-term choices. Humans tend to prefer wolves with weaker aggression and greater willingness to interact, ultimately leading dogs to evolve their unique social traits. This behavioral adaptation is crucial for the symbiotic relationship between dogs and humans, allowing dogs to integrate into human society as partners

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or workers.

5. Ecological Impacts of Domestication

5.1 Negative Ecological Impacts

Animal domestication has a profound impact on the global ecosystem. These impacts can be divided into negative impacts (such as vegetation degradation and biodiversity reduction) and positive impacts (such as maintaining ecosystems through moderate grazing), the direction and intensity of which depend on human management practices. Large-scale livestock grazing is the main driving factor for ecosystem degradation. Multiple model global assessments have shown that increased grazing intensity can lead to a decline in ecosystem multifunctionality, increased pressure on water and land use, and grassland degradation on a global scale [12]. Grazing not only accelerates soil erosion and changes the functional community of grassland soil microorganisms, but also weakens the activity and diversity of microbial communities related to methane oxidation and nitrification, further disrupting the nutrient cycling of grassland ecosystems [13].

Livestock are also an important source of greenhouse gas emissions, with cows, sheep, goats, and water buffaloes being among the major contributors to global methane (CH4) emissions. On a 20-year timescale, the global warming potential of methane is much higher than that of carbon dioxide, making livestock farming a key factor in climate change. In addition, the expansion of the number of livestock has created a close contact interface between wild animals, livestock, and humans, increasing the risk of transmission of zoonotic diseases such as brucellosis and avian influenza, while also exacerbating the spread of antibiotic resistance due to excessive use of antibiotics in livestock farming.

The wildification of companion animals, such as cats and dogs, poses a serious threat to wildlife, particularly in reef ecosystems. As top or secondary predators, stray cats and dogs can exert predation pressure, compete for resources, spread diseases, and even crossbreed with wild species, disrupting local food webs and reducing biodiversity. Felis catus is a typical example. They carry Toxoplasma gondii, pestis, rabies and other pathogens. About 97% of their diet is prey weighing less than 5 kg. So far, 2084 species have been recorded as prey for cats, and the impact on island ecosystems far exceeds that of continents - the number of protected species preyed upon by cats on islands is three times that of continental ecosystems. This targeted predation of endangered species has led to the extinction of several island reef endemic species, such as the Stephens Island wren, and continues to threaten fragile island reef biodiversity.

5.2 Positive Ecological Impacts of Moderate Domestication Management

Although the negative impacts of domestication are prominent, appropriate management can make domesticated animals drivers of ecosystem maintenance, especially in arid, cold, or sparsely populated areas. For example, moderate grazing can synergize with local soil and climate conditions to improve or maintain ecosystem structure. The different feeding habits and dietary preferences of cows and sheep can have varying impacts on coexisting plants, insects, and microorganisms. Compared to raising a single type of livestock, raising cattle and sheep in the same pasture can have a synergistic and complementary effect on the local vegetation structure [12].

The diversity of livestock also provides more diverse ecological niches for insects and soil organisms, and the increase in animal manure and plant litter types can alter the composition of microbial and insect communities [12]. Insects and microorganisms are key participants in organic matter decomposition and nutrient cycling, regulating important ecological processes such as pollination and soil formation. Therefore, increasing livestock diversity through mixed breeding can be a reasonable strategy for maintaining ecosystem function and environmental stability, indicating that the ecological impact of domestication is not inherently negative, but depends on human management decisions.

6. Human Ecological and Ethical Responsibilities in the Context of Domestication

6.1 Ethical Responsibility Toward Domesticated Species

The transition from hunting to domestication has made humans both creators of domesticated species and shapers of wild ecosystems. This dual role endows humans with two core responsibilities, namely ethical responsibility towards domesticated species (whose survival depends on humans) and ecological responsibility towards wild ecosystems (threatened by human activities). Domesticated species - from high-yielding cows to companion dogs - undergo genetic and behavioral changes through human selection to meet human needs, ultimately leading to their complete dependence on humans for survival. This dependence imposes an ethical obligation on humanity to safeguard its welfare, which includes three key dimensions. Firstly, avoid harmful choices. The targeted selection of pro-

duction traits (such as high milk production in cows and small body size in toy dogs) often comes at the expense of animal health. For example, choices made to increase milk production in cows can increase their risk of developing mastitis and metabolic diseases [9,10]. Choosing to give dogs extreme body sizes, such as the short snout of a bulldog, can lead to respiratory problems. Humans must abandon „single trait optimization" and adopt a „balanced selection" that balances production efficiency and animal health. Secondly, improving welfare in management. The docility and dependence of domesticated animals make them highly susceptible to adverse management measures such as overcrowding, rough handling, and malnutrition. Humans must implement welfare-friendly management measures, including optimizing feeding density to reduce stress for cows and providing sufficient exercise and social interaction to prevent behavioral disorders for dogs [7]. Standardized animal-based welfare indicators, such as the lameness score of cows and avoidance/approach distance of dogs, should be incorporated into daily management to monitor and improve welfare [11]. Finally, responsible end-of-life care. The ethical responsibility of humans extends to the end of domesticated animal life. For livestock, this means adopting humane slaughter techniques (such as pre-slaughter fainting) to minimize pain, while for companion animals, it means avoiding abandonment (which can lead to wildness) and implementing euthanasia when they are terminally ill.

