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Perspective

Disentangling Human Nature: Environment, Evolution and Our Existential Predicament

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Received: 24 April 2024; Accepted: 17 July 2024; Available online: 19 July 2024

ABSTRACT: Throughout our entire evolutionary history, the physical environment has played a significant role in shaping humans' subsistence adaptations. As early humans began to colonise novel biomes and construct ecological niches, their behavioural flexibility appeared as an unquestionable fact. During the Late Pleistocene-Holocene transition, the shift from foraging to farming radically altered ecosystem services, resulting in increased exposure to zoonotic pathogens and the emergence of structural inequalities that pervade our current human condition in the Anthropocene epoch. The article seeks to use an anthropological biosocial analysis to explore the diverse evolutionary paths humans have taken, which in turn shape their relationships with the natural world. Given the enigmatic nature of human behavior, it is essential to examine it holistically to understand how different subsistence patterns (e.g., intensive agriculture, foraging, and horticulture) have influenced resilience and adaptation to environmental challenges.

Keywords: Agriculture; Anthropocene; Anthropology; Evolution; Foraging; Holocene; Horticulture; Zoonoses

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1. Introduction

The physical environment has always played a determinant role throughout human evolution. Ancient hominins adapted to Plio-Pleistocene fluctuating ecosystems, exhibiting, for example, complex patterns of tool-using and carnivorous behaviour [1–10]. Nevertheless, as suggested by O'Brien et al. [11], it was early *Homo* who showed a more generalist and ecologically flexible pattern of behaviour compared with other sympatric hominins, e.g., *Paranthropus boisei*, who was an ecological specialist. The behavioural flexibility of early *Homo* to effectively adapt to a broader range of biomes and paleoenvironmental and paleoclimatic variabilities [12] likely prompted the subsequent amplification of cognitive traits (hence allowing the occupation of higher trophic levels via innovative meat-eating strategies) [13]. However, Raia et al. [14] have noted that, unlike other *Homo* species whose extinction may have been primarily driven by climate change, *H. sapiens* widened its climatic niche. Under this scenario, the recent findings concerning our earliest dispersal into Eurasia ~70–200 ka [15–19] and the interbreeding with other hominins such as *H. neanderthalensis* and Denisovans [20,21] further strengthen the view that the plasticity of the human socio-cognitive niche [22] has proven effective in penetrating Earth's ecosystems. On this basis, it is evident that this ecological flexibility has enabled our species to adapt and specialise in a wide variety of Late Pleistocene environments [23]. Humans occupying rainforests from Sri Lanka [24–26] to the Amazon [27–29] exemplify the complex patterns of human-environmental interactions exhibited during this period.Unarguably, from the Late Pleistocene of global human expansion to early urbanised societies and commercial networks, human niche construction has become the primary driver of ecosystem alterations, causing substantial rates of species extinctions and extirpations [30].

The Holocene thus marked the dawn of new socio-structural and ecological patterns whereby anthropogenic activities created the necessary conditions for agriculture, animal husbandry, the spread of zoonoses, and socio-economic inequalities [31]. It is worth remarking that before the domestication of cattle (*Bos* spp.) or swine (*Sus scrofa*) throughout the Pliocene/Pleistocene, early *Homo* began to enter the carnivore guild (primarily exhibiting scavenging patterns), which thus provided the opportunity for taeniid tapeworms circulating among carnivores (e.g., hyaenids and

https://doi.org/10.35534/natanthropol.2024.10014

felids) and bovids to contaminate hominins [32]. Notwithstanding these parasitic infections, and although the ancestors of the modern pathogens were likely present among the earliest hominins, it is unlikely that the transmission of the so-called crowd diseases (e.g., measles, influenza, and smallpox) could have occurred given the small number of individuals within their social groups [33]. It was not until the shift from foraging to farming ~12 ka [31] that anthropogenic modifications of the environment opened the window for novel human-animal interactions and the spread of zoonotic diseases; domesticated animals thus acted as conduits for human infection by wildlife pathogens [34].

Overall, due to the novel Holocene sedentary lifestyles, the rise in human population sizes and densities coupled with the intensification of plant and animal domesticates has inevitably triggered the loss of dietary breadth and the transmissibility of zoonotic pathogens [31,33,35]. This is not surprising, as the shifting of subsistence patterns from hunting and gathering to farming significantly impacted the well-being of human societies at that time. Chronologically speaking, for instance, intestinal parasites (human whipworm, *Trichuris trichiura*) have been found in a Late Mesolithic burial in Motala, Sweden, probably reflecting patterns of sedentism, crowding, and poor sanitation among the population of hunter-gatherers [36]. All these factors epitomised by the intensification of agriculture were thus significant drivers for the further transmissibility of bacterial pathogens such as *Salmonella enterica, Yersinia enterocolitica,* and *Yersinia pestis* among the Neolithic Scandinavian populations [37]. Since the Neolithic, the bacterium *Yersinia pestis* has spread across Eurasia, facilitated by the intensification of animal husbandry and human mobility [38]. In the Upper Mun River valley, northeast Thailand, King et al. [39] also reported that during the Iron Age, changes to social structure and anthropogenic disturbances of tropical forest ecosystems (from the creation of rice paddies and moat systems to the corralling of domestic animals to population growth and social inequality) were critical factors for pathogenic infections (primarily due to the close contact with stagnant water and faecal matter) and health disparities. Remarkably, *Y. pestis*, the etiological agent of The Black Death (1347–1352 CE), which spread across Eurasia and North Africa and killed half of the population of those regions, is likely to have been caused by a combination of climatic, ecological, social and economic factors such as human-rodent-flea interactions, intensive agriculture, cereal trade and military campaigns [40,41].

Therefore, the Holocene appears to have been one of the most dynamic periods of human adaptation and evolution [31]. It brought the acceleration of human dominion over nature, ranging from the European colonisation of the Americas to the nuclear explosions of the second half of the twentieth century. From these events, the Anthropocene has gained paramount importance [42] as a successive geological epoch and starting point of increasing anthropogenic alterations of Earth's sediment layers [43,44]. Consistent with this statement and in connection with the past socio-ecological processes that influenced host-pathogen dynamics, current zoonotic and vector-borne diseases are likely to be caused by human-induced alterations of ecosystems and climate change [45,46]. The new SARS-CoV-2 [47] thus reminds us that cross-species transmission depends significantly on the different modalities of human existence; our presence in the material world is, properly speaking, inextricably intertwined with other entities and hence, chaotic outcomes are highly contingent upon the quality of the human-environment interface. Zoonoses, in essence, are the by-product of the entangled and intricate relationships among humans, different animal taxa, and their econiches [48–53].

No wonder, then, the predicament of our human condition involves a wide array of socio-ecological, political, and economic factors affecting a globalised world and its endangered life forms. How could anthropological thinking help us unravel and tackle these issues? Here, we argue that anthropology's holistic nature provides an in-depth perspective fundamental to drawing inferences about human nature in connection with evolutionary history and contemporary life. Given our current global situation fraught with wars, pandemics, environmental degradation, and socio-economic inequalities, the practice of anthropological inquiry has an advantageous position in grasping conspicuous empirical realities. In short, the question of what it is to be human in connection with other existents is increasingly crucial as life complexifies due to the acceleration of neoliberalism and technoscientific innovations.