6.2 Ecological Responsibility Toward Wild Ecosystems

Human activities, including hunting, livestock farming, and the wilding of companion animals, have become the main driving factors for the reduction of wildlife and the degradation of ecosystems. This imposes an ecological responsibility on humanity to mitigate these impacts and protect wildlife diversity, which includes two key actions. Firstly, to control the negative effects of domestication. For livestock, this means reducing grazing intensity to restore degraded grasslands and adopting low-emission feeding strategies (such as adding methane suppressants to cattle feed) to reduce greenhouse gas emissions[13]. For companion animals, this means taking measures to prevent wildness, such as mandatory sterilization of cats and dogs, and restricting their free movement in areas with abundant wildlife. Targeted clearance plans, such as trapping, neutering, releasing, or killing stray cats, have been proven effective in protecting endangered species in reef ecosystems where stray cats pose the greatest threat. Next is the restoration of wild ecosystems affected by domestication. Human beings must take active measures to repair the damage caused by domestication. For example, in areas where overgrazing leads to grassland degradation, rotational grazing systems and native plant restoration can help restore soil fertility and vegetation cover [12]. In addition, the „One Health" framework (integrating human health, animal welfare, and ecological conservation) provides a holistic approach to addressing challenges related to the wildlife-livestock-human interface, such as zoonotic diseases and antibiotic resistance [13].

7. Theoretical Framework and Policy Recommendations for Mutually Beneficial Coexistence

7.1 The One-Health Framework as a Core Theoretical Basis

To achieve mutually beneficial coexistence between humans, domesticated species, and nature, a clear theoretical framework is needed to guide practice, and policy measures need to be formulated to implement this framework. The „One Health" framework recognizes the interdependence of human health, animal welfare, and environmental health, making it an ideal theoretical tool for addressing domestication challenges. For example, excessive use of antibiotics in livestock farming not only damages animal health (increasing antibiotic resistance), but also threatens human health (drug-resistant bacteria are transmitted to humans through food) and damages environmental health (antibiotic-contaminated soil and water) [12]. The ‚One Health' approach addresses this issue by integrating regulations on antibiotic use in livestock farming, monitoring of drug-resistant bacteria in humans and animals, and environmental remediation, forming a comprehensive solution that benefits all three areas. Another application of the „One Health" framework is the management of wildlife-livestock interfaces. By establishing a monitoring system for zoonotic diseases (such as early detection of avian influenza in wild birds and poultry), humans can prevent disease outbreaks that harm both animals and humans, while reducing the need for large-scale culling of livestock, protecting animal welfare, and ecological stability.

7.2 Policy Recommendations for Implementing Responsible Domestication

To translate theoretical principles into practice, policy measures should focus on three key areas. Firstly, standardization is beneficial for welfare breeding and management. The government should enact regulations to restrict harmful selection behaviors (such as prohibiting the breeding of extremely large dogs) and mandate ani-

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mal-based welfare indicators for livestock farming. Incentive programs, such as providing subsidies to farms that adopt mixed farming or welfare-friendly feeding methods, can encourage farmers to improve their management practices. Secondly, controlling the wildness of companion animals. Policies should include mandatory registration, sterilization, and confinement of cats and dogs in urban and wildlife areas. In ecologically sensitive areas such as islands, reefs, and nature reserves, the government can implement targeted plans to remove stray companion animals and restore affected ecosystems. Finally, promoting transparency in the selection and harvesting practices. Due to humans playing the role of „selective super predators" in both wild hunting and domestic breeding, policies should minimize directional selection pressure in these two situations. For domestic breeding, this means requiring breeders to disclose the health risks of selected traits (such as informing consumers of the respiratory risks of flat-faced dogs) [7,11].

In addition, welfare and ecological considerations should be integrated in policy design, and animal welfare and ecological protection should be regarded as equally important constraints rather than remedial measures afterwards. For example, when formulating grazing policies, the government should consider both the impact of grazing on grassland ecosystems and the welfare of livestock [12]. When designing wildlife conservation plans, the conflict between protection and the welfare of companion animals should be resolved (such as using trapping, sterilization release instead of killing stray cats) [13].

8. Conclusion

This paper outlines humanity's shift from hunting to animal domestication, showing how human selection for production (e.g., milk yield), behavioral (e.g., docility) and physiological (e.g., starch digestion) traits drove rapid evolution in domesticates like cattle and dogs. Notably, domestication is bidirectional—it also reshaped human societies, such as enabling settled agriculture. Yet domestication brought lasting ecological impacts: large-scale livestock grazing causes vegetation degradation and greenhouse gas emissions, while feral companion animals threaten biodiversity. This, plus domestic species' total dependence on humans, makes domestication a key Anthropocene event, marking humanity's shift from an ecosystem component to a force shaping evolution and ecology. Human activity now rivals natural selection as an evolutionary driver: ensuring domestic species' welfare and protecting wild ecosystems. The One-Health framework and policies like standardized management offer solutions. Ultimately, this transition is a reminder of humanity's power and duty.

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