2. Anthropological Thinking and the Immersion in Life's Complexity

As we navigate across anthropological reflections about our biological and socio-ecological conditions, living amid future uncertainties strengthens the will for a better understanding of human nature. Socio-cultural anthropology, in particular, enables us to observe holistically the interconnectedness between individuals and their socio-material realities.Our discipline's uniqueness has been demonstrated through long-term ethnographic immersion since its inception. Those theoretical and methodological contributions emphasise that the complex behavioural patterns exhibited by the Trobrianders [54,55], the Nuer [56], the Tsembaga [57] and the Hadza [58] are the fabric of social relations with more-than-human others. As Evans-Pritchard [56] reported, "The Nuer do not live in an iron age or even

in a stone age, but in an age in which plants and beasts furnish technological necessities." It comes as no surprise that the physical environment shapes the different modalities of humans' subsistence strategies. In Melanesia, the Trobrianders and Tsembaga focus mainly on horticulture. Meanwhile, in East Africa, the Nuer prioritize pastoralism with some horticulture, while the Hadza predominantly rely on hunting and gathering. There is, however, a point of convergence between the different modes of socio-ecological relations exhibited by these peoples. Specifically, how the Trobrianders, the Tsembaga, the Nuer, and the Hadza interact with their local ecologies reveals adaptive behaviours whose socio-material and superstructural mechanisms range from meat-eating strategies to kula transactions to marriage rules to ritual cycles to garden magic. It became clear, then, that these societies have adjusted successfully to a wide array of biomes (i.e., lowland rainforest, montane rainforest, and savannah), showing particular ways of relating with the highly localised flora and fauna. Paradoxically, even in the Global North, the capitalist mode of production has revealed the intricate interweaving of multispecies assemblages (e.g., the relations between humans, matsutake mushrooms, *Tricholoma matsutake*, and other non-human organisms) and their embedding in wider planetary ecologies [59]. It is hardly surprising that, as far as social anthropology is concerned, the tools of natural sciences acted as referential templates to inform how individual organisms' social relations (primarily human social relationships) needed to be analysed empirically [60]. Of course, those were principally human institutions' structural and functional properties. These societal systems are, however, enmeshments of sympatric species from diverse organismic kingdoms, as in the case of totemism. These phenomena are illuminating, given the latest anthropological and philosophical interests in multispecies entanglements [53,61–67]. The analysis of ethnographic data further underpins the complexity of these human-environment interactions, reporting indigenous metaphysical principles that regard the material world as a set of relationalities [68–74].

Thus, one might speculate that foragers and horticulturalists worldwide ground their ontological and epistemological schemes through mindful negotiations and relations with ecological niches.So, why do these kinds of relationships matter significantly in anthropological thinking?

It is thus palpable that, as anthropologists, we follow the "eternal pursuit of complexities" in that sociality transcends the anthropocentric order of things [75]. This move towards holistic thinking has profound implications regarding the construction of anthropological knowledge, especially in concert with other scientific disciplines. Thus, the studies of animal culture and cognition [76–78] and plant intelligence [79–81] may very well align with the basic principles of indigenous ontologies and ecological knowledge.

For instance, hunter-gatherers and horticulturalists have reported high levels of empirical knowledge regarding the behavior and cognition of animals and plants. Among these societies, therefore, the attribution of agentive qualities to animal and plant kingdoms depends considerably on profound biosocial interactions ranging from Circumpolar peoples' meat-eating strategies to Amazonian conceptualisations of the chemosensory properties of plants [71,82,83]. These highly social and embodied activities are likely based on coevolutionary interactions, providing these societies with an empirical platform to develop complex modes of relations with the natural world.

The ethnographic examples discussed in this section have shown how modern indigenous peoples exhibit subsistence adaptations that evolved within a wide range of ecosystems. Zeller et al. [12] argue that early *Homo* adapted to different biomes utilising different types of resources, hence showing a resilient and successful strategy over hundreds of millennia. From this evolutionary perspective, contemporary hunters, gatherers, horticulturalists, and even pastoralists exhibit patterns of behaviour partially in accord with the resilience and adaptability of our ancestors. However, as the Anthropocene supersedes the Holocene, the anthropogenic changes to ecosystems (e.g., the shift from integrated agricultural practices to monocultures) have taken modern humans away from the ancient resilience pathways [12]. As such, contrary to natives' relational ecologies, the so-called modernity tries to crush any remnant of resilience and adaptiveness through harmful and invasive cultural practices eradicating species dependent on narrow niches [84] or triggering trophic cascades [85] that drastically disrupt ecosystem structure. Following this line of reasoning, it becomes evident that although humans represent a prominent destructive force of Earth's systems, this does not follow a progressive evolutionary line.

3. Resilience in the Anthropocene

As stated earlier, the practice of anthropology involves holistic thinking that bridges the gap between biological and social domains.We cannot aim to understand our current climate crises, the emergence of zoonotic diseases, mass extinction, or rising socio-economic inequality without paying close attention to our evolutionary history's ecological

and socio-cultural determinants. The Holocene might be viewed as a good starting point for appreciating the different behavioural pathways undertaken by humans.

For example, during this geological epoch, there was a significant shift in human subsistence patterns. This change triggered a series of unpredictable harmful effects that have influenced our biosocial condition [31,35]. This relationship with the environment has shaped current patterns of sedentism, population growth, host-pathogen dynamics, and socio-economic and health disparities. On the other, evidence suggests that, throughout the Holocene climate change events, some small-scale societies coped and thrived primarily due to their adaptive and flexible political and socio-eco-cosmological systems [86].

If social-cultural anthropology aims to clarify the current Anthropocene epoch, it must integrate these biosocial facts of human evolution. We can thus shed light on the variations of behavioural patterns and coevolutionary spatio-temporal dynamics of the human-environment interface. Considering these evolutionary trajectories, we can also better appreciate the mechanisms behind modern Indigenous peoples to cope with the detrimental environmental impacts of modernity. Recent archaeological evidence from the Amazon rainforest suggests, for instance, that complex settlements existed before the European invasion [87]. Levis et al. [88] have also reported structured patterns of plant domestication by Amazonian peoples. However, according to Fausto and Neves [89], domestication is likely to be a foreign concept among Amazonians precisely because human-plant interactions are essentially characterised by "familiarisation", as exemplified by the complex ecological, biosocial and ontological relations that women establish with tubers (e.g., manioc, *Manihot esculenta* Crantz) [90–93]. For example, the Shuar women of the Ecuadorian Amazon consider cultigens (primarily *Manihot esculenta* Crantz) as their children and thus show special devotion during planting, tending, and harvesting them. The ecological and biosocial relations that women establish with tubers (from the unique care of the gardens to trophic exchanges to consanguineal relations) are hence well-embedded in a mytho-cosmological and ritual structure that enable the ontological associations between biological kingdoms and immaterial beings [93]. Remarkably, Mayshar et al. [94] reported that the cultivation of appropriable cereal grains, rather than perishable food sources like tubers, was likely the primary factor for the emergence of complex hierarchies during the Neolithic Revolution. This is illuminating considering the archaeological and ethnographic evidence that posits food storage (e.g., cereal grains and acorns) as a trigger of socio-economic and political inequalities [95] that likely led to the further emergence of religious specialists [96]. One might say that, besides patterns of shifting cultivation and the biological properties of tubers, Amazonian horticulture is a holistic subsistence strategy that entails different levels of interconnected relational processes (hence highlighting the socio-ecological and metaphysical qualities of entities involved in gardening activities) and thus is thoroughly at odds with notions of complex hierarchy through appropriation. From this, we can infer that the choice between intensive agriculture and traditional foraging/horticulture, and whether societies adopt or reject these strategies, significantly impacts the current state of ecosystems and people's well-being.Traditional subsistence strategies illustrate how societies have retained, adopted, or revived more adaptive and resilient paths to address the environmental and socio-economic impacts of the Holocene-Anthropocene transition.

One of the most pivotal topics of anthropology is the attentiveness to the biosocial dimensions of life entrenched within local and global networks. That is, anthropological thinking gives us the essential means to grasp the micro-macro contemporary societal issues. The COVID-19 pandemic may, therefore, be a clear consequence of harmful behaviors that have consistently affected Earth's ecosystems.Similar to bacterial diseases that had significant impacts on Neolithic and medieval populations—like salmonellosis and the devastating Black Death—SARS-CoV-2 has shown us how zoonotic diseases swiftly spread across geographic boundaries, highlighting our biological vulnerabilities. After all, our increasingly unsustainable relationship with the natural world will likely pave the way for future pathogenic infections [97,98], posing a significant risk for humanity. Notably, in the face of these health issues coupled with the unrestrainable effects of neocolonialism and global capitalism, traditional ecological knowledge may be a valuable empirical toolkit of resilience.

In the Andes, for instance, Gallegos-Riofrío et al. [99] have reported that a heterarchical organization and local cosmovision provide the rural communities with the means for developing sustainable and resilient agri-food systems. Likewise, among the Amazonian Shuar, traditional horticultural and foraging practices have allowed these people to obtain essential carbohydrate-rich foods such as tubers and medicinal plants to deal with the detrimental effects of the COVID-19 pandemic [100]. Concerning the use of medicinal plants to combat the pandemic, for instance, similar practices have been documented among other Indigenous and traditional peoples of Amazonia [101,102], Sub-Saharan Africa [103] and the Indian Himalayan Region [104]. If for the Shuar, plant life still plays a crucial role in shaping their way of being, ranging from metaphysics to aesthetics to well-being [105,106], then the transmission of ecological knowledge must be flexible enough to withstand external pressures. Shuar ethnopharmacology, therefore, reveals

patterns of behaviour also exhibited by ancient hominins [107] and extant great apes (e.g., Sumatran orangutans, *Pongo abelii*: [108] and chimpanzees, *Pan troglodytes*: [109]) in that complex associations with plant materials provide health benefits amid specific biological circumstances.

Interestingly, recent research suggests that most indigenous knowledge of medicinal plants is linguistically unique and appears strongly associated with threatened languages; consequently, language loss would inevitably drive the extinction of medicinal knowledge [110]. It is thus essential that the transmission of language and local medicinal knowledge be preserved (see, e.g., [111,112] for ethnobotanical surveys conducted among Amazonian peoples), viz., maintaining the continuity of social learning of specific behaviours relating to medicinal plants and their linguistic nuances. These adaptive behaviours, which likely have deep roots in our evolutionary history, may operate as powerful barriers against potential pathogenic diseases and precarious health facilities.

4. Conclusions

It has been argued in this paper that complex patterns of interactions with the physical environment have permeated our entire evolutionary history. Importantly, the Pleistocene-Holocene transition prompted a radical shift in subsistence strategies, driving our species to modify Earth's ecosystems drastically. The switch from hunting and gathering to intensive farming was thus the key factor in shaping our current biosocial condition, fraught with environmental degradation, pathogenic diseases, and structural inequalities. However, despite the Anthropocene intensifying the issues mentioned earlier, there are still examples of resilience and adaptive behavior among indigenous peoples.Traditional ecological knowledge can be viewed as an empirical platform in which ancestral behavioural patterns provide the paths for mindful human-environment interactions. Specifically, indigenous foraging and horticultural practices are increasingly important, mainly because these are necessary to acquire food and medicinal plants to cope with current environmental and socio-economic precarities.

These lines of evidence must thus persuade anthropology to embrace a biosocial perspective concerning our primordial origins on Earth and the variations of our evolutionary paths within different econiches. This is a challenging commitment for socio-cultural anthropologists who primarily look at human cultural diversity, paying little attention to ecological and biological determinants. If we aim to move beyond human categories of perception [113], a compenetration of diverse scientific pursuits might elucidate how life forms relate and coevolve, forming complex multispecies assemblages. Indeed, the future of our discipline's advancements depends on a solid interdisciplinary collaboration to tackle those complicated issues in the face of biocultural destruction. In sum, our relationships with microbes and a globalised planet indicate that we are part of a chain in which microecologies and planetary ones intersect.

Ethics Statement

Not applicable.

Informed Consent Statement

Not applicable.

Funding

This research received no external funding.

Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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